Radha Krishna Temple **Waheed Consulting**

SECTION 15010

GENERAL REQUIREMENTS FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

A. The General Requirements for mechanical work are intended to be complementary to the General Requirements of the Construction Contract.

B. Work Included: Provide complete mechanical systems where shown on the drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to the following summary of work:

1. Roof Top Units for air conditioning and heating (gas);
2. Restroom Exhaust System;
3. Commercial Kitchen Exhaust and Grease Ducts for 2 Kitchens;
4. Fully functional plumbing system to accommodate the facility requirements.
5. Complete fire sprinkler system as required designed and installed by the sprinkler Contractor; and
6. Other items and services required to complete the systems.

1.2 QUALITY ASSURANCE AND APPLICABLE STANDARDS

A. Use adequate numbers of skilled workmen that are thoroughly trained and experienced in the necessary crafts and are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Without additional cost to the Owner, provide such other labor and materials as are required to complete the work of this Section in accordance with the requirements of governmental agencies having jurisdiction, regardless of whether such materials and associated labor are called for elsewhere in these Contract Documents.

C. Codes: Perform all work in accordance with the latest edition of the following codes:

1. State and city building, fire, plumbing and mechanical codes.
2. National Electrical Code.
3. National Fire Protection Association.
4. American with Disabilities Act (ADA)
5. Texas Accessibility Standards (TAS).
6. All authorities having jurisdiction.

When codes conflict, the more stringent requirements shall govern.

D. Where conflicts occur between drawings, specifications or code requirements, the most stringent requirement shall take precedence.

E. Standards: The specifications and standards of the following organizations are by reference made a part of these specifications. All work, unless otherwise indicated, shall comply with the requirements and recommendations wherever applicable:

American National Standards Institute (A.N.S.I.)
Air Conditioning and Refrigeration Institute (A.R.I.)
American Gas Association (A.G.A.)
American Society for Testing and Materials (A.S.T.M.)
American Society of Mechanical Engineers (A.S.M.E.)
American Society of Refrigeration, Heating and Air Conditioning Engineers (A.S.H.R.A.E.)
Electrical Testing Laboratories (E.T.L)
National Bureau of Standards (N.B.S)
National Electrical Manufacturer's Association (N.E.M.A.)
National Fire Protection Association (N.F.P.A.)
Sheet Metal and Air Conditioning National Association (S.M.A.C.N.A.)
Underwriters' Laboratories, Inc. (U.L.)

1.3 REQUIREMENTS OF REGULATORY AGENCIES

A. The requirements and recommendations of the latest edition of the Occupational Safety and Health Act are by reference made a part of these specifications. All work shall comply with the requirements and recommendations wherever applicable.

1.4 RELATED WORK SPECIFIED ELSEWHERE

A. All Other Sections of Divisions 15 and 16.

B. All other divisions of the contract documents. Refer to each division's specifications and drawings for all requirements

1.5 SUBMITTALS

A. Comply with pertinent provisions of Section 01340.

B. Product Data: Submit the following:

1. Materials list of items proposed to be provided under Division 15.

2. Manufacturer's specifications and other data needed to prove compliance with the specified requirements. The term "Compliance" is understood to mean that the Contractor certifies that the submitted equipment will meet or exceed the contract document requirements. Items that do not clearly meet this definition should be identified and explained as required in the following paragraph.

3. Identify the difference between the specified item or function and the proposed. Explain with enough detail so that the Engineer/Owner can easily determine that the item complies with the functional intent. List any disadvantages or advantages of the proposed item versus the specified item. Submit technical data sheets and/or pictures and diagrams to support and clarify. Organize in a clear and concise format. All substitutions shall be approved in writing by Architect. The Architect’s decision shall be final.

4. Allow a minimum of ten (10) working days for the review of submittals and each re-submittal.

5. Compliance with the Contract documents shall be the sole responsibility of the Contractor. Items on equipment that are were not accepted by the Architect in writing as an approved equal shall be replaced or revised to comply with the

contract documents at the Contractor's expense.

6. Manufacturer's recommended installation procedures which, when reviewed by the Architect, shall become the basis for accepting or rejecting actual installation procedures used on the work.

7. Sign the submittal as an indication of compliance with the contract documents. Any deviations from the contract documents, shall be indicated on the submittal prior to signing. Any deviations not indicated shall be cause for rejection and removal of the non-complying equipment at the Contractor’s expense.

C. Submittals required of materials and equipment under this section include the following:

1. Piping and Accessories Materials:

a. Clearly marked up manufacturer's data showing compliance with the specifications for:

1) Piping material proposed for each system.
2) Valves, cocks, and specialties.
3) Test and measuring devices.
4) Flexible connectors for piping.
5) Flanges.

b. l/8" scale (minimum) sanitary sewer, domestic hot and cold water, storm, and refrigerant piping shop drawings showing coordinated piping routing and arrangements with all equipment, accessories and system expansion and contraction compensation methods.

2. Vibration Isolation and Sound Control Materials:

a. Submit shop drawings showing the structural design and details of inertia bases, steel beam bases, and other custom-fabricated work not covered by manufacturer's submitted data.

b. Furnish layouts of templates to be furnished to fabricators of equipment bases, foundations, and other support systems, as needed for coordination of vibration isolation units with other work.

c. locations of units and flexible connections. Include support isolatio points for piping, air handling units, inertia bases, etc.

d. Include schedule of isolation units, showing size or manufacturer's part number, the weight supported and resulting deflection of each unit.

e. For spring isolation units, show wire size, spring diameter, free height, solid-compression height, operating height, fatigue characteristics and ratio of horizontal to vertical stiffness.

f. For spring-and-pad type isolation units, show the basis of spring rate selection for the range of loading weights.

3. Mechanical Identification Materials:

a. Clearly marked-up product literature or samples showing compliance with specified materials for:

1) Valve tagging.
2) Pipe marking.
3) Equipment marking

4. Insulation:

a. Manufacturer's certified data on thermal performance.
b. Details, when required, of methods to be used in providing for unusual piping expansion and contraction.
c. Manufacturer's product data and application information on heat tracing system including all electrical requirements.
d. Manufacturer's data on any alternate insulation material of reduced thickness, including pre-insulated pipe.
e. Manufacturer's data on all jacketing materials, sealants and fasteners.

5. Pumps:

a. Provide factory certified performance curve clearly marked with the operating point of each pump.
b. Provide manufacturer's data on all panels, accessories, and specified factory options.
c. Provide all electrical characteristics.

6. Fire Protection System:

a. Provide hydraulic calculations for all areas.
b. Provide l/8" scale piping shop drawings showing coordinated piping routing and arrangements with all accessories.
c. Provide clearly marked-up manufacturer's data showing compliance with the specifications for:

1) All required system valves and switches.
2) Sprinkler heads for all areas and sprinkler cabinet.
3) Fire pump (if used) with jockey pump and controller.
4) Fire hoses, hose valves and cabinets.
5) Fire department connection.

d. Provide all electrical characteristics.
e. Submit all hydraulic calculations and drawings to be submitted to the Authority Having Jurisdiction and obtain stamp of approval prior to submission to the Architect/Engineer.

7. Plumbing Materials:

a. Clearly marked-up manufacturer's data showing compliance with the specifications on:

1) Fixtures, carriers and all accessories.
2) Plumbing equipment.
3) Water hammer arresters.
4) Backflow preventers.
5) Trap primers
6) Tempering valves.
7) Water heaters (see Heating below).

8. Heating:

   a. Provide clearly marked-up manufacturer's data showing compliance with scheduled values and specifications for:

      1) Hot water heaters.
      2) Unit heaters.

   b. Provide all electrical characteristics.

9. Refrigeration:

   a. Provide clearly marked-up manufacturer's data showing compliance with scheduled values and specifications for:

      1) D-X condensing units.
      2) Ground mounted Roof top units.
      3) Through-the-wall air conditioning units.

   b. Provide all electrical characteristics.

10. Air Handling:

   a. Provide clearly marked-up manufacturer's data showing compliance with scheduled values and specifications for:

      1) Fan coil units.
      2) Ventilation fans.
      3) Filters.
      4) Intake/relief hoods.
      5) Wall louvers.

   b. Provide all electrical characteristics.

11. Air Distribution Materials:

   a. Provide clearly marked-up manufacturer's data showing compliance with scheduled values and specifications for:

      1) Air devices.
      2) 1/4" scale ductwork shop drawings for all systems showing equipment locations, detailed data such as bottom of duct elevations, airstream sizes, all duct accessories, and duct construction details showing compliance with SMACNA requirements for the specified duct pressure of each system.
      3) Fire dampers, fire and smoke dampers.
      4) Air terminals.

12. Controls and Instrumentation:

    a. Provide detailed shop drawings showing all components, wiring, tubing, and accessories.
    b. Provide comprehensive sequence of operation description of each control system.
    c. Provide clearly marked-up manufacturer's data showing compliance with the specifications for all products proposed.
    d. Provide all electrical characteristics of components.

13. Testing and Balancing:

    a. List of instruments to be used with latest date of calibration test for each.
    b. Brief description of test and balance contractor experience.

14. Variable Frequency Drives/Speed Controllers (VFD):

    a. Provide clearly marked-up manufacturer's data showing compliance with scheduled values and specifications.
    b. Provide electrical characteristic.

15. Record Documents: Reference the requirements detailed in this section.

16. Operation and Maintenance Data: Reference the requirements detailed in this section.

D. Resubmittals of rejected submittals shall be limited to one (1) in number. Costs for processing subsequent resubmittals in excess of the first resubmittal, resulting from the Contractor's disregard of Architect/Engineer's primary submittal rejection comments, shall be borne by the Contractor. Costs shall be based on Architect/Engineer's hourly rates as published in their current professional fee schedules and shall also include reimbursable costs for delivery, mailing, and photocopies at direct cost plus ten percent (10%).

1.6 SUBSTITUTIONS

A. The use of manufacturers' names and catalog numbers followed by the phrase "or equal" is generally used to establish a standard of quality and utility for the specified items and to provide a dimensional reference for construction documents that are drawn to scale.

B. Submittals for "equal" items shall, where applicable, include the following data which are not necessarily required for specified items:

1. Performance characteristics.
2. Materials.
3. Finish.
4. Certification of conformance with specified codes and standards.
5. Manufacturer's specifications and other data needed to prove compliance with the specified requirements. The term "Compliance" is understood to mean that the Contractor certifies that the submitted equipment will meet or exceed the contract document requirements. Items that do not clearly meet this definition should be

identified and explained as required in Paragraph 6 below.

6. Identify the difference between the specified item or function and the proposed. Explain with enough detail so that the Architect/ Engineer/Owner can easily determine that the item complies with the functional intent. List any disadvantages or advantages of the proposed item versus the specified item. Submit technical data sheets and/or pictures and diagrams to support and clarify. Include shop drawings for all piping and ductwork equipment per Paragraph 1.5 Submittals. Organize in a clear and concise format.

C. Submittals of "equal" components or systems may be rejected if:

1. The material or equipment would necessitate the alteration of any portion of the mechanical, electrical, architectural or structural design.
2. Dimensions vary from the specified material or equipment in such a manner that accessibility or clearances are impaired or the work of other trades is adversely affected.

D. Proposed substitutions for materials or equipment must be submitted ten (10) days prior to final bid date for consideration as approved equals. Otherwise, such substitutions will not be permitted. Proposals for substitutions shall be made only by the prime bidders. Manufacturers, distributors, and sub-contractors shall not make proposals to the Architect for substitutions.

E.. No substitution shall be made unless authorized in writing by the Architect. Should a substitution be accepted, and should the substitute material prove defective or otherwise unsatisfactory for the service intended, and within the guarantee period, the Contractor shall replace this material or equipment with material or equipment specified, at his own expense, and to the satisfaction of the Architect.

F. Contractors submitting bids on substitute materials and equipment must also provide a written performance guarantee certifying that the substitute materials and equipment will produce the specified effects and meet the approval of the Architect.

1.7 ORDINANCES, PERMITS, METERS, UTILITIES AND ROYALTIES

A. Procure all permits and licenses necessary for completion of this project and pay all lawful fees required and necessary pursuant in obtaining said permits and licenses. All required certificates of approvals and inspections by local governing and regulating authorities shall be obtained and paid for by the Contractor.

B. Pay all fees required for the connection of water, gas and sewer to utility mains, and any meter fees if required.

C. Pay any royalty payments required or fees for the use of patented equipment or systems. Defend all law suits or claims for infringement of any patent rights and shall hold the Owner and/or Architect/Engineer harmless from loss as a result of said suits or claims.

1.8 COMPATIBILITY OF EQUIPMENT:

A. Assume full responsibility for satisfactory operation of all component parts of the mechanical systems to assure compatibility of all equipment and performance of the integrated systems in accordance with the requirements of the specifications. Should the Contractor consider any part of the specifications or drawings as rendering his acceptance of such responsibility impossible, prohibitive, or restrictive, he shall notify the Engineer before submitting his bid, and the bid shall be accompanied by a written statement of any objections or exceptions to the specifications and drawings.

1.9 EXISTING UTILITIES AND TEMPORARY SERVICES FOR CONSTRUCTION

A. Verify the location and capacity of existing utility services pertaining to work of Division 15. Relocate existing utilities unearthed by excavation as directed by the utility service companies affected.

B. Temporary Services for Construction:

1. Provide temporary services in strict accordance with the provisions of these specifications.

1.10 EXCAVATION AND BACKFILLING

A. Perform all excavation and backfilling necessary for the installation of the work. This shall include shoring and pumping in ditches to keep them in dry condition until the work has been installed. All shoring required to protect the excavation and safeguard employees shall be properly performed.

B. Perform excavation and backfilling in strict accordance with the provisions of these specifications including trench safety requirements.

C. All excavations shall be made to the proper depth, with allowances made for floor slabs, forms, beams, etc. Ground under piping shall be well compacted before piping is installed.

D. Backfilling shall be made with selected soil, free from rocks and debris and shall be pneumatically tamped with 6 inch layers to secure a field density ratio of 95 percent as defined by ASTM Designation D698-57T (Proctor Soil Compaction Test).

E. Excavated materials not suitable and not used in the backfill shall be removed from the site.

F. Field check and verify the locations of all underground utilities. Avoid disturbing these as far as possible. In the event existing utilities are damaged, they shall be repaired at no cost to Owner.

G. In a lime stabilized area, the lime stabilization shall be fully restored after the excavation is complete.

H. Replace concrete, curbs, paving and other surface improvements cut during excavation to their original condition.

1.11 JOBSITE CONDITIONS

A. Examine the areas and conditions under which work of this Section will be performed. Include required work to correct conditions detrimental to the timely and proper completion of all Division 15 Work. Do not proceed until unsatisfactory conditions are corrected.

1.12 PREPARATION AND COORDINATION

A. Perform coordination work in strict accordance with provisions of these specifications and the following:

1. Coordinate as necessary with other trades to assure proper and adequate interface with all work.
2. Where ducts, pipes other mechanical items are shown in conflict with locations of structural members and other equipment, include labor and materials required for extensions, offsets and supports to clear the encroachment.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
4. Coordinate accepted equipment changes from those scheduled or specified with other trades affected. Additional compensation to other trades for equipment changes is the responsibility of the Contractor making the change.

B. The Mechanical Drawings are diagrammatic, but are required to be followed as closely as actual construction and work of other trades will permit. Duct and piping arrangement have been designed for maximum economy consistent with good practice and other considerations. Install the systems arranged as shown on the drawings, except as otherwise approved in advance by the Architect.

C. Data indicated on the Drawings and in these Specifications are as exact as could be secured, but their absolute accuracy is not warranted. The exact locations, distances, levels, and other conditions will be governed by actual construction and the Drawings and Specifications should be used only for guidance in such regard.

D. Where items such as diffusers, thermostats, switches, and control panels are not specifically located on the Drawings, locate as determined in the field by the Architect. Where such items are installed without such specific direction, relocate as directed by the Architect and at no additional cost to the Owner.

E. Verify all dimensions and distances. No additional compensation will be allowed because of differences between work shown on the Drawings and actual dimensions and distances at the jobsite.

1.13 CONSTRUCTION REQUIREMENTS

A. The drawings show the arrangements of work. Should project conditions necessitate rearrangement, or if the materials or equipment can be installed to a better advantage in a different manner, the Contractor shall, before proceeding with the work, prepare and submit five copies of Drawings of the proposed arrangement for the Architect’s review. Allow a minimum of ten (10) working days for review.

B. Should the Contractor propose to install equipment requiring space conditions other than those shown, or rearrange the equipment, he shall assume responsibility for the rearrangement of the space and shall have the Architect review the change before proceeding with the work. The request for such changes shall be accompanied by shop drawings of the space in question. Identify monetary credits proposed or other benefits of the change. Allow a minimum of ten (10) working days for review.

C. The Contractor shall be responsible for the proper location and size of all slots, holes or openings in the building structure pertaining to his work and for the correct location of pipe sleeves.

1.14 CUTTING AND PATCHING

A. Perform cutting and patching associated with the work in strict accordance with the provisions of Division 1 of these Specifications and the following:

1. Coordinate work to minimize cutting and patching work.
2. Request for Architect's consent:

    a. Prior to cutting or coring of the building structure, submit a written request to the Architect for permission to proceed with cutting. Include x-rays of any floor area where cutting or coring is proposed.
    b. Contractor is cautioned that concrete floor contain steel tendons which can not be cut or damaged.

3. Perform Architect-approved cutting and demolition by methods which will prevent damage to other portions of the work and provide proper surfaces to receive installation of new work and/or repair.
4. Perform fitting and adjusting of products to provide finished installation complying with the specified tolerances and finishes.
5. Provide all core drilling of holes. Where sleeves and/or blockouts are required, they shall be cut or provided at locations required. On completion of this work or as work progresses, make all repairs and do all patching required as a result of work under this Contract. All patching shall be performed in a manner that will restore the surrounding work to its original condition to the satisfaction of the Architect.
6. Assume responsibility for the proper size of all sleeves and/or blockouts in the building structure pertaining to the work and for providing the correct location of pipe sleeves and/or blockouts.
7. Where openings are cut through masonry walls, provide lintels or structural supports to protect the remaining masonry. Adequate support shall be provided during the cutting operation to prevent any damage to the affected masonry.

1.15 PROJECT RECORD DOCUMENTS

A. Provide the record documents associated with the work of Division 15 in strict accordance with the provisions of these specifications.

B. Throughout progress of the Division 15 Work, maintain an accurate record of changes in the Contract Documents that apply to work of Division 15. Changes shall include all addendums issued during bidding. Maintain an accurate record of the location of mechanical service lines and outlets and all outside utilities.

C. Delegate the responsibility for maintenance of Record Documents to one person on the Contractor's staff.

D. Accuracy of Records:

1. Thoroughly coordinate changes within the Record Documents, making adequate and proper entries on each page of Specifications and each sheet of drawings and other documents where such entry is required to show the change properly. Match the symbology and format of the base documents.
2. Accuracy of records shall be such that a future verification of items shown in the Contract Documents may rely reasonably on information obtained from the approved Project Record Documents.

E. Maintain the job set of Record Documents completely protected from deterioration and from loss and damage until completion of the work and transfer of all recorded data to the final Project Record Documents.

F. Making Entries on Drawings:

1. Using an erasable colored pencil (not ink or indelible pencil), clearly describe the change by graphic line and note as required.
2. Date all entries.
3. Call attention to the entry by a "cloud" drawn around the area or areas affected.
4. In the event of overlapping changes, use different colors for the overlapping changes.
5. Make entries within 24 hours after receipt of information that the change has occurred.
6. Maintain the base drawing format and use the same symbology.
7. Convert field mark-ups to finished CADD record drawings when required in this section.

G. Conversion of Schematic Layouts:

1. In some cases on the drawings, arrangements of ductwork and piping and similar items are shown schematically and are not intended to portray precise physical layout. Determine final physical arrangement subject to the Architect's approval. However, design of future modifications of the facility may require accurate information as to the final physical layout of items which are shown only schematically on the drawings.
2. Show on the job set of record drawings, by dimension accurate to within one inch, the centerline of each run of items such as all sleeves and piping, etc., below grade, in walls, or in the concrete slab. A surface mounted device indicates the exact location:

    a. Clearly identify the item by accurate note such as "Sanitary Sewer " and the like.

    b. Show, by symbol or note, the vertical location of the item "under slab," "in ceiling plenum," "exposed," and the like.

    c. Make all identification sufficiently descriptive that it may be related reliably to the specifications.

H. Final Project Record Documents:

1. The purpose of the final Project Record Documents is to provide factual information regarding all aspects of the Work, both concealed and visible, to enable future modification of the Work to proceed without lengthy and expensive site measurement, investigation, and examination.
2. Provide CADD Electronic files in .DWG format. Upon written request by the Contractor, the Engineer will provide AutoCADD electronic files of the base contract drawings in .DWG format at no cost to the Contractor. Engineer will also provide a list of drawing layers and names that shall be maintained in the record set prepared by the Contractor

1.16 OPERATION AND MAINTENANCE DATA

A. Submit two (2) copies of a preliminary draft of the proposed manual or manuals to the Architect for review and comments. Allow a minimum of ten (10) working days for review.

B. Submit specified number copies of the approved manual to the Architect prior to indoctrination of operation and maintenance personnel.

C. Prepare in accordance with the following:

Format:	
Size:	8½" x 11"
Paper:	White bond, at least 20 lb. weight
Text:	Neatly written or printed
Drawings:	11" in height preferable; bind in with text; foldout acceptable;

larger drawings acceptable but fold to fit within the Manual and provide a drawing pocket inside rear cover or bind in with text.

Flysheets: Separate each section of the Manual with neatly prepared flysheets briefly describing contents of the ensuing section; flysheets may be in color.

Binding: Use heavy-duty plastic or fiber-board covers with binding mechanism concealed inside the manual; 3-ring binders will be acceptable; all binding is subject to the Architect's approval.

Measurements: Provide all measurements in U.S. standard units such as feet-and-inches, lbs, and cfm. Where items may be expected to be measured within ten years in accordance with metric formulae, provide additional measurements in the "International System of Units" (SI).

D. Provide front and back covers for each manual, using durable material approved by the Architect, and clearly identified on or through the cover with at least the following information:

OPERATING AND MAINTENANCE INSTRUCTIONS

Name and Address of Work

Name of Contractor

General subject of this manual

Space for approval signature of the engineer and approval date

E. Contents: Include at least the following:

1. Neatly typewritten index near the front of the manual, giving immediate information as to location within the manual of all emergency information regarding the installation.
2. Complete instructions regarding operation and maintenance of all equipment provided including lubrication, disassembly, and reassembly.
3. Complete nomenclature of all parts of all equipment.
4. Complete nomenclature and part number of all replaceable parts, name and address of nearest vendor, and all other data pertinent to procurement procedures.
5. Copy of all guarantees and warranties issued.
6. Manufacturer's bulletins, drawings, and descriptive data, clearly indicating the precise items included in this installation and deleting, or otherwise clearly indicating, all manufacturers' data with which this installation is not concerned.
7. Such other data as required in other sections of these specifications.

1.17 EQUIPMENT FOUNDATIONS

A. Provide equipment foundations associated with the work in accordance with the provisions of these specifications.

B. Provide concrete bases for all pad or floor mounted equipment. Bases shall be four inches (4") high above finished floors or grades (unless otherwise noted) and shall protrude two inches (2") beyond all sides of equipment and shall have exposed chamfered edges. Construct bases from ready-mixed hardrock concrete, ASTM C94, reinforced with #3 rebars, ASTM A615, Grade 40, at 18" on center each way.

C. Field verify exact location of outdoor pad mounted equipment with the Architect. Supply necessary fill and grade site to provide natural drainage away from equipment.

1.18 PAINTING

A. All equipment shall be delivered to the job with suitable factory finish. Should the finish be damaged in transit or during the installation, it shall be finished to match appearance of original finish. All work shall be subject to approval by Architect.

1.19 TESTING AND INSPECTION

A. Provide personnel and equipment, make required tests, and secure required approvals from the Architect and governmental agencies having jurisdiction.

B. Make written notice to the Architect adequately in advance of each of the following stages of construction:

1. When all rough-in is complete, but not covered;
2. As specified in all Division 15 sections.
3. At the completion of the work of Division 15.

C. When material or workmanship is found to not comply with the specified requirements, remove the noncomplying items from the job site and replace them with items complying with the specified requirements at no additional cost to the Owner. This shall be performed within 3 days after receipt of written notice of noncompliance.

1.20 WARRANTY

A. Contractor shall warranty all equipment and workmanship for a period of one (1) year after date of substantial completion and replace or repair any faulty equipment or installation at no cost to the Owner for such service during this period, all in accordance with requirements of Division 1.

B. This warranty shall not void specific warranties issued by manufacturers for greater periods of time. Nor shall it void any rights guaranteed to the Owner by law.

C. Warranties shall be in writing in a form satisfactory to the Owner, and shall be delivered to the Owner before final payment is made.

1.21 PROJECT COMPLETION

A. Upon completion of the work of Division 15, thoroughly clean all exposed portions of the mechanical installation, removing all traces of soil, labels, grease, oil and other foreign material and using only the type cleaner recommended by the manufacturer of the item being cleaned.

END OF SECTION 15010

I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

J. Insulated Piping: Comply with the following:

1. Attach clamps and spacers to piping.

    a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
    c. Do not exceed pipe stress limits according to ASME B31.9.

2. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
3. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
4. Shield Dimensions for Pipe: Not less than the following:

    a. NPS 1/4 to NPS 3-1/2 (DN8 to DN90): 12 inches long and 0.048 inch thick.
    b. NPS 4 (DN100): 12 inches long and 0.06 inch thick.

5. Insert Material: Length at least as long as protective shield.

3.3 EQUIPMENT SUPPORTS

A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

B. Grouting: Place grout under supports for equipment and make smooth bearing surface.

C. Prime and Paint Equipment Supports as specified in Section 09900 “Paints and Coatings”.

3.4 METAL FABRICATION

A. Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes 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 Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

3.6 PAINTING

A. Touching Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 09900 “Paints and Coatings”.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780

END OF SECTION 15060

SECTION 15070

MECHANICAL SOUND, VIBRATION AND SEISMIC CONTROL

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vibration Isolators.
2. Seismic Controls.
3. Vibration Isolation Bases.

B. Related Sections:

1. Section 03300 - Cast-In-Place Concrete
2. Section 09900 - Paints and Coatings
3. Section 15050 - Basic Mechanical Materials and Methods
4. Section 15060 - Hangers and Supports: for pipe hanger restraints.
5. Section 15815 - Metal Ducts: for flexible duct connectors.
6. Division 15 piping Sections for flexible pipe connectors.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following suporting data:

1. Product Data: Indicate types, styles, materials, and finishes for each type of isolator specified. Include load deflection curves.

B. Shop Drawings: Show designs and calculations, certified by a professional engineer, as required by the local authority, for the following:

1. Design Calculations: Calculations for selection of vibration isolators, design of vibration isolation bases, and selection of seismic restraints.
2. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to the structure and to the supported equipment. Include auxiliary motor slides and rails, and base weights.
3. Seismic Restraint Details: Detail fabrication and attachment of restraints and snubbers.

1.3 PROJECT CONDITIONS

A. Project seismic zone is 2B with a zone factor of 0.20.

1.4 COORDINATION

A. Coordinate layout and installation of vibration isolation and seismic-restraint devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of concrete housekeeping and vibration isolation bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Sections.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. B-Line Systems, Inc. (618-654-2184)
2. Kinetics Noise Control, Inc. (614-889-0480)
3. Mason Industries, Inc. (516-348-0282)

2.2 VIBRATION ISOLATORS

A. Isolator Pads: Oil and water resistant and factory cut to sizes that match requirements of the equipment supported.

1. Rubber Isolator Pads: Elastomer (neoprene or silicone) arranged in single or multiple layers and molded with a nonslip pattern and steel baseplates of sufficient stiffness to provide uniform loading over the pad area.
2. Load Range: From 10 to 50 psig and a deflection not less than 0.08 inch per 1 inch of thickness. Do not exceed a loading of 50 psig.

B. Rubber Isolator Mounts: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements, with encapsulated top- and baseplates. Factory-drilled and tapped top plate for bolted equipment mounting. Factory-drilled baseplate for bolted connection to structure. Color-code to indicate capacity range.

C. Rubber Hangers: Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements bonded to formed-steel housings with threaded connections for hanger rods. Color-code to indicate capacity range.

D. Spring Hangers: Combination spring and elastomeric hanger with coil spring and elastomeric insert in compression.

1. Frame: Formed steel, fabricated for connection to threaded rods and to allow for 30 degrees of angular hanger rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
5. Finishes: Baked enamel for metal components. Color-code to indicate capacity range.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install and anchor vibration-, sound-, and seismic-control products according to manufacturer's written instructions and authorities having jurisdiction.

B. Anchor interior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural floors as required by authorities having jurisdiction.

C. Anchor exterior mounts, isolators, hangers, and snubbers to vibration isolation bases. Bolt isolator baseplates to structural supports as required by authorities having jurisdiction.

D. Install pipe connectors at connections for equipment supported on vibration isolators.

END OF SECTION 15070

SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Identifying Devices and Labels

B. Related Sections:

1. Section 15050 - Basic Mechanical Materials And Methods.

1.2 SUBMITTALS

A. Product Data: For identification materials and devices.

B. Samples: Of color, lettering style, and graphic representation required for each identification material and device.

1.3 QUALITY ASSURANCE

A. Comply with ASME A13.1, "Scheme for the Identification of Piping Systems" for lettering size, length of color field, colors, and viewing angles of identification devices.

1.4 SEQUENCING AND SCHEDULING

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 IDENTIFYING DEVICES AND LABELS

A. General: Products specified are for applications referenced in other Division 15 Sections. If more than single type is specified for listed applications, selection is Installer's option.

B. Pipes Including Insulation: Full-band pipe markers, extending 360 degrees around pipe at each location.

C. Lettering: Manufacturer's standard preprinted captions as selected by Owner's Representative.

D. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering, to accommodate both directions, or as separate unit, on each pipe marker to indicate direction of flow.

E. Plastic Duct Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cold-air supply.
2. Yellow: Hot-air supply.
3. Blue: Exhaust, outside, return, and mixed air.
4. Terminology: Include direction of airflow; duct service such as supply, return, and exhaust; duct origin, duct destination, and design flow.

F. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive, vinyl tape, at least 3 mils thick.

1. Width: 1-1/2 inches on pipes with OD, including insulation, less than 6 inches; 2-1/2 inches for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

G. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch sequenced numbers. Include 5/32-inch hole for fastener.

1. Material: 0.032-inch thick, polished brass.
2. Size: 1-1/2-inches diameter, unless otherwise indicated.

H. Valve Tag Fasteners: Brass, wire-link chain and S-hooks.

I. Access Panel Markers: 1/16-inch thick, engraved plastic-laminate markers, with abbreviated terms and numbers corresponding to concealed valve. Provide 1/8-inch center hole for attachment.

J. Valve Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include screws.

1. Frame: Extruded aluminum.
2. Glazing: ASTM C 1036, Type I, Class 1, Glazing quality B, 2.5-mm, single-thickness glass.

K. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

1. Multiple Systems: Identify individual system number and service if multiple systems of same name are indicated.

PART 3 EXECUTION

3.1 LABELING AND IDENTIFYING PIPING SYSTEMS

A. Install pipe markers on each system as indicated below. Include arrows showing normal direction of flow.

1. Domestic Cold Water.
2. Domestic Hot Water.
3. Domestic Hot Water Return.
4. Gas.

5. Sanitary Drain.
6. Storm Drain.
7. Condensate.
8. Vent.

B. Marker Type: Plastic markers, with application systems. Install on pipe insulation segment where required for hot, noninsulated pipes.

C. Fasten markers on pipes and insulated pipes by one of following methods:

1. Snap-on application of pretensioned, semirigid plastic pipe marker.

D. Locate pipe markers where piping is exposed in machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior nonconcealed locations according to the following:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch, where flow pattern is not obvious.
3. Near penetrations through walls, floors, ceilings, or nonaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

3.2 VALVE TAGS

A. Install on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, plumbing fixture supply stops, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in valve schedule.

B. Tag Material: Brass.

C. Tag Size and Shape: According to the following:

1. Cold Water: 1-1/2 inches round.
2. Hot Water: 1-1/2 inches round.
3. Gas: 1-1/2 inches round.

D. Install framed valve schedule in each major mechanical equipment room.

E. Valve schedule and tag locations shall be shown on record drawings.

3.3 LABELING AND IDENTIFYING DUCT SYSTEMS.

A. Duct Systems: Identify air supply, return, exhaust, intake, and relief ducts with duct markers; or provide stenciled signs and arrows showing service and direction of flow.

1. Location: Locate signs near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.4 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices that have become visually blocked by work of this or other Divisions.

B. Clean faces of identification devices and glass frames of valve charts

END OF SECTION 15075

SECTION 15081

DUCT INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials
2. Jackets
3. Accessories and Attachments
4. Vapor Retarders

B. Related Sections:

1. Section 07840 - Firestopping: Firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Section 15083 - Pipe Insulation: For insulation for piping systems.
3. Section 15815 - Metal Ducts: For duct liner.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data:

a. Identify thermal conductivity, thickness, and jackets (both factory and field applied) for each type of product indicated.

2. Shop Drawings:

a. Submit manufacturer’s data for each type of insulation used.

1.3 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or similar industry recognized craft training program.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate clearance requirements with duct Installer for insulation application.

1.6 SCHEDULING

A. Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Mineral-Fiber Insulation:

a. CertainTeed Corp. (610-647-3011)
b. Knauf FiberGlass GmbH (800-825-4434)
c. Owens-Corning Fiberglas Corp. (800-438-7465)

2.2 INSULATION MATERIALS

A. Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

B. Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

C. Calcium Silicate Insulation: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a nonasbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.

1. Tape Width: 4 inches.

B. Bands: 3/4 inch wide, in one of the following materials compatible with jacket:

1. Galvanized Steel: 0.005 inch thick.

C. Wire: 0.080-inch, nickel-copper alloy; 0.062-inch, soft-annealed, stainless steel; or 0.062-inch, soft-annealed, galvanized steel.

D. Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.

1. Welded Pin Holding Capacity: 100 lb for direct pull perpendicular to the attached surface.

E. Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

1. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb for direct pull perpendicular to the adhered surface.

F. Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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 APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply multiple layers of insulation with longitudinal and end seams staggered.

E. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

F. Keep insulation materials dry during application and finishing.

G. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

H. Apply insulation with the least number of joints practical.

I. Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

J. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

K. Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

L. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
3. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

M. Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

N. Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.

1. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
2. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

O. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and partitions, except fire-rated walls and partitions.

P. Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire/smoke damper sleeves for fire-rated wall and partition penetrations.

Q. Floor Penetrations: Terminate insulation at underside of floor assembly and at floor support at top of floor.

1. For insulation indicated to have vapor retarders, taper termination and seal insulation ends with vapor-retarder mastic.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions 18 inches and smaller, 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 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.

4. Impale insulation over anchors and attach speed washers.
5. 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.
6. 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 segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
7. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches o.c.
8. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
10. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

B. Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per square foot, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Space anchor pins as follows:

    a. On duct sides with dimensions 18 inches and smaller, 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 16 inches o.c. each way, and 3 inches maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
    c. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

d. Do not overcompress insulation during installation.

4. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. 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 segment with 1/2-inch staples, 1 inch o.c., and cover with pressure-sensitive tape having same facing as insulation.
6. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply 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 the insulation surface with 6-inch wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches o.c.
8. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

3.5 FIELD-APPLIED JACKET APPLICATION

A. Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

1. Apply 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 jacket manufacturer's recommended adhesive.
3. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

3.6 DUCT SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

C. Insulate the following plenums and duct systems:

1. Indoor concealed supply-, return-, and outside-air ductwork.
2. Indoor concealed range-hood exhaust ductwork.

D. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Metal ducts with duct liner, unless noted otherwise.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums, casings, and filter boxes and sections, unless noted otherwise.
4. Flexible connectors.
5. Vibration-control devices.
6. Testing agency labels and stamps.
7. Nameplates and data plates.
8. Access panels and doors in air-distribution systems.

3.7 INDOOR DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Round and rectangular, supply-air ducts, concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 1-1/2 inches.
3. Number of Layers: One.
4. Minimum installed R-Value: 4.2
5. Vapor Retarder Required: Yes.

B. Service: Round and rectangular, return-air ducts, concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 1-1/2 inches.
3. Number of Layers: One.
4. Minimum installed R-Value: 4.2
5. Vapor Retarder Required: Yes.

C. Service: Round and rectangular, outside-air ducts, concealed.

1. Material: Mineral-fiber blanket.
2. Thickness: 1-1/2 inches.
3. Number of Layers: One.
4. Minimum installed R-Value: 4.2
5. Vapor Retarder Required: Yes.

D. Service: Round and rectangular, outside-air ducts, exposed.

1. Material: Mineral-fiber blanket.
2. Thickness: 1-1/2 inches.
3. Number of Layers: One.
4. Minimum installed R-Value: 4.2
5. Vapor Retarder Required: Yes.

3.8 ATTIC DUCT AND PLENUM APPLICATION SCHEDULE

A. Service: Round and rectangular, supply-air, return-air, and outside-air ducts.

1. Material: Mineral fiber blanket.
2. Thickness: 3 inches.
3. Number of Layers: One.

END OF SECTION 15081

SECTION 15083

PIPE INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Insulation Materials
2. Jackets
3. Accessories and Attachments
4. Vapor Retarders

B. Related Sections:

1. Section 07840 - Firestopping: Firestopping materials and requirements for penetrations through fire and smoke barriers.
2. Section 15060 - Hangers and Supports: For pipe insulation shields and protection saddles.
3. Section 15081 - Duct Insulation: For insulation for ducts and plenums.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

2. Shop Drawings:

a. Submit Manufactures data for each type of insulation used.
b. Application of field-applied jackets.

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or similar industry recognized craft training program.

B. Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
2. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

1.4 STORAGE, AND HANDLING

A. Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

1.5 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 15 Section 15060 "Hangers and Supports."

B. Coordinate clearance requirements with piping Installer for insulation application.

C. Coordinate installation and testing of electric heat tracing.

1.6 SCHEDULING

A. Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Mineral-Fiber Insulation:

    a. CertainTeed Corp. (610-647-3011)
    b. Knauf Fiber Glass GmbH.(800-825-4434)
    c. Owens-Corning Fiberglas Corp.(800-438-7465)

2. Flexible Elastomeric Thermal Insulation:
3.

    a. Armstrong World Industries, Inc.(800-448-1405)
    b. Rubatex Corp.(800-782-2839)

2.2 INSULATION MATERIALS

A. Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

1. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
2. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
3. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:

    a. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
    b. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.

4. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
5. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
6. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
7. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

B. Flexible Elastomeric Thermal Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Adhesive: As recommended by insulation material manufacturer.
2. Ultraviolet-Protective Coating: As recommended by insulation manufacturer.

C. Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

2.3 FIELD-APPLIED JACKETS

A. General: ASTM C 921, Type 1, unless otherwise indicated.

B. Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

C. PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils thick; roll stock ready for shop or field cutting and forming.

1. Adhesive: As recommended by insulation material manufacturer.
2. PVC Jacket Color: White or gray.
3. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.

D. Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil-thick, high-impact, ultraviolet-resistant PVC.

1. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
2. Adhesive: As recommended by insulation material manufacturer.

2.4 ACCESSORIES AND ATTACHMENTS

A. Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd.

1. Tape Width: 4 inches.

2.5 VAPOR RETARDERS

A. Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

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

3.2 PREPARATION

A. Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

3.3 GENERAL APPLICATION REQUIREMENTS

A. Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

B. Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

C. Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

E. Apply 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. Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

H. Keep insulation materials dry during application and finishing.

I. Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

J. Apply insulation with the least number of joints practical.

K. Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

L. Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

1. Apply insulation continuously through hangers and around anchor attachments.
2. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
3. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

M. Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

N. Apply adhesives and mastics at the manufacturer's recommended coverage rate.

O. Apply insulation with integral jackets as follows:

1. Pull jacket tight and smooth.
2. Circumferential Joints: Cover with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches o.c.
3. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches. Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.

    a. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.

4. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
5. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

P. Roof Penetrations: Apply insulation for interior applications to a point even with top of roof flashing.

1. Seal penetrations with vapor-retarder mastic.
2. Apply insulation for exterior applications tightly joined to interior insulation ends.
3. Extend metal jacket of exterior insulation outside roof flashing at least 2 inches below top of roof flashing.
4. Seal metal jacket to roof flashing with vapor-retarder mastic.

Q. Exterior Wall Penetrations: For penetrations of below-grade exterior walls, terminate insulation flush with mechanical sleeve seal. Seal terminations with vapor-retarder mastic.

R. Interior Wall and Partition Penetrations: Apply insulation continuously through walls and floors.

S. Fire-Rated Wall and Partition Penetrations: Apply insulation continuously through penetrations of fire-rated walls and partitions.

1. Firestopping and fire-resistive joint sealers are specified in Section 07840 "Firestopping."

T. Floor Penetrations: Apply insulation continuously through floor assembly.

1. For insulation with vapor retarders, seal insulation with vapor-retarder mastic where floor supports penetrate vapor retarder.

3.4 MINERAL-FIBER INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.

2. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet to form a vapor retarder between pipe insulation segments.
3. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

B. Apply insulation to flanges as follows:

1. Apply preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch and seal joints with vapor-retarder mastic.

C. Apply insulation to fittings and elbows as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire, tape, or bands.
3. Cover fittings with standard PVC fitting covers.

D. Apply insulation to valves and specialties as follows:

1. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
3. Apply insulation to flanges as specified for flange insulation application.
4. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

3.5 FLEXIBLE ELASTOMERIC THERMAL INSULATION APPLICATION

A. Apply insulation to straight pipes and tubes as follows:

1. Follow manufacturer's written instructions for applying insulation.
2. Seal longitudinal seams and end joints with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

B. Apply insulation to flanges as follows:

1. Apply pipe insulation to outer diameter of pipe flange.
2. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the 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 the same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

C. Apply insulation to fittings and elbows as follows:

1. Apply mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

D. Apply insulation to valves and specialties as follows:

1. Apply preformed valve covers manufactured of the same material as pipe insulation and attached according to the manufacturer's written instructions.
2. Apply cut segments of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, fabricate removable sections of insulation arranged to allow access to stainer basket.
3. Apply insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive. Cement to avoid openings in insulation that will allow passage of air to the pipe surface.

3.6 PIPING SYSTEM APPLICATIONS

A. Insulation materials and thicknesses are specified in schedules at the end of this Section.

B. Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

1. Flexible connectors.
2. Vibration-control devices.
3. Fire-suppression piping.
4. Below-grade piping, unless otherwise indicated.
5. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

3.7 FIELD QUALITY CONTROL

A. Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

B. Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

3.8 INSULATION APPLICATION SCHEDULE, GENERAL

A. Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

B. Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

3.9 INTERIOR INSULATION APPLICATION SCHEDULE

A. Service: Domestic cold water, hot and recirculated hot water, and condensate drains.

1. Operating Temperature: 60 to 140 deg F.
2. Insulation Material: Mineral fiber with jacket.
3. Insulation Thickness: Apply the following insulation thickness:

a. Copper Pipe, ALL sizes: ½".

4. Field-Applied Jacket: None.
5. Vapor Retarder Required: Yes.
6. Finish: None.

B. Service: Exposed sanitary drains and domestic water supplies and stops for fixtures for the disabled.

1. "Lav-Guard" as Manufaturer by Truebro.
2. Field-Applied Jacket: PVC P-trap and supply covers.
3. Vapor Retarder Required: No.
4. Finish: White.

C. Service: Refrigerant suction.

1. Operating Temperature: 35 to 50 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: Apply the following insulation thicknesses:

a. Copper Pipe ALL sizes: 1".

4. Field-Applied Jacket: None.
5. Vapor Retarder Required: No.
6. Finish: None.

3.10 EXTERIOR INSULATION APPLICATION SCHEDULE

A. This application schedule is for above ground insulation outside the building. Loose-fill insulation, for below ground piping, is specified in Division 2 piping distribution Sections.

B. Service: Refrigerant suction.

1. Operating Temperature: 35 to 50 deg F.
2. Insulation Material: Flexible elastomeric.
3. Insulation Thickness: Apply the following insulation thicknesses:

a. Copper Pipe, ALL sizes: ½".

b. PVC pipe, All sizes: ½"

END OF SECTION 15083

SECTION 15090

MOTORS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Basic Motor Requirements
2. Polyphase Motors
3. Single Phase Motors

B. Related Sections:

1. Division 15 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data:Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

1.3 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Listing and Labeling: Provide motors specified in this Section that are listed and labeled.

1. Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.

PART 2 PRODUCTS

2.1 BASIC MOTOR REQUIREMENTS

A. Basic requirements apply to mechanical equipment motors, unless otherwise indicated.

B. Motors 1/2 HP and Larger: Polyphase.

C. Motors Smaller than 1/2 HP: Single phase.

D. Frequency Rating: 60 Hz.

E. Voltage Rating: Determined by voltage of circuit to which motor is connected.

F. Service Factor: According to NEMA MG 1, general purpose continuous duty, design type “B.”

G. Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

H. Enclosure: Open dripproof, unless otherwise indicated.

I. Efficiency: Motors shall have a higher efficiency rating than industry standard average motor as delineated in IEEE Standard 112, Test Method 13.

2.2 POLYPHASE MOTORS

A. Description: NEMA MG 1, medium induction motor.

1. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
2. Energy-Efficient Design: Where indicated.
3. Stator: Copper windings, unless otherwise indicated. Multispeed motors have separate winding for each speed.
4. Rotor: Squirrel cage, unless otherwise indicated.
5. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.
6. Temperature Rise: Match insulation rating, unless otherwise indicated.
7. Insulation: Class F, unless otherwise indicated.

B. Source Quality Control: Perform the following routine tests according to NEMA MG 1:

1. Measurement of winding resistance.
2. No-load readings of current and speed at rated voltage and frequency.
3. Locked rotor current at rated frequency.
4. High-potential test.
5. Alignment.

2.3 SINGLE-PHASE MOTORS

A. Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.

1. Permanent-split capacitor.
2. Split-phase start, capacitor run.
3. Capacitor start, capacitor run.

B. Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.

C. Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.

D. Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.

PART 3 EXECUTION

3.1 ADJUSTING

A. Use adjustable motor mounting bases for belt-driven motors.

B. Align pulleys and install belts.

C. Tension according to manufacturer's written instructions.

END OF SECTION 15090

SECTION 15110

VALVES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Valves.

B. Related Sections:

1. Division 15 Piping System Sections: Special purpose valves

2. Section 15075 - Mechanical Identification: For valve tags and charts.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.
2. Maintenance data for valves to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility: Comply with the requirements specified in Division 1 Section 01600 "Materials and Equipment". Provide all valves of the same manufacturer where possible.

B. ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

C. MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

1.4 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 globe and gate valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store indoors and maintain valve temperature higher than ambient dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Ball Valves and Gate Valves:

a. Hammond Valve Corporation (800-348-6544)
b. Milwaukee Valve Company, Inc. (414-744-5240)
c. NIBCO Inc. (219-295-3000)

2. Balancing Valves:

a. Victaulic Tour and Anderson (215-252-6400)
b. Hays Fluid Controls (800-354-4297)

3. Check Valves:

a. Crane Company; Valves and Fitting Division (800-323-3679)
b. Hammond Valve Corporation (800-348-6544)
c. Milwaukee Valve Company, Inc. (414-744-5240)
d. NIBCO Inc. (219-295-3000)

2.2 BASIC, COMMON FEATURES

A. Design: Rising stem or rising outside screw and yoke stems, except as specified below.

1. Nonrising stem valves may be used only where headroom prevents full extension of rising stems.

B. Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

C. Sizes: Same size as upstream pipe, unless otherwise indicated.

D. Operators: Use specified operators and handwheels, except provide the following special operator features:

1. Handwheels: For valves other than quarter turn.
2. Lever Handles: For quarter-turn valves 6 inches (DN150) and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.

E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

F. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

G. Threads: ASME B1.20.1.

H. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

I. Solder Joint: ASME B16.18.

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F for gate, globe, and check valves; below 421 deg F for ball valves.

2.3 BALL VALVES

A. Ball Valves, 4 Inches (DN100) and Smaller: MSS SP-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch (DN15) valves and smaller and conventional port for 3/4-inch (DN20) valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

1. Operator: Vinyl-covered steel lever handle.
2. Stem Extension: For valves installed in insulated piping.
3. Memory Stop: For operator handles (balancing valves).

2.4 GATE VALVES

A. Gate Valves, 2-1/2 Inches (DN65) and Smaller: MSS SP-80; Class 125, 200-psi cold working pressure (CWP), ASTM B 62 cast-bronze body and bonnet, solid-bronze wedge, copper-silicon alloy rising stem, teflon-impregnated packing with bronze packing nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

B. Gate Valves, 3 Inches (DN80) and Larger: MSS SP-70, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bonnet, solid cast-iron wedge, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with 2-piece packing glad assembly, flanged end connections; and with cast-iron handwheel.

2.5 CHECK VALVES

A. Swing Check Valves, 2-1/2 Inches (DN65) and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections:

B. Swing Check Valves, 3 Inches (DN80) and Larger: MSS SP-71, Class 125, 200-CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

C. Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

F. Do not attempt to repair defective valves; replace with new valves.

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

C. Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

D. Locate valves for easy access and provide separate support where necessary.

E. Install valves in horizontal piping with stem at or above the center of the pipe and in a position to allow full stem movement.

F. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.

G. Sectional Valves: Install sectional gate or ball valves closet to main on each branch and riser serving plumbing fixtures or equipment, and where indicated.

H. Shutoff Valves: Install gate or ball shutoff valve on each water supply to equipment, on each supply to plumbing fixtures without supply stops, and where indicated.

I. Drain Valves: Install drain valves for equipment, at base of each water riser, at low points in horizontal piping, and where required to drain water piping.

1. Install hose-end drain valves with cap and chain at low points in water mains, risers, and branches.
2. Install stop-and-waste drain valves where indicated.

J. Balancing Valves: Install in each hot-water circulation return branch, discharge side of each pump and circulator, and where indicated. Refer to Section 15430 "Plumbing Specialties" for balancing valves.

3.3 SOLDERED CONNECTIONS

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Open gate and globe valves to fully open position.

E. Remove the cap and disc holder of swing check valves having composition discs.

F. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

G. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

3.4 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

C. For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

3.6 VALVE END SELECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2-1/2 Inches (DN65) and Smaller: Solder ends.
2. Steel Pipe Sizes, 2-1/2 Inches (DN65) and Smaller: Threaded or grooved end.
3. Steel Pipe Sizes, 3 Inches (DN80) and Larger: Grooved end or flanged.

3.7 APPLICATION SCHEDULE

A. General Application: Use gate and ball, valves for shutoff duty; globe and ball for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Ball Valves: Class 150, 600-psi CWP, with stem extension.

C. Domestic Hot Water Recirculation Systems: Use the following valve types:

1. Balancing Valves: Automatic or adjustable Ball valves with readout ports.

3.8 ADJUSTING

A. Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION 15110

SECTION 15122

METERS AND GAGES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermometers. .
2. Pressure Gages.
3. Water Meters.

B. Related Sections:

1. Section 02500 - Utility Services: For water meters outside the building.
2. Section 02810 - Irrigation Systems: For irrigation water sub-meters outside the buildings.
3. Section 15194 - Natural Gas Piping: For gas meters.
4. Division 15 Mechanical Equipment Sections that specify meters and gages as part of factory-fabricated equipment.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data: Include scale range, ratings, and califbrated performance curves for each meter, gage, fitting, specialty and accessory specified.

   a. Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified.

2. Shop Drawings: Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.
3. Product Certificates: Signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and compliance with specified requirements.
4. Maintenance Data: For meters and gages to include in maintenance manuals specified in Division 1. Include data for the following:

   a. Flow-measuring systems.
   b. Flowmeters.
   c. Water meters.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Liquid-in-Glass Thermometers:

a. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit (800-328-8258)
b. Marsh Bellofram. (800-727-5646)
c. Weiss Instruments, Inc.(800-322-1453)

2. Pressure Gages:

a. Dresser Industries, Inc.; Instrument Div.; Ashcroft Commercial Sales Operation (800-328-8258)
b. Marsh Bellofram. (800-727-5646)
c. Weiss Instruments, Inc. (800-322-1453)

3. Water Meters and Submeters:

a. As required by the local authority having jurisdiction.

2.2 THERMOMETERS, GENERAL

A. Scale Range: Temperature ranges for services listed are as follows:

1. Domestic Hot and Cold Water: 30 to 240 deg F, with 2-degree scale divisions.

B. Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

2.3 LIQUID-IN-GLASS THERMOMETERS

A. Description: ASTM E 1.

B. Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches long.

C. Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

D. Tube: Red or blue reading, mercury filled with magnifying lens.

E. Scale: Satin-faced nonreflective aluminum with permanently etched markings.

F. Stem: Brass for separable socket; of length to suit installation.

2.4 PRESSURE GAGES

A. Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

B. Case: Drawn steel, brass, or aluminum with 4-1/2-inch- diameter, glass lens.

C. Connector: Brass, NPS 1/4 (DN8).

D. Scale: White-coated aluminum with permanently etched markings.

E. Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.

F. Range: Comply with the following:

1. Fluids under Pressure: Two times the operating pressure (or 0 to 160 psi).

2.5 PRESSURE-GAGE FITTINGS

A. Valves: NPS 1/4 (DN8) brass needle type with round knurled handle.

B. Snubbers: ASME B40.5, NPS 1/4 (DN8) extended stem brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

2.6 WATER METERS AND SUB-METERS

A. Water Meter shall be provided as required by the local authority having jurisdiction.

B. Provide and install sub-meter for site irrigation system.

C. Dsecription: AWWA C700, displacement type, bronze case. Registers flow in gallons (liters) or cubic feet (cubic meters) as required by utility.

D. Description: AWWA C701, turbine type. Registers flow in gallons (liters) or cubic feet (cubic meters) as required.

PART 3 EXECUTION

3.1 METER AND GAGE INSTALLATION, GENERAL

A. Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

3.2 THERMOMETER INSTALLATION

A. Install thermometers and adjust vertical and tilted positions.

B. Install in the following locations:

1. Domestic hot water supply main (downstream of storage tank).
2. Domestic hot water return main.
3. Domestic hot water storage tank.
4. Domestic water heater discharge.
5. Building domestic cold water service entrance.

3.3 PRESSURE-GAGE INSTALLATION

A. Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.

B. Install dry-type pressure gages in the following locations:

1. Upstream and downstream of each pressure-reducing valve.
2. Building water-service entrance.

C. Install liquid-filled-type pressure gages at suction and discharge of each pump.

D. Install pressure-gage needle valve and snubber in piping to pressure gages.

3.4 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to AWWA M6 and utility's requirements.

1. Install displacement-type water meters with shutoff valve on water meter inlet. Install valve on water meter outlet and valved bypass around meter, unless prohibited by authorities having jurisdiction.

2. Install compound-type water meters with shutoff valves on water meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.
3. Install detector-type water meters with shutoff valves on water meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.

3.5 ROUGHING-IN FOR WATER METERS

A. Install roughing-in piping and specialties for domestic water and/or site irrigation water meter installation according to utility's instructions and requirements.

B. See Section 15140 for domestic water piping requirements.

3.6 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install meters and gages adjacent to equipment to allow service and maintenance.

B. Make electrical connections to power supply and electrically operated meters and devices.

C. Ground electrically operated meters.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

D. Install electrical connections for power and devices.

E. Electrical power, wiring, and connections are specified in Division 16 Sections.

3.7 ADJUSTING AND CLEANING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of meters and gages to proper angle for best visibility.

C. Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION 15122

SECTION 15140

DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe and Tube Materials.
2. Fittings.
3. Joining Materials.
4. Polyethylene Encasement.

B. Related Sections:

1. Section 02300 - Earthwork
2. Section 02500 - Utility Services: for exterior water service piping.
3. Section 15050 - Basic Mechanical Materials and Methods
4. Section 15060 - Hangers and Supports
5. Section 15110 – Valves
6. Section 15122 - Meters and Gages.
7. Section 15430 - Plumbing Specialties

1.2 DEFINITIONS

A. Water Service Piping: Water piping outside building that conveys water to building (by Site Subcontractor).

B. Service Entrance Piping: Water piping at entry into building between water service piping and water distribution piping (by Plumbing Subcontractor, beginning at 5’-0” outside of building).

C. Water Distribution Piping: Water piping inside building that conveys water to fixtures and equipment throughout the building.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Combined Fire-Protection and Domestic, Service Entrance Piping: 250 psig (provide only where permitted by the authority having jurisdiction).
2. Service Entrance Piping: 160 psig.
3. Water Distribution Piping: 125 psig.

1.4 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data: Water Samples, Test Results, and Reports: Specified in "Field Quality Control" and "Cleaning" articles.

1.5 QUALITY ASSURANCE

A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.

B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

C. Comply with NSF 61, "Drinking Water System Components--Health Effects," Sections 1 through 9 for potable-water piping and components.

PART 2 PRODUCTS

2.1 PIPE AND TUBE MATERIALS

A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.

B. Soft Copper Tube: ASTM B 88, Types K and L, water tube, annealed temper.

C. Hard Copper Tube: ASTM B 88, Types L, water tube, drawn temper.

D. Ductile-Iron Pipe: AWWA C151, 250-psig minimum pressure rating with mechanical- or push-on-joint bell, plain spigot end, and AWWA C104 cement-mortar lining. Include AWWA C111 ductile-iron gland, rubber gasket, and steel bolts with mechanical-joint pipe. Include AWWA C111 rubber gasket with push-on-joint pipe.

E. Flanged, Ductile-Iron Pipe: AWWA C115 ductile-iron barrel with 250-psig pressure rating and AWWA C104 cement-mortar lining. Include Class 150 or 300, iron-alloy threaded flanges that match piping.

F. CPVC PIPING

1. CPVC Schedule 40 Pipe: ASTM F 441/F 441M.

a. CPVC Schedule 40 Fittings: ASTM F 438, socket type.

2.2 PIPE AND TUBE FITTINGS

A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.

B. Copper, Solder-Joint Pressure Fittings: ASME B16.18 cast-copper alloy or ASME B16.22 wrought copper.

C. Copper, Grooved-End Fittings: ASTM B 75 copper tube or ASTM B 584 bronze castings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.

E. Copper Unions: ASME B16.18, cast-copper-alloy, hexagonal-stock body with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends. Include threads conforming to ASME B1.20.1 on threaded ends.

F. Ductile-Iron, Mechanical- or Push-on-Joint Fittings: AWWA C110, ductile- or gray-iron standard pattern; or AWWA C153, ductile-iron compact pattern; with 250-psig minimum pressure rating and AWWA C104 cement-mortar lining. Include AWWA C111 ductile- or gray-iron glands, rubber gaskets, and steel bolts with mechanical-joint fittings. Include AWWA C111 rubber gaskets with push-on-joint fittings.

G. Ductile-Iron, Flexible Expansion Joints: Compound fitting with combination of flanged and mechanical-joint ends conforming to AWWA C110 or AWWA C153. Include 2 gasketed ball-joint sections, 1 or more gasketed sleeve sections, 250-psig minimum working-pressure rating, and AWWA C550 epoxy interior coating. Assemble components for offset and expansion indicated. Include AWWA C111 ductile-iron glands, rubber gaskets, and steel bolts.

H. Ductile-Iron, Grooved-End Fittings: ASTM A 47 (ASTM A 47M) malleable-iron castings or ASTM A 536 ductile-iron castings with cement-mortar lining or AWWA C550 interior coating and dimensions matching ductile-iron pipe.

I. Ductile-Iron Flanged Fittings: AWWA C110, ductile- or gray-iron standard pattern; with 250-psig minimum pressure rating and AWWA C104 cement-mortar lining.

J. Ferrous Expansion Joints: Compound, galvanized steel fitting with telescoping body and slip-pipe section. Include 150-psig minimum pressure rating, packing rings, packing, limit rods, chrome-plated finish on slip-pipe section, flanged ends, and AWWA C550 epoxy interior coating.

K. Ferrous, Double Expansion Joints: Compound, galvanized steel fitting with telescoping body and 2 slip-pipe sections. Include 150-psig minimum pressure rating, packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, flanged ends, and AWWA C550 epoxy interior coating.

2.3 JOINING MATERIALS

A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.

B. Refer to Section 15050 "Basic Mechanical Materials and Methods" for commonly used joining materials.

C. Solder: ASTM B 32, Alloy Sn95, Sn94, or E; lead free.

D. Brazing Filler Metal: AWS A5.8, BCuP, copper phosphorus or BAg, silver classification.

E. Copper, Keyed Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

F. Ductile-Iron, Keyed Couplings: AWWA C606 for ductile-iron-pipe dimensions. Include ferrous housing sections, gasket suitable for hot water, and bolts and nuts.

G. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

PART 3 EXECUTION

3.1 EXCAVATION

A. Refer to Section 02300 "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.
C. Fitting Option: Mechanically formed tee-branch outlets and brazed joints may be used on aboveground copper tubing.

D. Underground, Service Entrance Piping: Do not use flanges or valves underground. Use the following:

1. 2-Inch NPS (DN50) and Smaller: Soft copper tube, Type K (Type A); copper, solder-joint pressure fittings; and soldered joints.
2. 2-1/2- to 3-1/2-Inch NPS (DN65 to DN90): Soft copper tube, Type K (Type A); copper, solder-joint pressure fittings; and soldered joints.
3. 4- to 8-Inch NPS (DN100 to DN200): Ductile-iron pipe and fittings, and mechanical or push-on joints.

E. Aboveground, Water Distribution Piping: Use the following:

1. 3-1/2-Inch NPS (DN90) and Smaller: Hard copper tube, Type L (Type B); copper, solder-joint fittings; and soldered joints.
2. 4- to 6-Inch NPS (DN100 to DN150): Hard copper tube, Type L (Type B) with grooved ends; copper, grooved-end fittings; and copper, keyed couplings.

F. Underground, Water Distribution Piping: Do not use flanges or valves underground. Use the following:

1. 2-Inch NPS (DN50) and Smaller: Soft copper tube, Type L (Type B); wrought-copper, solder-joint pressure fittings; and soldered joints.
2. 2-1/2- to 4-Inch NPS (DN65 to DN100): Hard copper tube, Type L (Type B); wrought-copper, solder-joint pressure fittings; and soldered joints.

G. Non-Potable-Water Piping: Use the following:

1. 3-1/2-Inch NPS (DN90) and Smaller: Hard copper tube, Type L (Type B); solder-joint pressure fittings; and soldered joints - or - PVC ASTM D 1785, schedule 40.

3.3 PIPING INSTALLATION, GENERAL

A. Refer to Section 15050 "Basic Mechanical Materials and Methods" for basic piping installation.

3.4 SERVICE ENTRANCE PIPING INSTALLATION

A. Extend service entrance piping to exterior water service piping in sizes and locations indicated for service entrances into building. Refer to Section 02500 "Utility Services" for water service piping.

B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside building at each service entrance pipe per local Utility Code requirements.

C. Install water-pressure regulators downstream from shutoff valves. Refer to Section 15410 "Plumbing Specialties" for water-pressure regulators.

D. Ductile-Iron, Service Entrance Piping: Comply with AWWA C600. Install buried piping between shutoff valve and connection to water service piping with restrained joints. Anchor pipe to wall or floor at entrance. Include thrust-block supports at vertical and horizontal offsets.

1. Encase piping with polyethylene film according to ASTM A 674 or AWWA C105 if required by the local authority having jurisdiction.

E. Install wall penetration system at each service entrance pipe penetration through foundation wall. Make installation watertight. Refer to Section 15050 "Basic Mechanical Materials and Methods" for wall penetration systems.

3.5 WATER DISTRIBUTION PIPING INSTALLATION

A. Install piping with 0.25 percent slope downward toward drain.

3.6 JOINT CONSTRUCTION

A. Refer to Section 15050 "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Grooved Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.7 HANGER AND SUPPORT INSTALLATION

A. Refer to Section 15060 "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Riser clamps, MSS Type 8 or Type 42, for vertical runs.
2. Adjustable steel clevis hangers, MSS Type 1, for individual, straight, horizontal runs 100 feet and less.
3. Adjustable roller hangers, MSS Type 43, for individual, straight, horizontal runs longer than 100 feet.
4. Spring cushion rolls, MSS Type 49, if indicated, for individual, straight, horizontal runs longer than 100 feet.
5. Pipe rolls, MSS Type 44, for multiple, straight, horizontal runs 100 feet or longer. Support pipe rolls on trapeze.
6. Spring hangers, MSS Type 52, for supporting base of vertical runs.

B. Install supports according to Section 15060 "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for copper tubing with the following maximum spacing and minimum rod diameters:

1. 3/4-Inch NPS (DN20) and Smaller: Maximum horizontal spacing, 60 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
2. 1-Inch NPS (DN25): Maximum horizontal spacing, 72 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
3. 1-1/4-Inch NPS (DN32): Maximum horizontal spacing, 72 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
4. 1-1/2 and 2-Inch NPS (DN40 and DN50): Maximum horizontal spacing, 96 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 10 feet.
5. 2-1/2-Inch NPS (DN65): Maximum horizontal spacing, 108 inches with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
6. 3-Inch NPS (DN80): Maximum horizontal spacing, 10 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
7. 3-1/2-Inch NPS (DN90): Maximum horizontal spacing, 10 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.
8. 4- and 5-Inch NPS (DN100 and DN125): Maximum horizontal spacing, 10 feet with 1/2-inch minimum rod diameter; maximum vertical spacing, 10 feet.

F. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Connect service entrance piping to exterior water service piping. Use transition fitting to join dissimilar piping materials.

B. Connect water distribution piping to service entrance piping at shutoff valve, and extend to and connect to the following:

1. Water Heaters: Connect cold-water supply and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Connect hot- and cold-water supply piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section "Plumbing Fixtures."
3. Equipment: Connect hot- and cold-water supply piping as indicated. Provide shutoff valve and union for each connection. Use flanges instead of unions for connections 2-1/2-inch NPS (DN65) and larger.
4. Booster Systems (Where required): Connect cold-water suction and discharge piping.

3.9 FIELD QUALITY CONTROL

A. Inspect service entrance piping and water distribution piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

    a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test service entrance piping and water distribution piping 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 water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
3. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
4. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
5. Prepare reports for tests and required corrective action.

3.10 CLEANING

A. Clean and disinfect service entrance piping and water distribution piping as follows:

1. Purge new piping and parts of existing water piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed, procedure described in either AWWA C651 or AWWA C652 or as described below:

a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
b. Fill and isolate system according to either of the following:

1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for 3 hours.

c. Flush system with clean, potable water until chlorine is no longer in water coming from system after the standing time.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows contamination.

B. Prepare and submit reports for purging and disinfecting activities.

C. Clean interior of piping system. Remove dirt and debris as work progresses.

3.11 COMMISSIONING

A. Fill water piping. Check components to determine that they are not air bound and that piping is full of water.

B. Perform the following steps before putting into 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. Remove plugs used during testing of piping and plugs used for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and that cartridges are clean and ready for use.

C. Check plumbing equipment and verify proper settings, adjustments, and operation. Do not operate water heaters before filling with water.

D. Check plumbing specialties and verify proper settings, adjustments, and operation.

1. Water-Pressure Regulators: Set outlet pressure at 80 psig maximum, unless otherwise indicated.

E. Energize pumps and verify proper operation.

END OF SECTION 15140

SECTION 15150

DRAINAGE AND VENT PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe Materials.
2. Fittings.
3. Joining Materials.

B. Related Sections:

1. Section 02300 - Earthwork: for excavating, trenching, and backfilling.
2. Section 02500 - Utility Services
3. Section 02620 - Drainage and Containment
4. Section 07840 - Firestopping: for fire-barrier sealers.
5. Section 08310 - Access Doors: for access panels to concealed components.
6. Section 09900 - Paints and Coatings: for field-applied finishes for piping.
7. Section 11400 - Food Service Equipment: for drainage and vent services for food service equipment.
8. Section 11450 -Residential Equipment: for drainage and vent services for clothes washers.
9. Section 15050 - Basic Mechanical Materials and Methods.
10. Section 15060 - Hangers and Supports.
11. Section 15075 - Mechanical Identification.
12. Section 15083 - Pipe Insulation.
13. Section 15410 - Plumbing Fixtures.
14. Section 15430 - Plumbing Specialties.

1.2 DEFINITIONS

A. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewage from building (by Site Contractor).

B. Drainage Piping: Building sewer piping outside building that conveys storm drainage from building (by Plumbing Contractor, beginning at 5’-0” outside of building.)

C. Service Entrance Piping: Drainage piping at entry into building between outside building sewer piping and inside drainage piping (by Site Contractor).

D. Drainage and Vent Piping: Piping inside building that conveys waste water and vapors from fixtures and equipment throughout the building.

E. The following are industry abbreviations for plastic and other piping materials:

1. PVC: Polyvinyl chloride.

1.3 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working-pressure ratings, unless otherwise indicated:

1. Soil, Waste, and Vent Systems: 10-foot head of water.
2. Storm Drainage Systems: 10-foot head of water.

1.4 SUBMITTALS

A. Product Data:

1. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in project.

B. Test Results and Reports: Specified in "Field Quality Control" Article.

1.5 QUALITY ASSURANCE

A. Provide listing/approval stamp, label, or other marking on piping made to specified standards.

B. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 PRODUCTS

2.1 PIPE MATERIALS

A. General: Applications of the following pipe and tube materials are indicated in Part 3 "Piping Applications" Article.

B. Hub-and-Spigot, Cast-Iron Soil Pipe: ASTM A 74, Service weight ASTM C 564 rubber gasket.

C. Hubless, Cast-Iron Soil Pipe: ASTM A 888 or CISPI 301.

D. PVC Plastic Pipe: ASTM D 2665, Schedule 40.

E. Steel Pipe: ASTM A 53.

F. Ductile Iron Pipe: AWWA C151.

G. Copper Tubing: ASTM B 306.

H. PVC Piping

1. PVC Pipe: ASTM D 2665, solid-wall drain, waste, and vent.

a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns.

2. Cellular-Core, Schedule 40, PVC Pipe: ASTM F 891, Schedule 40.

a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Schedule 40 pipe.

3. Cellular-Core, Sewer and Drain Series, PVC Pipe: ASTM F 891, Series PS 100.

a. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311, drain, waste, and vent patterns and to fit Series PS 100 sewer and drain pipe.

2.2 PIPE AND TUBE FITTINGS

A. General: Applications of the following pipe and tube fitting materials are indicated in Part 3 "Piping Applications" Article.

B. Hub-and-Spigot, Cast-Iron, Soil-Pipe Fittings: ASTM A 74, Service weighthub and spigot. Include ASTM C 564 rubber gasket for each hub.

C. Hubless, Cast-Iron, Soil-Pipe Fittings: CISPI 301.

D. Ferrous Expansion Joints: Compound, galvanized steel fitting with telescoping body and slip-pipe section. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe section, and flanged ends.

E. Ferrous, Double Expansion Joints: Compound, galvanized steel fitting with telescoping body and 2 slip-pipe sections. Include packing rings, packing, limit rods, chrome-plated finish on slip-pipe sections, and flanged ends.

F. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311 drain, waste, and vent pipe patterns.

G. PVC Plastic, Tubular Fittings: ASTM F 409 drainage pattern, with ends as required for application.

H. Steel Pipe Fittings:

1. Cast-Iron, Threaded, Drainage Fittings: ASME B16.12 [glavanized].
2. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, [galvanized,] standard pattern.
3. Cast-Iron Flanges: ASME B16.1, Class 125.
4. Cast-Iron, Flanged Fittings: ASME B 16.1, Class 125 [,galvanized].

I. Ductile Iron Pipe Fittings:

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile or gray-iron glands, rubber gaskets, and steel bolts.

J. Copper Tube Fittings:

1. ASME B16.23, cast copper or ASME B16.29 wrought copper, solder-joint fittings.

2.3 JOINING MATERIALS

A. General: Applications of the following piping joining materials are indicated in Part 3 "Piping Applications" Article.

B. Refer to Division 15 Section 15050 "Basic Mechanical Materials and Methods" for commonly used joining materials.

C. Hubless, Cast-Iron, Soil-Piping Couplings: ASTM C 1277 assembly of metal housing, corrosion-resistant fasteners, and ASTM C 564 rubber sleeve or gasket with integral, center pipe stop. Include the following:

1. Heavy-Duty, Stainless-Steel couplings: ASTM A 666, Type 304, stainless-steel housing or shield; and stainless-steel clamps. Include gasket.

    a. Clamp Width: 3 inches wide with 4 clamps, for piping 1-1/2- to 4-inch NPS.
    b. Clamp Width: 4 inches wide with 6 clamps, for piping 5- to 10-inch NPS.

2. Heavy-Duty, FM-Approved, Stainless-Steel Couplings: ASTM A 666, Type 304, stainless-steel housing; and stainless-steel clamps. Include gasket or bushing.

    a. Clamp Width: 3 inches wide with 2 clamps, for piping 1-1/2- to 4-inch NPS.
    b. Clamp Width: 4 inches wide with 2 clamps, for piping 5- to 10-inch NPS.

3. Heavy-Duty, Cast-Iron Couplings: ASTM A 48, 2-piece, cast-iron housing; and stainless-steel bolts and nuts. Include gasket.

D. Transition Couplings: Coupling or other manufactured fitting same size as, with pressure rating at least equal to, and with ends compatible with piping to be joined.

E. Flexible, Transition Couplings for Underground, Nonpressure Piping: ASTM C 1173 with elastomeric sleeve. Include ends same sizes as piping to be joined and include corrosion-resistant metal band on each end.

1. Sleeve Type for Plain-End Piping: Rubber or elastomeric sleeve and stainless-steel band assembly, fabricated to match outside diameters of piping to be joined. Include the following:

    a. Sleeves for Cast-Iron Soil Piping: ASTM C 564 rubber.
    b. Sleeves for Plastic Piping: ASTM F 477 elastomeric seal.
    c. Sleeves for Dissimilar Piping: Compatible with piping materials to be joined.
    d. Bands: Stainless steel, one at each pipe insert.

2. Gasket Type for Dissimilar-End Piping: Rubber or elastomeric compression gasket, made to match inside diameter of pipe or hub, and outside diameter of adjoining pipe. Include the following:

    a. Gaskets for Cast-Iron Soil Piping: ASTM C 564 rubber.
    b. Gaskets for Plastic Piping: ASTM F 477 elastomeric seal.
    c. Gaskets for Dissimilar Piping: Compatible with piping materials to be joined.

PART 3 EXECUTION

3.1 EXCAVATION

A. Refer to Division 2 Section 02300 "Earthwork" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Transition and special fittings with pressure ratings at least equal to piping pressure rating may be used in applications below, unless otherwise indicated.

B. Flanges may be used on aboveground piping, unless otherwise indicated.

C. Aboveground, Soil, Waste, and Vent Piping: Use the following:

1. 1-1/2-Inch NPS: Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.

2. 2- to 4-Inch NPS: Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
3. 2- to 4-Inch NPS: Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.

4. 5- and 6-Inch NPS (DN125 and DN150): Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
5. 5- and 6-Inch NPS (DN125 and DN150): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.

D. Underground, Soil, Waste, and Vent Piping: Use the following:

1. 1-1/2-Inch NPS: Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.

2. 2- to 4-Inch NPS: Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
3. 2- to 4-Inch NPS: Hub-and-spigot, cast-iron soil pipe, Extra Heavy class; hub-and-spigot, cast-iron, soil-pipe fittings, Extra Heavy class; and compression joints.

4. 2- to 4-Inch NPS: Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.
    d. Couplings: Compact, Type 304, stainless steel.

5. 2- to 4-Inch NPS (DN50 to DN100): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
6. 5- and 6-Inch NPS (DN125 and DN150): Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
7. 5- and 6-Inch NPS (DN125 and DN150): Hub-and-spigot, cast-iron soil pipe, Extra Heavy class; hub-and-spigot, cast-iron, soil-pipe fittings, Extra Heavy class; and compression joints.

8. 5- and 6-Inch NPS (DN125 and DN150): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.
    d. Couplings: Compact, Type 304, stainless steel.

9. 5- and 6-Inch NPS (DN125 and DN150): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
10. 8-Inch NPS (DN200): Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
11. 8-Inch NPS (DN200): Hub-and-spigot, cast-iron soil pipe, Extra Heavy class; hub-and-spigot, cast-iron, soil-pipe fittings, Extra Heavy class; and compression joints.
12. 8-Inch NPS (DN200): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.
    d. Couplings: Compact, Type 304, stainless steel.

13. 8-Inch NPS (DN200): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

E. Aboveground, Storm Drainage Piping: Use the following:

1. 2- to 4-Inch NPS (DN50 to DN100): Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
2. 2- to 4-Inch NPS (DN50 to DN100): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.
    d. Couplings: Heavy-duty, Type 301, stainless steel.

3. 2- to 4-Inch NPS (DN50 to DN100): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

4. 5- and 6-Inch NPS (DN125 and DN150): Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
5. 5- and 6-Inch NPS (DN125 and DN150): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.
    d. Couplings: Heavy-duty, Type 301, stainless steel.

6. 5- and 6-Inch NPS (DN125 and DN150): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

F. Underground, Storm Drainage Piping: Use the following:

1. 3- and 4-Inch NPS (DN80 and DN100): Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.

2. 3- and 4-Inch NPS (DN80 and DN100): Hub-and-spigot, cast-iron soil pipe, Extra Heavy class; hub-and-spigot, cast-iron, soil-pipe fittings, Extra Heavy class; and compression joints.
3. 3- and 4-Inch NPS (DN80 and DN100): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.
    d. Couplings: Compact, Type 304, stainless steel.

4. 3- and 4-Inch NPS (DN80 and DN100): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
5. 5- and 6-Inch NPS (DN125 and DN150): Hub-and-spigot, cast-iron soil pipe, Service class; hub-and-spigot, cast-iron, soil-pipe fittings, Service class; and compression joints.
6. 5- and 6-Inch NPS (DN125 and DN150): Hub-and-spigot, cast-iron soil pipe, Extra Heavy class; hub-and-spigot, cast-iron, soil-pipe fittings, Extra Heavy class; and compression joints.
7. 5- and 6-Inch NPS (DN125 and DN150): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.
    d. Couplings: Compact, Type 304, stainless steel.

8. 5- and 6-Inch NPS (DN125 and DN150): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.
9. 8-Inch NPS (DN200): Hub-and-spigot, cast-iron soil pipe, Extra Heavy class; hub-and-spigot, cast-iron, soil-pipe fittings, Extra Heavy class; and compression joints.
10. 8-Inch NPS (DN200): Hubless, cast-iron soil pipe; hubless, cast-iron, soil-pipe fittings; and one of the following hubless, cast-iron, soil-piping couplings:

    a. Couplings: Heavy-duty, Type 304, stainless steel.
    b. Couplings: Heavy-duty, FM-approved, Type 304, stainless steel.
    c. Couplings: Heavy-duty, cast iron.

d. Couplings: Compact, Type 304, stainless steel.

11. 8-Inch NPS (DN200): PVC plastic pipe, PVC socket fittings, and solvent-cemented joints.

G. Aboveground, Sewage Force Mains: Use the following:

1. 2- to 4-Inch NPS (DN50 and DN100): Hard copper water tube, Type L (Type B); copper, solder-joint pressure fittings; and soldered joints.
2. 2- to 4-Inch NPS (DN50 and DN100): Hard copper water tube, Type L (Type B); copper, grooved-end fittings; and copper, keyed couplings.
3. 2- to 4-Inch NPS (DN50 to DN100): Galvanized steel pipe and cast-iron, threaded fittings.
4. 2- to 4-Inch NPS (DN50 to DN100): Galvanized steel pipe; steel, grooved-end fittings; and steel, keyed couplings.
5. 5- and 6-Inch NPS (DN125 and DN150): Hard copper water tube, Type L (Type B); copper, grooved-end fittings; and copper, keyed couplings.
6. 5- and 6-Inch NPS (DN125 and DN150): Galvanized steel pipe and cast-iron, threaded fittings.
7. 5- and 6-Inch NPS (DN125 and DN150): Galvanized steel pipe; steel, grooved-end fittings; and steel, keyed couplings.
8. 5- and 6-Inch NPS (DN125 and DN150): Ductile-iron, grooved-end pipe; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings.

H. Underground, Sewage-Force-Main, Service Entrance Piping: Use the following:

1. 2- to 3-Inch NPS (DN50 to DN80): Soft copper water tube, Type K (Type A); wrought-copper, solder-joint pressure fittings; and soldered joints.
2. 2- to 3-Inch NPS (DN50 to DN80): Soft copper water tube, Type L (Type B); wrought-copper, solder-joint pressure fittings; and soldered joints.
3. 4- and 6-Inch NPS (DN100 and DN150): Ductile-iron pipe; ductile-iron, mechanical- or push-on-joint fittings; rubber gaskets; and mechanical or push-on joints.

3.3 PIPING INSTALLATION, GENERAL

A. Refer to Division 15 Section 15050 "Basic Mechanical Materials and Methods" for basic piping installation.

3.4 SERVICE ENTRANCE PIPING INSTALLATION

A. Refer to Division 2 Section 02530 "Sanitary Sewerage" for sanitary piping and refer to Division 2 Section 02630 “Storm Drainage” to storm piping.

B. Extend building sanitary drain piping and connect to sanitary sewer piping in sizes and locations indicated for service entrances into building. Install cleanout and extension to grade at connections of building sanitary drains with building sanitary sewers.

C. Extend building storm drain piping and connect to storm sewer piping in sizes and locations indicated for service entrances into building. Install cleanout and extension to grade at connections of building storm drains and building storm sewers.

D. Extend building sanitary drain, force-main piping and connect to sanitary sewer piping in size and location indicated for service entrance into building. Install cleanout, fitting with closure plug or equivalent, inside building.

E. Extend building storm drain, force-main piping and connect to storm sewer piping in size and location indicated for service entrance into building. Install cleanout, fitting with closure plug or equivalent, inside building.

F. Ductile-Iron, Force-Main, Service Entrance Piping: Comply with AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.

1. Encase piping with polyethylene film according to ASTM A 674 or AWWA C105 if required due to local conditions.

G. Install wall penetration system at each service entrance pipe penetration through foundation wall. Make installation watertight. Refer to Division 15 Section 15050 "Basic Mechanical Materials and Methods" for wall penetration systems.

3.5 DRAINAGE AND VENT PIPING INSTALLATION

A. 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."

B. Make changes in direction for 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 2 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 make change in direction of flow greater than 90 degrees. Use proper size of standard increasers and reducers if different sizes of piping are connected. Reducing size of drainage piping in direction of flow is prohibited.

C. Lay buried building drain 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.

D. Install drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Sanitary Building Drain: 2 percent downward in direction of flow for piping 3-inch NPS (DN80) and smaller; 1 percent downward in direction of flow for piping 4-inch NPS (DN100) and larger.
2. Horizontal, Sanitary Drainage Piping: 2 percent downward in direction of flow.
3. Storm Building Drain: 1 percent downward in direction of flow.
4. Horizontal, Storm Drainage Piping: 2 percent downward in direction of flow.
5. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

E. Install force mains at elevations indicated if required due to local conditions.

F. Install engineered, sanitary drainage and vent systems in locations indicated and as follows:

1. Combination Waste and Vent: Comply with standards of authorities having jurisdiction.
2. Reduced-Size Venting: Comply with standards of authorities having jurisdiction.

G. Install engineered, controlled-flow, storm drainage systems in locations indicated. Comply with standards of authorities having jurisdiction.

H. Sleeves are not required for cast-iron soil piping passing through concrete slab on grade if slab is without membrane waterproofing.

I. Install PVC plastic drainage piping according to ASTM D 2665.

J. Install underground, PVC plastic drainage piping according to ASTM D 2321.

3.6 JOINT CONSTRUCTION

A. Refer to Division 15 Section 15050 "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Cast-Iron, Soil-Piping Joints: Make joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Compression Joints: Make with rubber gasket matching class of pipe and fittings.
2. Hubless Joints: Make with rubber gasket and sleeve or clamp.

C. Grooved Joints: Assemble joints with coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

D. PVC Piping Joints: Join drainage piping according to ASTM D 2665.

E. Handling of Solvent Cements, Primers, and Cleaners: Comply with procedures in ASTM F 402 for safe handling during joining of plastic pipe and fittings.

3.7 HANGER AND SUPPORT INSTALLATION

A. Refer to Division 15 Section 15060 "Hangers and Supports" for pipe hanger and support devices. Install the following:

1. Riser clamps, MSS Type 8 or Type 42, for vertical runs.
2. Adjustable steel clevis hangers, MSS Type 1, for individual, straight, horizontal runs 100 feet and less.
3. Adjustable roller hangers, MSS Type 43, for individual, straight, horizontal runs longer than 100 feet.
4. Spring cushion rolls, MSS Type 49, if indicated, for individual, straight, horizontal runs longer than 100 feet.
5. Pipe rolls, MSS Type 44, for multiple, straight, horizontal runs 100 feet or longer. Support pipe rolls on trapeze.
6. Spring hangers, MSS Type 52, for supporting base of vertical runs.

B. Install supports according to Division 15 Section 15060 "Hangers and Supports."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.

E. Install hangers for cast-iron soil piping with the following maximum spacing and minimum rod diameters:

1. 1-1/2- and 2-Inch NPS (DN40 and DN50): Maximum horizontal spacing, 60 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.

2. 3-Inch NPS (DN80): Maximum horizontal spacing, 60 inches with 1/2-inch minimum rod diameter; maximum vertical spacing, 15 feet.
3. 4- and 5-Inch NPS (DN100 and DN125): Maximum horizontal spacing, 60 inches with 5/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
4. 6-Inch NPS (DN150): Maximum horizontal spacing, 60 inches with 3/4-inch minimum rod diameter; maximum vertical spacing, 15 feet.
5. 8- through 12-Inch NPS (DN200 through DN300): Maximum horizontal spacing, 60 inches with 7/8-inch minimum rod diameter; maximum vertical spacing, 15 feet.
6. Spacing for horizontal pipe in 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install hangers for PVC plastic piping with the following maximum spacing and minimum rod diameters:

1. 1-1/2- and 2-Inch NPS (DN40 and DN50): Maximum horizontal spacing, 48 inches with 3/8-inch minimum rod diameter; maximum vertical spacing, 48 inches.
2. 4- and 5-Inch NPS (DN100 and DN125): Maximum horizontal spacing, 48 inches with 5/8-inch minimum rod diameter; maximum vertical spacing, 48 inches.
3. 6-Inch NPS (DN150): Maximum horizontal spacing, 48 inches with 3/4-inch minimum rod diameter; maximum vertical spacing, 48 inches.
4. 8- through 12-Inch NPS (DN200 through DN300): Maximum horizontal spacing, 48 inches with 7/8-inch minimum rod diameter; maximum vertical spacing, 48 inches.

G. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.8 CONNECTIONS

A. Connect service entrance piping to exterior sewerage and drainage piping. Use transition fitting to join dissimilar piping materials.

B. Connect drainage piping to service entrance piping, and extend to and connect to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section 15410 "Plumbing Fixtures."
2. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code. Refer to Section 15430 "Plumbing Specialties."
3. Equipment: Connect drainage piping as indicated. Provide shutoff valve, if indicated, and union for each connection. Use flanges instead of unions for connections 2-1/2-inch NPS (DN65) and larger.

C. Connect force-main piping to service entrance piping, and extend to and connect to the following:

1. Sump Pumps: Connect force-main piping to sump-pump discharge.
2. Sewage Pumps: Connect force-main piping to sewage-pump discharge.

3.9 FIELD QUALITY CONTROL

A. Inspect drainage and vent piping as follows:

1. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

    a. Roughing-In Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
    b. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

3. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

B. Test drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedure, 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 has been covered or concealed before it has been tested and approved.
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 feet of head. Water level must not drop from 15 minutes before inspection starts through completion of inspection. 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 using new materials and retest piping or portion thereof until satisfactory results are obtained.
6. Prepare reports for tests and required corrective action.

C. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedure, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for 4 hours. Leaks and loss in test pressure constitute defects that must be repaired.
3. Repair leaks and defects using new materials and retest piping or portion thereof until satisfactory results are obtained.
4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTING

D. Clean interior of piping system. Remove dirt and debris as work progresses.

E. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

F. Place plugs in ends of uncompleted piping at end of day and when work stops.

G. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with 2 coats of water-based latex paint.

END OF SECTION 15150

SECTION 15300

FIRE-SUPPRESSION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:

1. Dry-pipe sprinkler systems.

B. Related Sections include the following:

1. Division 2 Section "Water Distribution" for piping outside the building.
2. Division 10 Section "Fire-Protection Specialties" for cabinets and fire extinguishers.
3. Division 13 Section "Fire Alarm" for alarm devices not specified in this Section.

1.3 SYSTEM DESCRIPTIONS

A. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.

1.4 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig (1200 kPa).

B. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.

1. Unless otherwise indicated, the following is maximum residual pressure at required flow at each hose-connection outlet:

a. NPS 1-1/2 (DN 40) Hose Connections: 100 psig (690 kPa).
b. NPS 2-1/2 (DN 65) Hose Connections: 175 psig (1200 kPa).

C. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:

a. Building Service Areas: Ordinary Hazard, Group 1.
b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
c. General Storage Areas: Ordinary Hazard, Group 1.
d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
e. Office and Public Areas: Light Hazard.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (6.3 mL/s over 139-sq. m) area.
b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. (9.5 mL/s over 139-sq. m) area.
c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 1500-sq. ft. (12.6 mL/s over 139-sq. m) area.
d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (18.9 mL/s over 232-sq. m) area.
e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (25.2 mL/s over 232-sq. m) area.
f. Special Occupancy Hazard: As determined by authorities having jurisdiction.

4. Minimum Density for Deluge-Sprinkler Piping Design:

a. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm (9.5 mL/s) over entire area.
b. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm (12.6 mL/s) over entire area.
c. Extra-Hazard, Group 1 Occupancy: 0.30 gpm (18.9 mL/s) over entire area.
d. Extra-Hazard, Group 2 Occupancy: 0.40 gpm (25.2 mL/s) over entire area.
e. Special Occupancy Hazard: As determined by authorities having jurisdiction.

5. Maximum Protection Area per Sprinkler: Per UL listing.
6. Maximum Protection Area per Sprinkler:

a. Office Spaces: 120 sq. ft. (11.1 sq. m) 225 sq. ft. (20.9 sq. m).
b. Storage Areas: 130 sq. ft. (12.1 sq. m).
c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.

7. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:

a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
c. Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes.

D. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and ASCE 7, "Minimum Design Loads for Buildings and Other Structures": Section 9, "Earthquake Loads."

1.5 SUBMITTALS

A. Product Data: For the following:

1. Piping materials, including sprinkler specialty fittings.
2. Pipe hangers and supports, including seismic restraints.
3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
4. Air compressors, including electrical data.
5. Excess-pressure pumps, including electrical data.
6. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
7. Hose connections, including size, type, and finish.
8. Hose stations, including size, type, and finish of hose connections; type and length of fire hoses; finish of fire hose couplings; type, material, and finish of nozzles; and finish of rack.
9. Roof hose cabinets.
10. Monitors.
11. Fire hydrants.
12. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
13. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:

1. NFPA 13, "Installation of Sprinkler Systems."
2. NFPA 13R, "Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height."
3. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
4. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
5. NFPA 230, "Fire Protection of Storage."

1.7 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell end and plain end.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron gland, rubber gasket, and steel bolts and nuts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell end and plain end.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern.
2. Gaskets: AWWA C111, rubber.

C. Grooved-End, Ductile-Iron Pipe: AWWA C151, with factory- or field-formed, radius-cut-grooved ends according to AWWA C606.

1. Grooved-Joint Piping Systems:

a. Available Manufacturers:

1) Victaulic Co. of America.

b. Grooved-End Fittings: ASTM A 536, ductile-iron casting with OD matching ductile-iron-pipe OD.
c. Grooved-End-Pipe Couplings: AWWA C606, gasketed fitting matching ductile-iron-pipe OD. Include ductile-iron housing with keys matching ductile-iron-pipe and fitting grooves, rubber gasket with center leg, and steel bolts and nuts.
d. Grooved-End-Pipe Transition Coupling: UL 213 and AWWA C606, gasketed fitting with end matching ductile-iron-pipe OD and end matching steel-pipe OD. Include ductile-iron housing with key matching ductile-iron-pipe groove and key matching steel-pipe groove, rubber gasket listed for use with housing, and steel bolts and nuts.
e. Grooved-End Transition Flange: UL 213, gasketed fitting with key for ductile-iron-pipe dimensions. Include flange-type, ductile-iron housing with rubber gasket listed for use with housing and steel bolts and nuts.

2.3 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.
2. Malleable-Iron Threaded Fittings: ASME B16.3.
3. Gray-Iron Threaded Fittings: ASME B16.4.
4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe, hot-dip galvanized where indicated. Include ends matching joining method.
5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.

1. Locking-Lug Fittings: UL 213, ductile-iron body with retainer lugs that require one-quarter turn to secure pipe in fitting.

a. Available Manufacturers:

1) Anvil International, Inc.

2) Victaulic Co. of America.
3) Ward Manufacturing.

C. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795 hot-dip galvanized-steel pipe where indicated.

1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
2. Steel Flanges and Flanged Fittings: ASME B16.5.

D. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, square-cut factory- or field-formed, square-cut- or roll grooved ends.

1. Grooved-Joint Piping Systems:

a. Available Manufacturers:

1) Anvil International, Inc.
2) Central Sprinkler Corp.
3) Ductilic, Inc.
4) JDH Pacific, Inc.
5) National Fittings, Inc.
6) Shurjoint Piping Products, Inc.
7) Southwestern Pipe, Inc.
8) Star Pipe Products; Star Fittings Div.
9) Victaulic Co. of America.
10) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.
c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, rubber gasket listed for use with housing, and steel bolts and nuts.

2.4 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig (1200-kPa) minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 250-psig (1725-kPa) minimum 300-psig (2070-kPa) working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:

1. Available Manufacturers:

a. Anvil International, Inc.
b. Central Sprinkler Corp.
c. Ductilic, Inc.
d. JDH Pacific, Inc.
e. National Fittings, Inc.
f. Shurjoint Piping Products, Inc.
g. Southwestern Pipe, Inc.

h. Star Pipe Products; Star Fittings Div.
i. Victaulic Co. of America.
j. Ward Manufacturing.

2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.
3. Snap-On and Strapless Outlet Fittings: UL 213, ductile-iron housing or casting with gasket and threaded outlet.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.

1. Available Manufacturers:

a. Central Sprinkler Corp.
b. Fire-End and Croker Corp.
c. Viking Corp.
d. Victaulic Co. of America.

D. Sprinkler Branch-Line Test Fittings: Brass body with threaded inlet, capped drain outlet, and threaded outlet for sprinkler.

1. Available Manufacturers:

a. Elkhart Brass Mfg. Co., Inc.
b. Fire-End and Croker Corp.
c. Potter-Roemer; Fire-Protection Div.

E. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.

1. Available Manufacturers:

a. AGF Manufacturing Co.
b. Central Sprinkler Corp.
c. G/J Innovations, Inc.
d. Triple R Specialty of Ajax, Inc.

F. Drop-Nipple Fittings: UL 1474, adjustable with threaded inlet and outlet, and seals.

1. Available Manufacturers:

a. CECA, LLC.
b. Merit.

G. Dry-Pipe-System Fittings: UL listed for dry-pipe service.

2.5 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig (1200 kPa) minimum pressure rating. Valves shall have 250-psig (1725-kPa) minimum pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:

1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
3. Available Manufacturers:

    a. Grinnell Fire Protection.
    b. McWane, Inc.; Kennedy Valve Div.
    c. NIBCO.
    d. Stockham.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.

1. NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
2. NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
3. NPS 3 (DN 80): Ductile-iron body with grooved ends.
4. Available Manufacturers:

    a. NIBCO.
    b. Victaulic Co. of America.

D. Butterfly Valves: UL 1091.

1. NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.

    a. Available Manufacturers:

        1) Global Safety Products, Inc.
        2) Milwaukee Valve Company.

2. NPS 2-1/2 (DN 65) and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.

    a. Available Manufacturers:

        1) Central Sprinkler Corp.
        2) Global Safety Products, Inc.
        3) McWane, Inc.; Kennedy Valve Div.
        4) Mueller Company.
        5) NIBCO.
        6) Pratt, Henry Company.
        7) Victaulic Co. of America.

E. Check Valves NPS 2 (DN 50) and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.

1. Available Manufacturers:

    a. AFAC Inc.
    b. American Cast Iron Pipe Co.; Waterous Co.
    c. Central Sprinkler Corp.
    d. Clow Valve Co.
    e. Crane Co.; Crane Valve Group; Crane Valves.
    f. Crane Co.; Crane Valve Group; Jenkins Valves.

g. Firematic Sprinkler Devices, Inc.
h. Globe Fire Sprinkler Corporation.
i. Grinnell Fire Protection.
j. Hammond Valve.
k. Matco-Norca, Inc.
l. McWane, Inc.; Kennedy Valve Div.
m. Mueller Company.
n. NIBCO.
o. Potter-Roemer; Fire Protection Div.
p. Reliable Automatic Sprinkler Co., Inc.
q. Star Sprinkler Inc.
r. Stockham.
s. United Brass Works, Inc.
t. Venus Fire Protection, Ltd.
u. Victaulic Co. of America.
v. Watts Industries, Inc.; Water Products Div.

F. Gate Valves: UL 262, OS&Y type.

1. NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.

a. Available Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.
4) United Brass Works, Inc.

2. NPS 2-1/2 (DN 65) and Larger: Cast-iron body with flanged ends.

a. Available Manufacturers:

1) Clow Valve Co.
2) Crane Co.; Crane Valve Group; Crane Valves.
3) Crane Co.; Crane Valve Group; Jenkins Valves.
4) Hammond Valve.
5) Milwaukee Valve Company.
6) Mueller Company.
7) NIBCO.
8) Red-White Valve Corp.
9) United Brass Works, Inc.

G. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.

1. Indicator: Electrical, 115-V ac, prewired, 2-circuit, supervisory switch Visual.
2. NPS 2 (DN 50) and Smaller: Ball or butterfly valve with bronze body and threaded ends.

a. Available Manufacturers:

1) Milwaukee Valve Company.
2) NIBCO.
3) Victaulic Co. of America.

3. NPS 2-1/2 (DN 65) and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

    a. Available Manufacturers:

        1) Central Sprinkler Corp.
        2) Grinnell Fire Protection.
        3) McWane, Inc.; Kennedy Valve Div.
        4) Milwaukee Valve Company.
        5) NIBCO.
        6) Victaulic Co. of America.

2.6 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig (1200-kPa) minimum pressure rating. Control valves shall have 250-psig (1725-kPa) minimum pressure rating if valves are components of high-pressure piping system.

1. Available Manufacturers:

    a. AFAC Inc.
    b. Central Sprinkler Corp.
    c. Firematic Sprinkler Devices, Inc.
    d. Globe Fire Sprinkler Corporation.
    e. Grinnell Fire Protection.
    f. Reliable Automatic Sprinkler Co., Inc.
    g. Star Sprinkler Inc.
    h. Venus Fire Protection, Ltd.
    i. Victaulic Co. of America.
    j. Viking Corp.

2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

    a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.
    b. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

3. Dry-Pipe Valves: UL 260, differential type; with bronze seat with O-ring seals, single-hinge pin, and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

    a. Air-Pressure Maintenance Device: UL 260, automatic device to maintain correct air pressure in piping. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) maximum inlet pressure.

        1) Available Manufacturers:

a) AFAC Inc.
b) Central Sprinkler Corp.
c) General Air Products, Inc.
d) Globe Fire Sprinkler Corporation.
e) Grinnell Fire Protection.
f) Reliable Automatic Sprinkler Co., Inc.
g) Star Sprinkler Inc.
h) Viking Corp.

b. Air Compressor: UL 753, fractional horsepower, 120-V ac, 60 Hz, single phase.

1) Available Manufacturers:

a) AFAC Inc.
b) Gast Manufacturing, Inc.
c) Grinnell Fire Protection.
d) Reliable Automatic Sprinkler Co., Inc.
e) Viking Corp.

B. Automatic Drain Valves: UL 1726, NPS 3/4 (DN 20), ball-check device with threaded ends.

1. Available Manufacturers:

a. AFAC Inc.
b. Grinnell Fire Protection.

2.7 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig (1200-kPa) minimum pressure rating. Sprinklers shall have 250-psig (1725-kPa) minimum, 300-psig (2070-kPa) pressure rating if sprinklers are components of high-pressure piping system.

B. Available Manufacturers:

1. AFAC Inc.
2. Central Sprinkler Corp.
3. Firematic Sprinkler Devices, Inc.
4. Globe Fire Sprinkler Corporation.
5. Grinnell Fire Protection.
6. Reliable Automatic Sprinkler Co., Inc.
7. Star Sprinkler Inc.
8. Venus Fire Protection, Ltd.
9. Victaulic Co. of America.
10. Viking Corp.

C. Automatic Sprinklers: With heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch (12.7-mm) orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

1. Open Sprinklers: UL 199, without heat-responsive element.

a. Orifice: 1/2 inch (12.7 mm), with discharge coefficient K between 5.3 and 5.8.
b. Orifice: 17/32 inch (13.5 mm), with discharge coefficient K between 7.4 and 8.2.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.
2. Pendent sprinklers.
3. Pendent, dry-type sprinklers.
4. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

2.8 FIRE DEPARTMENT CONNECTIONS

A. Available Manufacturers:

1. AFAC Inc.
2. Central Sprinkler Corp.
3. Elkhart Brass Mfg. Co., Inc.
4. Fire-End and Croker Corp.
5. Fire Protection Products, Inc.
6. GMR International Equipment Corporation.
7. Guardian Fire Equipment Incorporated.
8. Potter-Roemer; Fire-Protection Div.
9. Reliable Automatic Sprinkler Co., Inc.
10. United Brass Works, Inc.

B. Wall-Type, Fire Department Connection: UL 405, 175-psig (1200-kPa) minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR & STANDPIPE."

1. Type: Flush, with two inlets and square or rectangular escutcheon plate.
2. Finish: Polished chrome-plated.

2.9 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch-(250-mm-) diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 (DN 20) inlet and NPS 1 (DN 25) drain connections.

1. Available Manufacturers:

a. AFAC Inc.
b. Central Sprinkler Corp.

c. Firematic Sprinkler Devices, Inc.
d. Globe Fire Sprinkler Corporation.
e. Grinnell Fire Protection.
f. Reliable Automatic Sprinkler Co., Inc.
g. Star Sprinkler Inc.
h. Viking Corp.

C. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig (1725-kPa) pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Available Manufacturers:

a. ADT Security Services, Inc.
b. Grinnell Fire Protection.
c. ITT McDonnell & Miller.
d. Potter Electric Signal Company.
e. System Sensor.
f. Viking Corp.
g. Watts Industries, Inc.; Water Products Div.

D. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

1. Available Manufacturers:

a. Grinnell Fire Protection.
b. Potter Electric Signal Company.
c. System Sensor.
d. Viking Corp.

E. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Available Manufacturers:

a. McWane, Inc.; Kennedy Valve Div.
b. Potter Electric Signal Company.
c. System Sensor.

F. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

1. Available Manufacturers:

a. Potter Electric Signal Company.
b. System Sensor.

2.10 PRESSURE GAGES

A. Available Manufacturers:

1. AGF Manufacturing Co.
2. AMETEK, Inc.; U.S. Gauge.
3. Brecco Corporation.
4. Dresser Equipment Group; Instrument Div.
5. Marsh Bellofram.
6. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter, dial pressure gage with range of 0 to 250 psig (0 to 1725 kPa) minimum.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EARTHWORK

A. Refer to Division 2 Section "Earthwork" for excavating, trenching, and backfilling.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

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

3.4 PIPING APPLICATIONS, GENERAL

A. Shop weld pipe joints where welded piping is indicated.

B. Do not use welded joints for galvanized-steel pipe.

C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

D. Underground Service-Entrance Piping: Ductile-iron, mechanical joint pipe and fittings and restrained joints. Or ductile-iron, grooved-end pipe and fittings; grooved-end-pipe couplings; and grooved joints. Include corrosion-protective encasement.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Dry-Pipe Sprinkler System, 175-psig (1200-kPa) Maximum Working Pressure:
1. NPS 1-1/2 (DN 40) and Smaller: Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
2. NPS 1-1/2 (DN 40) and Smaller: Plain-end, galvanized, standard-weight steel pipe; locking-lug fittings; and twist-locked joints.
3. NPS 2 (DN 50): Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
4. NPS 2 (DN 50): Grooved-end, galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
5. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
6. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Grooved-end, galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.
7. NPS 4 to NPS 6 (DN 100 to DN 150): Threaded-end, galvanized, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
8. NPS 4 to NPS 6 (DN 100 to DN 150): Grooved-end, galvanized, standard-weight steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:

1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.

a. Shutoff Duty: Use ball, butterfly, or gate valves.

2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14.

a. Shutoff Duty: Use ball, butterfly, or gate valves.
b. Throttling Duty: Use ball or globe valves.

3.7 JOINT CONSTRUCTION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Twist-Locked Joints: Insert plain-end piping into locking-lug fitting and rotate retainer lug one-quarter turn.

D. Pressure-Sealed Joints: Use UL-listed tool and procedure. Include use of specific equipment, pressure-sealing tool, and accessories.

E. Mechanically Formed, Copper-Tube-Outlet Joints: Use UL-listed tool and procedure. Drill pilot hole in copper tube, form branch for collar, dimple tube to form seating stop, and braze branch tube into formed-collar outlet.

F. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
2. Steel Pipe: Square-cut or roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
3. Copper Tube: Roll-groove tubing. Use grooved-end fittings and grooved-end-tube couplings.
4. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

G. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.

1. NPS 2 (DN 50) and Smaller: Use dielectric unions, couplings, or nipples.
2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
3. NPS 5 (DN 125) and Larger: Use dielectric flange insulation kits.

3.8 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 2 Section "Water Distribution" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to Division 2 Section "Water Distribution" for backflow preventers.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.9 PIPING INSTALLATION

A. Refer to Division 15 Section "Basic Mechanical Materials and Methods" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints.

D. Install underground copper service-entrance piping according to NFPA 24.

E. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

F. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

G. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger connections.

H. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

I. Install sprinkler piping with drains for complete system drainage.

J. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

K. Install drain valves on standpipes.

L. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

M. Install alarm devices in piping systems.

N. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install standpipe system piping according to NFPA 14.
2. Install sprinkler system piping according to NFPA 13.

O. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

P. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

Q. Drain dry-type standpipe piping.

R. Drain dry-pipe sprinkler piping.

S. Pressurize and check dry-pipe sprinkler system piping and air-pressure maintenance devices air compressors.

3.10 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.

D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

E. Specialty Valves:

1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.
2. Dry-Pipe Valves: Install trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

    a. Air-Pressure Maintenance Devices for Dry-Pipe Systems: Install shutoff valves to permit servicing without shutting down sprinkler system; bypass valve for quick system filling; pressure regulator or switch to maintain system pressure; strainer; pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range; and 175-psig (1200-kPa) maximum inlet pressure.
    b. Install air compressor and compressed-air supply piping.
    c. Install compressed-air supply piping from building's compressed-air piping system.

3. Deluge Valves: Install in vertical position, in proper direction of flow, in main supply to deluge system.

3.11 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:

1. Rooms without Ceilings: Upright sprinklers.
2. Rooms with Suspended Ceilings: Flush sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Spaces Subject to Freezing: Upright sprinklers Upright, pendent, dry sprinklers; and sidewall, dry sprinklers as indicated.
5. Deluge-Sprinkler Systems: Upright, open sprinklers.
6. Sprinkler Finishes:

    a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
    b. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
    c. Flush Sprinklers: Bright chrome, with painted white escutcheon.

3.12 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.13 HOSE-CONNECTION INSTALLATION

A. Install hose connections adjacent to standpipes, unless otherwise indicated.

B. Install freestanding hose connections for access and minimum passage restriction.

C. Install NPS 1-1/2 (DN 40) hose-connection valves with flow-restricting device, unless otherwise indicated.

D. Install NPS 2-1/2 (DN 65) hose connections with quick-disconnect NPS 2-1/2 by NPS 1-1/2 (DN 65 by DN 40) reducer adapter and flow-restricting device, unless otherwise indicated.

E. Install wall-mounting-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Refer to Division 10 Section "Fire-Protection Specialties" for cabinets.

3.14 FIRE HYDRANT INSTALLATION

A. Install fire hydrants mounted in vertical wall with shutoff valve inside building in heated space.

3.15 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.

B. Install ball drip valve at each check valve for fire department connection.

3.16 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

D. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

E. Connect compressed-air supply to dry-pipe sprinkler piping.

F. Connect air compressor to the following piping and wiring:

1. Pressure gages and controls.

2. Electrical power system.
3. Fire alarm devices, including low-pressure alarm.

G. Electrical Connections: Power wiring is specified in Division 16.

H. Connect alarm devices to fire alarm.

I. Ground equipment according to Division 16 Section "Grounding and Bonding."

J. Connect wiring according to Division 16 Section "Conductors and Cables."

K. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.17 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14 and in Division 15 Section "Mechanical Identification."

3.18 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
3. Energize circuits to electrical equipment and devices.
4. Start and run excess-pressure pumps.
5. Start and run air compressors.
6. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
7. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
8. Coordinate with fire alarm tests. Operate as required.
9. Coordinate with fire-pump tests. Operate as required.
10. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.19 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.20 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 1 Section "Closeout Procedures."

END OF SECTION 15300

SECTION 15410

PLUMBING FIXTURES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plumbing Fixture Standards
2. Miscellaneous Fixture Standards
3. Miscellaneous Component Standards

B. Related Sections:

1. Section 07920 - Joint Sealant: For sealing between fixtures and walls, floors, and counters.
2. Section 15110 - Valves
3. Section 15430 - Plumbing Specialties
4. Appendix: Plumbing Fixture Schedules

1.2 DEFINITIONS

A. Accessible: Plumbing fixture, building, facility, or portion thereof that can be approached, entered, and used by physically handicapped, disabled, and elderly people.

B. Fitting: Device that controls flow of water into or out of plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, traps and waste pipes. Pipe fittings, tube fittings, and general-duty valves are included where indicated.

1.3 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data for each plumbing fixture category and type specified. Include selected fixture, trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
2. Maintenance data for plumbing fixtures and components to include in the operation and maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category from one source and by a single manufacturer.

1. Exception: Where fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for this category.

B. Regulatory Requirements: Comply with requirements of CABO A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; regarding plumbing fixtures for physically handicapped people.

C. Energy Policy Act Requirements: Comply with requirements of Public Law 102-486, "Energy Policy Act," regarding water flow rate and water consumption of plumbing fixtures.

D. Listing and labeling: Provide electrically operated fixtures and components specified in this Section that are listed and labeled.

E. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver plumbing fixtures in manufacturer's protective packing, crating, and covering.

B. Store plumbing fixtures on elevated platforms in dry location.

1.6 PROJECT CONDITIONS

A. Field Measurements: Coordinate roughing-in and final fixture locations and verify that plumbing fixtures can be installed to comply with original design and referenced standards.

1.7 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials described in Section 01790 “Spare Parts and Maintenance” that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. See Plumbing Fixture Matrix for list of which Manufacturer's are approved for use on a specific item.

B. Approved Manufacturers:

1. American Standard, Inc. (732-980-3234)
2. Elkay Manufacturing Co. (630-574-8484)
3. Fiat Products Ltd.; Division of Crane Plumbing (847-864-9777)
4. Halsey Taylor (630-574-3500)
5. Haws Corp. (510-525-5801)
6. Jay R. Smith Mfg. Co. (334-277-8520)
7. Josam Co. (800-365-6726)
8. Just Mfg. Co. (847-678-5190)
9. Kohler Co. (800-456-4537)
10. E. L. Mustee & Sons, Inc. (800-321-3128)
11. Oasis Industries Inc. (800-323-2748)
12. Sunroc Corp (800-4SUNROC)

13. Waterpik Technologies, Inc. (800-766-7338)
14. Toto USA, Inc. (800-350-8686)
15. Wade (800-527-8478)
16. Western Emergency Equipment (800-758-9378)
17. Stern-Williams (913-362-5635)
18. Zurn Industries, Inc. (716-665-1132)

2.2 PLUMBING FIXTURE STANDARDS

A. Comply with applicable standards below and other requirements specified.

1. Electric Water Coolers: ARI 1010 and UL 399.
2. Emergency Equipment: ANSI Z358.1.
3. National Sanitation Foundation Construction: NSF 2 and NSF 61.
4. Bathtubs: ANSI Z124.1, ANSI Z124.1a, and ANSI Z124.1b.
5. Plastic Laundry Trays: ANSI Z124.6.
6. Plastic Mop-Service Basins: ANSI Z124.6.
7. Shower Enclosures: ANSI Z124.2 and ANSI Z124.2a.
8. Whirlpool Bathtubs: ANSI Z124.1, ANSI Z124.1a, and ANSI Z124.1b; and ASME A112.19.7M.
9. Porcelain-Enameled Fixtures: ASME A112.19.4M.
10. Slip-Resistant Bathing Surfaces: ASTM F 462.
11. Stainless-Steel Fixtures Other than Service Sinks: ASME A112.19.3M.
12. Vitreous-China Fixtures: ASME A112.19.2M.
13. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.
14. Water-Closet, Flushometer Tank Trim: ASSE 1037.
15. Whirlpool Bathtub Fittings: ASME A112.19.8M.

2.3 LAVATORY/SINK FAUCET STANDARDS

A. Comply with ASME A112.18.1M, NSF 61 and other requirements specified for lavatory, sink, and similar-type-fixture faucet fittings. Include hot- and cold-water indicators; 2.5-gpm-maximum flow rate; and finish as shown on Plumbing Fixture Schedule on metal body. Coordinate faucet inlets with supplies and fixture holes and outlet with spout and fixture receptor.

1. Faucet:

a. Valve shall be ceramic discs in cartridge assembly.
b. Handles as indicated.
c. Pop-up or grid drain as indicated.

2. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
3. Faucet Hose: ASTM D 3901.
4. Hose-Connection Vacuum Breakers: ASSE 1011.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
7. Pipe Threads: ASME B1.20.1.
8. Sink Spray Hoses: ASTM D 3573.

2.4 BATHTUB/SHOWER FAUCET STANDARDS

A. Comply with ASME A112.18.1M and other requirements specified for bathtub and shower faucet fittings. Include hot- and cold-water indicators; 2.5-gpm-maximum flow rate; and finish as shown on Plumbing Fixture Schedule. Coordinate faucet inlets with supplies and outlet with diverter valve; tub spout; and shower head, arm, and flange.

1. All Trim to be metallic.
2. Valving shall be ceramic discs in cartridge assemblies.
3. Cast brass valve-body with integral cast-in service stops.
4. Pressure balancing faucets shall utilize a diaphragm-balancing cartridge with integral check valves.
5. Combination, Pressure-Equalizing- and Thermostatic-Control, Antiscald Faucets: ASSE 1016.
6. Pressure balancing faucets shall utilize a diaphragm-balancing cartridge with integral check valves.
7. Hand-Held Showers: ASSE 1014.
8. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
9. Hose-Coupling Threads: ASME B1.20.1 or ASME B1.20.7.
10. Manual-Control Antiscald Faucets: ASTM F 444.
11. Pipe Threads: ASME B1.20.1.
12. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
13. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

2.5 MISCELLANEOUS FITTING STANDARDS

A. Comply with ASME A112.18.1M and other requirements specified for fittings, other than faucets. Include finish to coordinate with finishes shown on Plumbing Fixture Schedule. Coordinate fittings with other components and connectors.

1. Atmospheric Vacuum Breakers: ASSE 1001.
2. Automatic Flow Restrictors: ASSE 1028.
3. Brass and Copper, Supplies and Tubular Brass: ASME A112.18.1M.
4. Fixed Flow Restrictors: ASSE 1034.
5. Manual-Operation Flushometers: ASSE 1037.

2.6 MISCELLANEOUS COMPONENT STANDARDS

A. Comply with applicable standards below and other requirements specified for components for plumbing fixtures, equipment, and appliances.

1. Disposers: ASSE 1008 and UL 430.
2. Floor Drains: ASME A112.21.1M.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Pipe Threads: ASME B1.20.1.
5. Plastic Shower Receptors: ANSI Z124.2 and ANSI Z124.2a.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Insulation Kits: CABO A117.1.
8. Supports: ASME A112.6.1M.
9. Whirlpool Bathtub Equipment: UL 1795.

2.7 FITTINGS

A. Fittings for Plumbing Fixtures: Refer to plumbing fixture schedules in the Appendix for materials for supplies, supply stops, supply risers, traps, and other fittings.

B. Fittings for Equipment Specified in Other Sections: Fittings include the following:

1. Supply Inlets: Brass pipe or copper tube, size required for final connection.
2. Supply Stops: Chrome-plated brass, angle or straight; compression, loose-key type; same size as supply inlet and with outlet matching supply riser.
3. Supply Risers: 3/8-inch NPS (DN10) rigid brass tube with 1/4-inch NPS (DN8) offset, knob-end tailpiece. Use chrome-plated tube for exposed applications.
4. Traps: Tubular brass with 0.045-inch wall thickness, slip-joint inlet, cleanout, wall flange, escutcheons, and size to match equipment. Use chrome-plated tube for exposed applications.
5. Continuous Waste: Tubular brass, 0.045-inch wall thickness, with slip-joint inlet, and size to match equipment.
6. Indirect Waste: Tubular brass, 0.045-inch wall thickness, and size to match equipment.

2.8 FINISHES

A. Refer to Plumbing Fixture Matrix for Finishes.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for potable, hot- and cold-water supply piping systems; soil, waste, and vent piping systems; and supports. Verify that locations and sizes of piping and locations and types of supports match those indicated, before installing and connecting fixtures. Use manufacturer's roughing-in data when roughing-in data are not indicated.

B. Examine walls, floors, and cabinets for suitable conditions where fixtures are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Include supports for plumbing fixtures according to the following:

1. Carriers: For wall-hanging water closets and fixtures supported from wall construction.
2. Chair Carriers: For wall-hanging urinals, lavatories, sinks, drinking fountains, and electric water coolers.
3. Heavy-Duty Chair Carriers: For accessible urinals, lavatories, and other fixtures where indicated.
4. Reinforcement: For floor-mounted lavatories and sinks that require securing to wall and recessed, box-mounted, electric water coolers.
5. Fabricate reinforcement from 2-by-4-inch or 2-by-6-inch fire-retardant-treated-wood blocking between studs or 1/4-by-6-inch steel plates attached to studs, in wall construction, to secure fixtures to wall. Include length that will extend beyond ends of fixture mounting bracket and attach to at least 2 studs.

B. Include fitting insulation kits for accessible fixtures according to the following:

1. Lavatories: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.
2. Sinks: Cover hot- and cold-water supplies, stops and handles, drain, trap, and waste to wall.

3. Fixtures with Offset Drain: Cover hot- and cold-water supplies, offset drain, trap, and waste to wall.
4. Other Fixtures: Cover exposed fittings below fixture.

3.3 PLUMBING FIXTURE INSTALLATION

A. Assemble plumbing fixtures and trim, fittings, faucets, and other components according to manufacturers' written instructions.

B. Install fixtures level and plumb according to manufacturers' written instructions, roughing-in drawings, and referenced standards.

C. Install floor-mounted, floor-outlet water closets with closet flanges and gasket seals.

D. Install shower arm elbow fitting secure to backing to prevent movement.

E. Install toilet seats on water closets.

F. Install wall-hanging, back-outlet urinals with gasket seals.

G. 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 handicapped people to reach.

H. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

I. Fasten wall-hanging plumbing fixtures securely to supports attached to building substrate when supports are specified, and to building wall construction where no support is indicated.

J. Fasten floor-mounted fixtures to substrate. Fasten fixtures having holes for securing fixture to wall construction, to reinforcement built into walls.

K. Fasten recessed, wall-mounted fittings to reinforcement built into walls.

L. Fasten wall-mounted fittings to reinforcement built into walls.

M. Fasten counter-mounting plumbing fixtures to casework.

N. Secure supplies to supports or substrate within pipe space behind fixture.

O. Set shower receptors and mop basins in leveling bed of cement grout.

P. Install individual stop valve in each water supply to fixture. Use gate or globe valve where specific stop valve is not specified.

1. Exception: Omit stop valves on supplies to emergency equipment, except when permitted by authorities having jurisdiction. When permitted, install valve chained and locked in OPEN position.

Q. Install water-supply stop valves in accessible locations.

R. Install faucet, laminar-flow fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.

S. Install supply, flow-control fittings with specified flow rates in fixture supplies at stop valves.

T. Install faucet, flow-control fittings with specified flow rates and patterns in faucet spouts when faucets are not available with required rates and patterns. Include adapters when required.

U. Install shower, flow-control fittings with specified maximum flow rates in shower arms.

V. Install traps on fixture outlets. Omit traps on fixtures having integral traps. Omit traps on indirect wastes, except where otherwise indicated.

W. Install escutcheons at wall, floor, and ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons where required to conceal protruding pipe fittings.

X. Seal joints between fixtures and walls, floors, and counters using sanitary-type, 1-part, mildew-resistant, silicone sealant according to sealing requirements specified in Section 07920 "Sealants." Match sealant color to fixture color.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing fixtures and piping systems and plumbing equipment specified in other Division 15 Sections.

B. Supply and Waste Connections to Plumbing Fixtures: Refer to plumbing fixture schedules at the end of this Section for fitting sizes and connection requirements for each plumbing fixture.

C. Supply and Waste Connections to Equipment Specified in Other Sections: Connect equipment with supply inlets, supply stops, supply risers, and traps specified in this Section. Use fitting sizes required to match connected equipment. Connect fittings to plumbing piping.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

E. Arrange for electric-power connections to fixtures and devices that require power. Electric power is specified in Division 16 Sections.

3.5 FIELD QUALITY CONTROL

A. Verify that installed fixtures are categories and types specified for locations where installed.

B. Check that fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized and demonstrate proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

3.6 ADJUSTING AND CLEANING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers, hot-water dispensers, and controls. Replace damaged and malfunctioning units and controls.

C. Adjust water pressure at drinking fountains, electric water coolers, faucets, shower valves, and flushometer valves having controls, to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Include the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
2. Remove sediment and debris from drains.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of fixtures for temporary facilities, except when approved in writing by Owner.

3.8 SCHEDULES

A. See Plumbing Fixture Matrix attached to this Section.

END OF SECTION 15410

SECTION 15430

PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Backflow Preventers.
2. Water Regulators.
3. Thermostatic Mixing Valves.
4. Clothes Washer Drain & Supply.
5. Hydrants.
6. Trap Primer Valves.
7. Drain Valves.
8. Backwater Valves.
9. Floor Drains.
10. Roof Drains.
11. Lint Interceptors.
12. Miscellaneous Piping Specialties.

B. Related Sections:

1. [Section 07311 – Asphalt Shingles.]
2. [Section 07610 – Sheet Metal Roofing.]
3. [Section 07530 – Elastomeric Membrane Roofing.]
4. [Section 07620 – Sheet Metal Flashing and Trim.]
5. Section 15050 - Basic Mechanical Materials and Methods.
6. Section 15075 - Mechanical Identification: for labeling and identifying requirements.
7. Section 15110 – Valves.
8. Section 15122 - Meters and Gages.
9. Section 15140 - Domestic Water Piping..
10. Section 15150 - Drainage and Vent Piping.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project.

B. Product Data: For each plumbing specialty indicated. Include rated capacities of selected equipment and shipping, installed, and operating weights. Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products:

1. Backflow preventers.
2. Water regulators.
3. Thermostatic mixing valves and water tempering valves.
4. Water hammer arresters.
5. Trap primer valves.
6. Drain valves.
7. Hydrants.

8. Clothes washer drain & supply.
9. Backwater valves.
10. Cleanouts.
11. Floor drains, open receptors, and trench drains.
12. Vent caps, vent terminals, and roof flashing assemblies.
13. Roof drains.
14. Lint traps.

C. Reports: Specified in "Field Quality Control" Article.

D. Maintenance Data: For specialties to include in the maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

A. Provide listing/approval stamp, label, or other marking on plumbing specialties made to specified standards.

B. Listing and Labeling: Provide electrically operated plumbing specialties specified in this Section that are listed and labeled.

1. Terms "Listed" and "Labeled": As defined in National Electrical Code, Article 100.

C. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.

D. Comply with NFPA 70, "National Electrical Code," for electrical components.

1.4 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials described in Section 01790 “Spare Parts and materials” below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Backflow Preventers:

a.	Ames Co., Inc.	(916-666-2493)
b.	Watts Industries, Inc.; Water Products Div.	(508-688-1811)
c.	Zurn Industries, Inc.; Wilkins Div.	(805-238-7100)

2. Water Regulators:

a.	Conbraco Industries, Inc.	(704-847-9191)
b.	Watts Industries, Inc.; Water Products Div.	(508-688-1811)
c.	Zurn Industries, Inc.; Wilkins Div.	(805-238-7100)

3. Thermostatic Water Mixing Valves:

a.	Lawler Manufacturing Co., Inc.	(800-763-2709)

b. Leonard Valve Co. (401-461-1200)
c. Symmons Industries, Inc. (617-848-2250)

4. Clothes Washer Drain & Supply

a. Acorn Engineering Co. (800-488-8999)
b. Guy Gray Manufacturing Co., Inc. (502-554-4423)
c. Symmons Industries, Inc. (617-848-2250)

5. Hydrants:

a. Smith: Jay R. Smith Mfg. Co. (334-277-8520)
b. Woodford Manufacturing Co. (719-574-0600)
c. Zurn Industries, Inc.; Hydromechanics Div. (814-455-0921)

6. Water Hammer Arresters:

a. Precision Plumbing Products, Inc. (503-256-4010)
b. Sioux Chief Manufacturing Co., Inc. (816-779-6104)
c. Smith: Jay R. Smith Mfg. Co. (334-277-8520)

7. Trap Primer Valves:

a. Precision Plumbing Products, Inc. (503-256-4010)
b. Smith: Jay R. Smith Mfg. Co. (334-277-8520)
c. Watts Industries, Inc.; Water Products Div. (508-688-1811)
d. Zurn Industries, Inc.; Hydromechanics Div. (814-455-0921)

8. Floor Drains (FD-1)

a. Smith, Jay R. Mfg. Co.; Figure 2010
b. Josam Co.
c. Zurn Industries, Inc.

9. Floor Drains, (FD-2)

a. Smith, Jay R. Mfg. Co.; Figure 2450
b. Josam Co.
c. Zurn Industries, Inc.

10. GREASE INTERCEPTORS

a. Smith, Jay R. Mfg. Co.
b. Josam Co.
c. Park Equipment Co.

11. LINT INTERCEPTORS

a. Smith, Jay R. Mfg. Co.
b. Josam Co.
c. Park Equipment Co..

2.2 BACKFLOW PREVENTERS

A. General: ASSE standard, backflow preventers, of size indicated for maximum flow rate and maximum pressure loss indicated.

1. Body: Bronze, with flanged ends.

a. Interior Lining: AWWA C550 or FDA-approved, epoxy coating for backflow preventers having cast-iron or steel body.

2. Interior Components: Corrosion-resistant materials.
3. Exterior Finish: Rough Brass.
4. Strainer on inlet.
5. Test Kit with Plastic Case: Per manufacturer's recommendation.

B. Pipe-Applied, Atmospheric-Type Vacuum Breakers: ASSE 1001, with floating disc and atmospheric vent.

C. Hose-Connection Vacuum Breakers: ASSE 1011, nickel plated, with nonremovable and manual drain features, and ASME B1.20.7 garden-hose threads on outlet. Units attached to rough-bronze-finish hose connections may be rough bronze.

D. Intermediate Atmospheric-Vent Backflow Preventers: ASSE 1012, suitable for continuous pressure application. Include inlet screen and 2 independent check valves with intermediate atmospheric vent.

E. Reduced-Pressure-Principle Backflow Preventers: ASSE 1013, suitable for continuous pressure application. Include outside screw and yoke gate valves on inlet and outlet, and strainer on inlet; test cocks; and pressure-differential relief valve with ASME A112.1.2 air-gap fitting located between 2 positive-seating check valves.

1. Pressure Loss: 12 psig maximum, through middle one-third of flow range.

F. Double-Check Backflow Prevention Assemblies: ASSE 1015, suitable for continuous pressure application. Include shutoff valves on inlet and outlet, and strainer on inlet; and test cocks with 2 positive-seating check valves.

1. Pressure Loss: 5 psig maximum, through middle one-third of flow range.

G. Antisiphon-Pressure-Type Vacuum Breakers: ASSE 1020, suitable for continuous pressure application. Include shutoff valves, spring-loaded check valve, spring-loaded floating disc, test cocks, and atmospheric vent.

1. Pressure Loss: 5 psig maximum, through middle one-third of flow range.

2.3 WATER REGULATORS

A. General: ASSE 1003, water regulators, rated for initial working pressure of 150 psig minimum, of size, flow rate, and inlet and outlet pressures indicated. Include integral factory-installed or separate field-installed Y-pattern strainer.

1. 2-Inch NPS (DN50) and Smaller: Bronze body with threaded ends.
2. 2-1/2-Inch NPS (DN65) and Larger: Bronze or cast-iron body with flanged ends. Include AWWA C550 or FDA-approved interior epoxy coating for regulators with cast-iron body.
3. Interior Components: Corrosion-resistant materials.
4. Exterior Finish: Standard

5. Single-seated, direct-operated type.

B. Single-seated, direct-operated, integral-bypass type.

C. Pilot-operated type, single- or double-seated, cast-iron-body main valve, with bronze-body pilot valve.

2.4 THERMOSTATIC MIXING VALVES

A. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body. Include check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and capacity at pressure loss as indicated.

1. Bimetal Thermostat, Operation and Pressure Rating: 125 psig minimum.

B. Thermostatic Water Mixing Valves: Unit, with the following:

1. Piping, of sizes and in arrangement indicated. Include valves and unions.
2. Piping Component Finish: Rough brass.
3. Thermometer: Manufacturer's standard.

2.5 CLOTHES WASHER DRAIN & SUPPLY

A. General: Recessed-mounting outlet boxes with fittings complying with ASME A112.18.1M. Include box with faceplate, services indicated for equipment connections, and wood-blocking reinforcement.

B. Clothes Washer Outlet Boxes: With hose connections, drain, and the following:

1. Box and Faceplate: Plastic.
2. Shutoff Fittings: 2 hose bibbs.
3. Supply Fittings: Two 1/2-inch NPS (DN15) gate, globe, or ball valves and 1/2-inch NPS (DN15) copper, water tubing.
4. Drain Fitting: 2-inch NPS (DN50) drainage piping P-trap with 2-inch NPS (DN50) standpipe extending from floor to outlet box and 2-inch NPS (DN50) waste.

2.6 HYDRANTS

A. Wall Hydrants: ASME A112.21.3M, nonfreeze, key operation. Provide one operating key.

1. Inlet: 3/4- or 1-inch NPS (DN20 or DN25) threaded or solder joint.
2. Outlet: ASME B1.20.7 garden-hose threads, and integral or field-installed, nonremovable, drainable, hose-connection vacuum breaker with ASME B1.20.7 garden-hose threads on outlet.
3. Type: Projecting.
4. Finish: Nickel bronze.

B. Wall Hydrants: ASME A112.21.3M or ASSE 1019, nonfreeze, automatic draining, anti-back flow type, key operation, with 3/4- or 1-inch NPS (DN20 or DN25) threaded or solder-joint inlet, and ASME B1.20.7 garden-hose threads on outlet. Include operating key for each hydrant.

1. Type: Recessed
2. Finish: Nickel bronze.

C. Wall Hydrants: ASME A112.21.3M, projecting, automatic draining, antibackflow type, key operation. Include operating key for each hydrant.

1. Inlet: 3/4- or 1-inch NPS (DN20 or DN25) threaded or solder joint.
2. Outlet: ASME B1.20.7 garden-hose threads.
3. Finish: Nickel bronze.

2.7 TRAP PRIMER VALVES

A. Trap Seal Primer Valves: ASSE 1018, water-supply-fed type, with the following characteristics:

1. 125-psig minimum working pressure.
2. Bronze body with atmospheric-vented drain chamber.
3. Inlet and Outlet Connections: 1/2-inch NPS (DN15) threaded, union, or solder joint.
4. Gravity Drain Outlet Connection: 1/2-inch NPS (DN15) threaded or solder joint.
5. Finished: Rough bronze.

2.8 DRAIN VALVES

A. Hose-End Drain Valves: MSS SP-110, 3/4-inch NPS (DN20) ball valve, rated for 400-psig minimum CWP. Include 2-piece, ASTM B 62 bronze body with standard port, chrome-plated brass ball, replaceable seats and seals, blowout-proof stem, and vinyl-covered steel handle.

1. Inlet: Threaded or solder joint.
2. Outlet: Short-threaded nipple with ASME B1.20.7 garden-hose thread and cap.
3. Hose-End Drain Valve Option: MSS SP-80, gate valve, Class 125, ASTM B 62 body, with 3/4-inch NPS (DN20) threaded or solder-joint inlet and ASME B1.20.7 garden-hose threads on outlet and cap. Hose bibbs are prohibited for this application.

B. Stop-and-Waste Drain Valves: MSS SP-110, ball valve, rated for 200-psig minimum CWP or MSS SP-80, Class 125, gate valve; ASTM B 62 bronze body, with 1/8-inch NPS (DN6) side drain outlet and cap.

2.9 FLOOR DRAINS

A. Floor Drains, (FD-1): Comply with ASME A112.21.1M and ASME A112.3.1.

1. Application: Finished Floor.
2. Body Material: Gray iron.
3. Seepage Flange: Required.
4. Clamping Device: [Required], [Not required].
5. Outlet: Bottom.
6. Strainer Material: Nickel bronze
7. Strainer Finish: Nickel bronze.
8. Top Shape: Round or square.
9. Top Loading Classification: Light duty
10. Trap Material: Cast iron.
11. Trap Pattern: Standard P-trap
12. Trap Features: Trap seal primer valve drain connection.

B. Floor Drains, (FD-2): Comply with ASME A112.21.1M and ASME A112.3.1.

1. Application: Equipment Room.
2. Body Material: Gray iron.
3. Seepage Flange: Required.
4. Clamping Device: [Required] [Not required]
5. Outlet: Bottom.
6. Sediment Bucket: Stainless Steel, solid bottom with mesh screen.
7. Top or Strainer Material: Gray iron.
8. Top of Body and Strainer Finish: Gray iron.
9. Top Shape: Rectangular.
10. Dimensions of Top or Strainer: 12-3/4”x10-3/4”.
11. Top Loading Classification: Medium duty.
12. Trap Material: Cast iron.
13. Trap Pattern: Standard P-trap.
14. Trap Features: Trap seal primer valve drain connection.

2.10 GREASE INTERCEPTORS:Comply with PDI-G101.

C. Plumbing and Drainage Institute Seal: Required.

D. Body Matrerial: [Cast iron] [Cast iron or steel].

E. Body Extension: [Required] [Not required].
F. Flow Rate: <Insert interceptor design rate>.

G. Inlet and Outlet Size: <Insert size>.

H. Cleanout: Integral [or filed installed on outlet].

1. Mounting: [Above floor] [recessed in acid-resistant, coated steel frame and cradle] [Recessed, flush with floor] <Insert other>.
2. Operation: Manual Cleaning.

2.11 LINT INTERCEPTORS

I. Body Material: Cast iron or steel.

J. Inerior Separation Device: [Baffels] [Screens] <Insert other>.

K. Flow Rate: <Insert description if required>.

L. Inlet and Outlet Size: <Insert size>.

M. Mounting: [Inline] [Above floor] <Insert other>.

2.12 MISCELLANEOUS PIPING SPECIALTIES

N. Water Hammer Arresters: ASME A112.26.1M, ASSE 1010, or PDI-WH 201, bellows or piston type with pressurized cushioning chamber. Sizes are based on water-supply fixture units, ASME A112.26.1M sizes A through F and PDI-WH 201 sizes A through F.

O. Interior Hose Bibbs: Bronze body, with renewable composition disc, 1/2- or 3/4-inch NPS (DN15 or DN20) threaded or solder-joint inlet. Provide ASME B1.20.7 garden-hose threads on outlet and integral or field-installed, nonremovable, drainable, hose-connection vacuum breaker.

1. Finish: Rough brass.
2. Operation: Wheel handle.

P. Roof Flashing Assemblies: Refer to Section 07311.

Q. Open Drains: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section of length to provide depth indicated; and where indicated, increaser fitting of size indicated, joined with ASTM C 564 rubber gaskets. Size P-trap as indicated.

R. Deep-Seal Traps: Cast iron or bronze, with inlet and outlet matching connected piping, cleanout where indicated, and trap seal primer valve connection where indicated.

1. 2-Inch NPS (DN50): 4-inch minimum water seal.
2. 2-1/2 Inch NPS (DN65) and Larger: 5-inch minimum water seal.

S. Floor-Drain Inlet Fittings: Cast iron, with threaded inlet and threaded or spigot outlet, and trap seal primer valve connection.

T. Air-Gap Fittings: ASME A112.1.2, cast iron or cast bronze, with fixed air gap, inlet for drain pipe or tube, and threaded or spigot outlet.

U. Stack Flashing Fittings: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.

V. Vent Caps: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and set-screws to secure to vent pipe.

W. Vent Terminals: Commercially manufactured, shop-fabricated or field-fabricated, frost-proof assembly constructed of galvanized steel, copper, or lead-coated copper. Size to provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counter flashing, as indicated.

X. Expansion Joints: ASME A112.21.2M, assembly with cast-iron body with bronze sleeve, packing gland, and packing, of size and end types corresponding to connected piping.

PART 3 EXECUTION

3.1 PLUMBING SPECIALTY INSTALLATION

A. General: Install plumbing specialty components, connections, and devices according to manufacturer's written instructions.

B. Install backflow preventers of type, size, and capacity indicated, at each water-supply connection to mechanical equipment and systems, and to other equipment and water systems as indicated. Comply with authorities having jurisdiction. Locate backflow preventers in same room as connected equipment. Install air-gap fitting on units with atmospheric-vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.

C. Install pressure regulators with inlet and outlet shutoff valves and balance valve bypass. Install pressure gages on inlet and outlet. Refer to Section 15122 “Meters and Gauges”.

D. Install hose bibbs with integral or field-installed vacuum breaker.

E. Install wall hydrants with integral or field-installed vacuum breaker.

F. Install trap seal primer valves in accessible locations with valve outlet piping pitched down toward drain trap a minimum of one percent and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow. Identify device locations on record drawings.

G. Install backwater valves in building drain piping as indicated. 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.

H. Install expansion joints on vertical risers, stacks, and conductors as indicated.

I. Install cleanouts in aboveground piping and building drain piping as indicated, and where not indicated, according to the following:

1. Size same as drainage piping up to 4-inch NPS (DN100). Use 4-inch NPS (DN100) 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 4-inch NPS (DN100) and smaller and 100 feet for larger piping.
4. Locate at base of each vertical soil and waste stack.

J. Install cleanout deck plates, of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.

K. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.

L. Install flashing flange and clamping device with each stack and cleanout passing through floors with waterproof membrane.

M. Install vent flashing sleeves on stacks passing through roof. Secure over stack flashing according to manufacturer's written instructions.

N. Install frost-proof vent caps on each vent pipe passing through roof (where required). Maintain 1-inch clearance between vent pipe and roof substrate.

O. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor or as indicated. Size outlets as indicated.

P. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:

1. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
2. Radius, 30 to 60 Inches: Equivalent to one percent slope.
3. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.

Q. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

R. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

S. Position floor drains for easy access and maintenance.

T. Install interceptors, including trapping, venting, and flow control fitting, according to authorities having jurisdiction and with clear space for servicing.

1. Above-Floor Installation: Set unit with bottom resting on floor, unless otherwise indicated.
2. Flush with Floor Installation: Set unit and extension if required, with cover flush with finished floor.
3. Recessed Floor Installation: Set unit in receiver housing having bottom or cradle supports, with receiver housing cover flush with finished floor.
4. Install clean out immediately downstream from interceptors not having integral cleanout on outlet.

U. Fasten wall-hanging plumbing specialties securely to supports attached to building substrate if supports are specified and to building wall construction if no support is indicated.

V. Fasten recessed, wall-mounting plumbing specialties to reinforcement built into walls.

W. Secure supplies to supports or substrate.

X. Install individual stop valve in each water supply to plumbing specialties. Use ball, gate, or globe valve if specific valve is not indicated.

Y. Install water-supply stop valves in accessible locations.

Z. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

AA. Locate drainage piping as close as possible to bottom of floor slab supporting fixtures and drains.

BB. 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.

CC. Include wood-blocking reinforcement for recessed and wall-mounting plumbing specialties.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping connections between plumbing specialties and piping specified in other Division 15 Sections.

2. Install piping connections indicated between appliances and equipment specified in other Sections; connect directly to plumbing piping systems.

3. Install piping connections indicated as indirect wastes from appliances and equipment specified in other Sections, to spill over receptors connected to plumbing piping systems.

B. Install hoses between plumbing specialties and appliances as required for connections.

C. Arrange for electric-power connections to plumbing specialties and devices that require power. Electric power is specified in Division 16 Sections.

D. Supply Runouts to Plumbing Specialties: Install hot- and cold-water-supply piping of sizes indicated, but not smaller than required by authorities having jurisdiction.

E. Drainage Runouts to Plumbing Specialties: Install drainage and vent piping, with approved trap, of sizes indicated, but not smaller than required by authorities having jurisdiction.

F. Interceptor Connections: Connect piping, flow-control fittings, and accessories as indicated.

1. Grease Interceptors: Connect inlet and outlet to unit, and flow-control fitting and vent to unit inlet piping. Install valve on outlet of automatic drawoff-type unit.
2. Solids Interceptors: Connect inlet and outlet.

G. Ground electric-powered plumbing specialties.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 FLASHING INSTALLATION

A. Fabricate flashing manufactured from single piece unless large pans, sumps, or other drainage shapes are required.

B. Burn joints of lead sheets where required.

C. Solder joints of copper sheets where required.

D. 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.

E. Set flashing on floors and roofs in solid coating of bituminous cement.

F. Secure flashing into sleeve and specialty clamping ring or device.

G. Install flashing for piping passing through roofs with counter flashing or commercially made flashing fittings, according to Division 7 Section 07620 "Flashing and Sheet Metal”.

H. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

I. Fabricate and install flashing and pans, sumps, and other drainage shapes as indicated. Install drain connection if indicated.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of factory-authorized service representative to supervise the field assembly of components and installation of grease recovery units, including piping and electrical connections, and to report results in writing.

1. Test and adjust plumbing specialty controls and safeties. Replace damaged and malfunctioning controls and components.

3.5 COMMISSIONING

A. Before startup, perform the following checks:

1. System tests are complete.
2. Damaged and defective specialties and accessories have been replaced or repaired.
3. Clear space is provided for servicing specialties.

B. Before operating systems, perform the following steps:

1. Close drain valves, hydrants, and hose bibbs.
2. Open general-duty valves to fully open position.
3. Remove and clean strainers.
4. Verify that drainage and vent piping are clear of obstructions. Flush with water until clear.

C. Startup Procedures: Follow manufacturer's written instructions.

D. Adjust operation and correct deficiencies discovered during commissioning.

3.6 DEMONSTRATION

A. Startup Services: Engage a factory-authorized service representative to perform startup services and train Owner's maintenance personnel in Section 01820 and as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup of and servicing interceptors.

2. Train Owner's maintenance personnel on procedures and schedules related to startup of and servicing grease recovery units.

3.7 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 15430

SECTION 15440

DOMESTIC WATER IN-LINE PUMPS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Domestic Water Inline Pumps

B. Related Sections:

1. Section 15110 - Valves
2. Section 15122 - Meters and Gages
3. Section 15140 - Domestic Water Piping
4. Section 15950 - Testing, Adjusting and Balancing
5. Division 16 Sections for power-supply wiring, field-installed disconnects, electrical devices, and motor controllers.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating items selected for use in Project with the following supporting data:

1. Product Data:

a. Include certified performance curves and rated capacities of selected models; shipping, installed, and operating weights; furnished specialties; and accessories for each type and size of pump specified. Indicate pumps' operating point on curves.

2. Maintenance Data: For each pump specified to include in maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of pumps through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Domestic Water Inline Pumps:

a. Amtrol Pumps, Inc. (800-xxxxxxxx)
b. ITT Fluid Technology Corp.; ITT Bell & Gossett Div. (800-908-8932)
c. Taco, Inc. (401-942-8000)

2.02 GENERAL

A. Description: Factory-assembled and -tested, single-stage, centrifugal pump units; complying with UL 778; suitable for potable-water service; with all-bronze or stainless-steel construction and components in contact with water made of corrosion-resistant materials.

B. Motors: Comply with requirements in Division 15 Section "Motors" with built-in thermal-overload protection appropriate for motor size and duty.

C. End Connections for NPS 2 (DN50) and Smaller: Threaded. Pumps available only with flanged ends may be furnished with threaded companion flanges.

D. End Connections for NPS 2-1/2 (DN65) and Larger: Flanged.

E. Finish: Manufacturer's standard paint applied to factory-assembled and -tested units before shipping.

F. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles.

2.3 DOMESTIC WATER IN-LINE PUMPS

A. Description: Horizontal in-line circulator, rated for 125-psig minimum working pressure and minimum continuous water temperature of 225 deg F.

1. Construction: Radially split, all-bronze casing.
2. Impeller: ASTM B 36/B 36M, rolled brass; or ASTM B 584, cast bronze; overhung, single suction, and keyed to shaft.
3. Seal: Mechanical.
4. Shaft and Sleeve: Steel shaft, with oil-lubricated copper sleeve.
5. Pump Bearings: Oil-lubricated, bronze-journal or thrust type.
6. Shaft Coupling: Flexible, capable of absorbing torsional vibration and shaft misalignment.
7. Motor: Single speed, with oil-lubricated bearings, unless otherwise indicated; and resiliently mounted to pump casing.

a. Motor Size: For motors larger than 1/2 hp, select motor size that will not overload through full range of pump performance curve.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water distribution piping to verify actual locations of connections before pump installation.

3.2 INSTALLATION

A. Install pumps according to manufacturer's written instructions and with access for periodic maintenance, including removing motors, impellers, couplings, and accessories.

B. Support pumps and piping so weight of piping is not supported by pumps.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Connect water distribution piping to pumps. Install suction and discharge pipe equal to or greater than size of pump nozzles. Refer to Section 15140 " Domestic Water Piping."
2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Section 15110 "Valves" for general-duty valves.
3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Section 15122 "Meters and Gages" for pressure gages and gage connectors.

B. Electrical wiring and connections are specified in Division 16 Sections.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 COMMISSIONING

A. Check suction piping connections for tightness.

B. Final Checks before Starting: Perform the following preventive maintenance operations:

1. Lubricate oil-lubricated-type bearings.
2. Verify that pump is free to rotate by hand and that pump for handling hot liquids is free to rotate with pump hot and cold. Do not operate pump if it is bound or drags, until cause of trouble is determined and corrected.
3. Verify that pump controls are correct for required application.

C. Starting procedure for pumps is as follows:

1. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
2. Open circulating line valve if pump should not be operated against dead shutoff.
3. Open discharge valve slowly.
4. Check general mechanical operation of pump and motor.
5. Close circulating line valve once there is sufficient flow through pump to prevent overheating.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain pumps as specified below:

1. Conduct training as specified in Section 01820 "Training”.

2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining pumps.

END OF SECTION 15440

SECTION 15486

FUEL-FIRED, DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gas fired water heaters.
2. Expansion tanks.
3. Accessories.

B. Related Sections:

1. Section 03300 - Cast-in-Place Concrete
2. Section 15050 - Basic Mechanical Materials and Methods
3. Section 15100 - Valves
4. Section 15122 - Meters and Gages
5. Section 15430 - Plumbing Specialties
6. Section 15550 - Breechings, Chimneys, and Stacks

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data:

a. For each type and size of water heater ,include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
b. Wiring Diagrams: Power, signal, and control systems. Differentiate between manufacturer-installed and field-installed wiring.

2. Product Certificates: Signed by manufacturers of water heaters certifying that products furnished comply with requirements.

3. Maintenance Data: For water heaters to include in maintenance manuals specified in Division 1.

4. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on specific units indicated.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ANSI Compliance: Provide gas water heaters that comply with ANSI standards for gas water heaters and related products and that bear AGA certification label.

E. ASME Compliance: Fabricate and label water heater, hot-water storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

F. ASHRAE Standards: Comply with performance efficiencies prescribed for the following:

1. ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," for commercial water heaters.

1.4 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include storage tanks, circulators, and burner assemblies.
2. Warranty Period: From date of Substantial Completion:

a. Storage Tanks: Five (5) years.
b. Circulators and Burner Assemblies: One (1) Year.
c. Tank Type Water Heaters: Three (3) Year Leakage, One (1) Year Parts.
d. Boilers: Five (5) Year Leakage, One (1) Year Parts.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers

1. Gas Fired Water Heaters: (Power Vent, Storage Type)

a. Lochinvar Corp. (615-889-8900)
b. Smith: A. O. Smith Water Products Co. (800-447-1953) - National Accounts Department
c. State Industries (xxxxxxxxxxx).

2. Expansion Tanks:

a. Amtrol, Inc. (800-947-2324)
b. Smith: A. O. Smith Water Products Co. (800-447-1953) - National Accounts Department
c. Wessels Co. (313-875-5000)
d. Taco, Inc. (401-942-8000)

2.2 GAS FIRED WATER HEATERS (STORAGE TYPE)

A. Description: Comply with ANSI Z21.10.3.

B. Storage Tank Construction: ASME-code steel with 160-psig working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with tank for piping connections, relief valve, pressure gage, thermometer, drain, anode rods, and controls as required. Attach tappings to tank shell before testing and labeling.

    a. NPS 2 (DN50) and Smaller: Threaded ends according to ASME B1.20.1, pipe threads.
    b. NPS 2-1/2 (DN65) 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.

2. Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
3. Insulation: Comply with ASHRAE 90.1. Surround entire storage tank except connections and controls.
4. Jacket: Steel, with enameled finish.

C. Burner: For use with atmospheric vent water heaters for natural-gas fuel.

1. Temperature Control: Adjustable thermostat.
2. Safety Controls: Automatic, high-temperature-limit and low-water cutoff devices or systems.
3. Automatic Ignition: ANSI Z21.20, automatic gas-ignition system and components.

D. Anode Rods: Factory installed, magnesium.

E. Dip Tube: Factory installed. Not required if cold-water inlet is near bottom of storage tank.

F. Drain Valve: ASSE 1005, corrosion-resistant metal, factory installed.

G. Draft Control: Draft diverter; comply with ANSI Z21.12.

2.3 GAS FIRED WATER HEATERS (HIGH EFFICIENCY)

A. Description: Configuration and components complying with appropriate requirements of ANSI Z21.13 and UL 795, with nominal efficiency rating not less than 83.7 percent.

B. Unit Construction: ASME code with 160-psig working-pressure rating.

1. Tappings: Factory fabricated of materials compatible with tank for piping and other connections as required. Attach tappings to unit before testing and labeling.

    a. NPS 2 (DN50) and Smaller: Threaded ends according to ASME B1.20.1, pipe threads.
    b. NPS 2-1/2 (DN65) 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.

2. Interior Finish: Corrosion-resistant metal or materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.
3. Insulation: Comply with ASHRAE 90.1.

4. Jacket: Steel, with enameled finish.

C. Burner: For use with natural-gas fuel, and complying with appropriate requirements of UL 795.

D. Piping: Manufacturer's standard copper tubing.

E. Draft Control: Draft diverter; comply with ANSI Z21.12.

2.4 EXPANSION TANKS

A. 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.

B. Construction: 150-psig working-pressure rating.

C. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.

D. Tank Interior Finish: Materials and thicknesses complying with NSF 61, barrier materials for potable-water tank linings. Extend finish into and through tank fittings and outlets.

E. Tank Exterior Finish: Manufacturer's standard, unless finish is indicated.

F. Air-Charging Valve: Factory installed.

2.5 WATER HEATER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: According to the following:

1. Gas Water Heaters: ANSI Z21.22, combination temperature and pressure relief valve.
2. Option: Separate temperature and pressure relief valves are acceptable instead of combination relief valve.

B. Pressure Relief Valves: According to the following:

1. Gas Water Heaters: ANSI Z21.22 pressure relief valve for storage tanks of 200,000 Btuh (58.6 kW).

C. Vacuum Relief Valves: According to the following:

1. Gas Water Heaters: ANSI Z21.22.
2. Exception: Omit if water heater has integral vacuum-relieving device.

D. Gas Shutoff Valves: ANSI Z21.15, manually operated. Furnish for installation in piping.

E. Gas Pressure Regulators: ANSI Z21.18, appliance type, factory or field installed. Include pressure rating, capacity, and pressure differential required for water heater and gas supply.

F. Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.

G. Water Heater Stand and Drain Pan Units: High-density-polyethylene-plastic, 18-inch-high, enclosed-base stand complying with IAPMO PS 103 and IAS No. 2. Include integral or separate drain pan with raised edge and NPS 1 (DN25) drain outlet with ASME B1.20.1, pipe thread.

H. Water Heater Stands: Water heater manufacturer's factory-fabricated, steel stand for floor mounting and capable of supporting water heater and water. Include dimension that will support bottom of water heater a minimum of 18 inches above the floor.

I. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated, steel bracket for wall mounting and capable of supporting water heater and water.

J. Drain Pans: Corrosion-resistant metal with raised edge. Include dimensions not less than base of water heater and include drain outlet not less than NPS 3/4 (DN20).

K. Piping Manifold Kits: Water heater manufacturer's factory-fabricated inlet and outlet piping arrangement for multiple-unit installation. Include piping and valves for field assembly that is capable of isolating each water heater and of providing balanced flow through each water heater.

L. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE 90.1 or ASHRAE 90.2.

PART 3 EXECUTION

3.1 CONCRETE BASES

A. Install concrete bases of dimensions indicated. Refer to Section 03300 "Cast-in-Place Concrete" and Section 15050 "Basic Mechanical Materials and Methods."

3.2 WATER HEATER INSTALLATION

A. Install commercial water heaters on concrete bases.

1. Exception: Omit concrete bases for commercial water heaters if installation on stand, bracket, suspended platform, or direct on floor is indicated.

B. Install 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.

C. Anchor water heaters to substrate.

D. Where required, install seismic restraints for water heaters. Anchor to substrate.

E. Install and connect gas water heaters according to NFPA 54.

1. Install appliance, gas pressure regulators on gas-burner inlets of water heaters without pressure regulators.
2. Install vent piping from gas-train pressure regulators and valves to outside of building where required. Terminate vent piping with brass-screened vent cap fitting. Do not combine vents except with approval of authorities having jurisdiction.

F. Install temperature and pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.

G. Install pressure relief valves in water piping for water heaters without storage. Extend relief valve outlet with water piping in continuous downward pitch and discharge onto closest floor drain.

H. Install vacuum relief valves in cold-water-inlet piping.

I. Install vacuum relief valves in water heater storage tanks that have copper lining.

J. Install water heater drain piping as indirect waste to spill into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Section 15430 "Plumbing Specialties" for drain valves.

K. Install thermometers on water heater inlet and outlet piping. Refer to Section 15122 "Meters and Gages" for thermometers.

L. Assemble and install inlet and outlet piping manifold kits for multiple water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each water heater. Include shutoff valve, and thermometer in each water heater inlet and outlet, and throttling valve in each water heater outlet. Refer to Section 15100 "Valves" for general-duty valves and Section 15122 "Meters and Gages" for thermometers.

M. Arrange for insulation on equipment and piping not furnished with factory-applied insulation.

N. Install piping-type heat traps on inlet and outlet piping of water heater storage tanks without integral or fitting-type heat traps.

O. Fill water heaters with water.

P. Charge compression tanks with air as required by manufacturer.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect hot- and cold-water piping with shutoff valves and unions. Connect hot-water-circulating piping with shutoff valve, check valve, and union.

D. Connect gas piping to gas burner with drip leg, tee, shutoff valve, and union; minimum size same as inlet connection.

E. Make connections with dielectric fittings where piping is made of dissimilar metal.

F. Gas, Water Heater Vent Connections: Connect to vent system. Include draft hoods and diverters where required. Use vents same size as or larger than water heater outlets, but not smaller than indicated unless smaller vent size has been calculated according to NFPA 54. Comply with gas utility requirements for sizing. Gas vents are specified in Section 15550 "Breechings, Chimneys, and Stacks." Provide ducted combustion air.

G. Electrical Connections: Power wiring and disconnect switches are specified in Division 16 Sections. Arrange wiring to allow unit service.

H. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Engage a factory-authorized service representative to perform startup service.

B. In addition to manufacturer's written installation and startup checks, perform the following:

1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment and retest until satisfactory results are achieved.
2. Verify that piping system tests are complete.
3. Check for piping connection leaks.
4. Check for clear relief valve inlets, outlets, and drain piping.
5. Check operation of circulators.
6. Test operation of safety controls, relief valves, and devices.
7. Energize electric circuits.
8. Adjust operating controls.
9. Adjust hot-water-outlet temperature settings. Do not set above 140 deg F unless piping system application requires higher temperature.
10. Balance water flow through manifolds of multiple-unit installations.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water heaters.

1. Conduct training as specified in Section 01820 "Training".
2. Train Owner's maintenance personnel on procedures for starting and stopping troubleshooting, servicing, and maintaining equipment.

END OF SECTION 15486

SECTION 15738

VERTICAL PACKAGED TERMINAL AIR-CONDITIONING UNITS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Vertical packaged terminal air conditioning units
2. Controls

B. Related Sections:

1. Section 07920 - Sealants

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data:

a. Include rated capacities, weights, furnished specialties, and accessories for each model indicated.

2. Shop Drawings: Detail layout and installation of wall penetrations.

a. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

3. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 1, Section 01830, “Operation and Maintenance Data.”

4. Warranties: Special warranties specified in this Section.

1.3 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the NEC, Article 100.

2. Unit shall be rated in accordance with ARI Standard 310/380-93 and certified by UL.

1.4 COORDINATION

A. Coordinate layout and installation of units and wall construction where unit penetrates wall or is supported by it.

1.5 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Standard Warranty: Manufacturer shall warrant all components for one full year from Substantial Completion date with an additional four years for the compressor. Contractor shall be responsible for installation, start-up, and first year service labor.

C. Optional Full Seven Year Extended Warranty: Manufacturer shall offer an optional full seven year warranty to cover all parts and labor beginning on Substantial Completion date.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:

1. "The Suite 20 SPU Series"; First Co.

2.2 VERTICAL PACKAGED TERMINAL AIR CONDITIONAL UNIT

A. Description: Packaged, self-contained, vertical through-the-wall air cooled terminal unit with electric heat, straight cool with electric heat, or straight cool with hot water heat unit, with wall sleeve, cabinet, electric refrigeration system, electric heating, outside air grille, fully charged with refrigerant and filled with oil.

B. Electrical Characteristics:

1. Refer to schedule on drawings

2. Disconnect Switch: Factory installed non-fused disconnect switch on equipment.

C. Cabinet: 20 gage galvanized steel, with removable front and side panels. Fully insulated for sound attenuation and reduced air infiltration.

D. Adjustable Fresh Air: To meet code requirements for fresh air introduction.

E. Removable Front and Side Cabinet Panels: Accessible to controls and unit.

F. Wall Sleeves: Constructed of 20 gauge galvanized steel with heavy-duty rubber gasket material to provide a weather tight seal. Provide sleeve with disposable weather guard and debris guard to be used during construction. Sleeve shall have baked enamel finish inside and outside. Evaporator condensate water shall drain through the sleeve and directly to a common drain riser. Secondary (overflow) water from either the primary drain or rainwater shall be diverted to the building’s exterior.

G. Grille: Anodized corrosion-resistant aluminum.

1. Color: As approved by the Architect.

H. Refrigeration System:

1. Direct expansion cooling coil.

2. Hermetically sealed compressor with internal spring isolation, external isolation, permanent split capacitor motor and overload protection.

3. Accumulator (if required by compressor manufacturer)

4. Condenser coil and fan.

I. Air System: Centrifugal forward curved evaporator fans with three-speed permanent split capacitor motor, optional filter grille.

J. Heating Coil: Electric

K. Condensate Drain: Must be routed to HUB drain.

L. Condenser Fan: Propeller type with separate split capacitor motor.

M. Size: As scheduled on Drawings.

N. Corrosion Protection: Provide the following accessories.

1. Pre-coated aluminum coils with copper tubing.

2. Totally enclosed fan motor with moisture-resistant windings.

2.3 CONTROLS

A. Control Module: Remote thermostat with heat anticipator, heat-off-cool switch, on-auto fan switch.

B. Evaporator Coil Freeze Protection: Provide a temperature sensor to de-energize the compressor should the evaporator coil experience freezing conditions.

C. Low Ambient Lockout: Locks out compressor at ambient temperatures below 40 degrees to extend compressor life.

D. Random Restart: When power is turned on after a power outage, a built-in random restart (3 to 4 minutes) prevents all units from restarting simultaneously. Simultaneous restarting can damage electrical components.

E. Compressor Restart Delay: A 3-minute delay ensures that system pressures are allowed to equalize before a compressor restart.

F. Fan Delay: In the cooling mode, the fan motor delay allows the fan to continue to operate up to 45 seconds after thermostat is satisfied.

2.4 SOURCE QUALITY CONTROL

A. Unit Performance Ratings: Factory test to comply with ARI 310/380, "Packaged Terminal Air-Conditioners and Heat Pumps."

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units according to manufacturer's written instructions.

B. Coordinate installation of wall sleeves in finished wall assembly; seal and weatherproof.

3.2 CONNECTIONS

A. Electrical: Connect units to wiring systems and to ground per manufacturer recommendation.

B. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

3.4 COMMISSIONING

A. After installation, check the following:

1. Unit is level on base and is flashed in exterior wall.
2. Unit casing has no visible damage.
3. Compressor, air-cooled condenser coil, and fans have no visible damage.
4. Set outdoor air vent damper to “open” position.
5. Condensers are clean and free of construction debris.
6. Controls are connected and operable, cycle unit through hi/lo fan and heat/cool operation.
7. Shipping bolts, blocks, and tie-down straps are removed.
8. Return air and outdoor vent air filters are installed and clean.
9. Drain pan and slinger ring are functioning properly.
10. Effectively disable the temperature limiter stops.

B. Check fan-wheel rotation (evaporator and condenser) for correct direction without vibration and binding.

C. Start unit according to manufacturer's written instructions.

1. Complete manufacturer's startup checks.

D. After starting and performance test, clean filters.

END OF SECTION 15738

SECTION 15782

ROOFTOP AIR CONDITIONING UNITS (DX)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged rooftop heating and cooling units.

B. Related Sections include the following:

1. Division 7 for type and style of roof curbs and equipment supports.
2. Division 15 Section "Mechanical Vibration Controls and Seismic Restraints" for manufactured isolation bases.
3. Division 15 Section "Control Systems Equipment" for temperature-control devices, and control wiring and control devices connected to energy recovery units.

1.3 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each unit scheduled, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; access door, outside air and exhaust louver locations; furnished specialties; accessories; and installation and startup instructions.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 1.

D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE Standards.

B. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE Standards. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE Standards. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.
2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulations.

C. Comply with AGA Standards for gas-fired furnace section.

D. Comply with NFPA 70.

E. Unit efficiencies to be equal to or greater than ASHRAE 90.1 Standards.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver rooftop units as factory-assembled units with protective crating and covering.

B. Coordinate delivery of units in sufficient time to allow movement into building.

C. Handle rooftop units to comply with manufacturer's written rigging and installation instructions for unloading and moving to final location.

1.6 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations with roof construction. Roof specialties are specified in Division 7.

1.7 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.
2. Warranty Period, Gas Fired Heat Exchangers: Manufacturers standard, but not less than 10 years after date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Fan Belts: One set for each size of belt-drive fan.
2. Filters: One set of filters for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Rooftop Units:

a. Aaon
b. York International Corp.
c. Carrier Corp.; Carrier Air Conditioning Div.
d. Trane Company (The); North American Commercial Group.

2.2 ROOFTOP UNITS.

A. Description: Factory assembled and tested; designed for roof or slab installation; and consisting of gas heater, compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers. Units shall be U.L. listed and ARI certified.

B. Casing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, removable panels or access doors with neoprene gaskets for inspection and access to the compressor, supply fan and electrical components, minimum 1/2 inch (12.5 mm) 1-1/2 pound thick thermal insulation coated with neoprene, knockouts for electrical and piping connections, exterior condensate drain connection, and lifting lugs. The platform and plenum shall overhang the roof curb for water run-off.

C. Evaporator Fans: DWDI Forward curved, centrifugal, belt driven with adjustable sheaves or direct-drive fans; and with self aligning permanently lubricated motor bearings.

D. Exhaust/Relief Fans: Forward-curved, centrifugal or propeller type, directly driven with permanently lubricated motor bearings.

E. Condenser Fans: Propeller type, directly driven with permanently lubricated motor bearings.

F. Refrigerant Coils: Aluminum-plate fin and seamless copper tube in galvanized steel casing with equalizing-type vertical distributor. Coils shall be leak tested at 375 psig and suitable for use with R-22 and shall have a suction header and a liquid distributor to distribute to all circuits uniformly and equally.

G. Drain Pans: Drain pans shall be 304 stainless steel, positively sloped and shall extend under the entire cooling coil section and shall be insulated of sufficient thickness to prevent any condensation.

H. Filters: 2-inch- (50-mm-) thick pleated, high-efficiency, throwaway filters in filter rack; with 25 to 35 percent dust-spot efficiency and 90 percent average arrestance

I. Compressors: Serviceable, semigermetic, or fully hermetic compressors with integral vibration isolators and crankcase heaters.

1. Safety Controls: Manual-reset type for low pressure, high pressure, and compressor motor overload protection.
2. Factory-installed Hot-Gas Bypass.
3. Timed-Off Control: Automatic-reset control shuts compressor off after 5 minutes.

J. Heat Exchangers: Manufacturer's standard construction for gas-fired heat exchangers and burners with the following controls:

1. Redundant, dual gas valves (2-stage heating).
2. Intermittent pilot ignition.
3. Electronic-spark ignition system.
4. High-limit cutout.
5. Forced-draft proving switch.

K. Economizer Dampers: Return- and outside-air dampers with damper operator and control package.

1. Leakage: Maximum leakage 2.5 percent at nominal airflow of 400 cfm per ton (54 L/s per kW) with 1-inch wg (250-Pa) pressure differential.
2. Damper Operator: 24 V, with gear train sealed in oil with spring return.

L. Economizer Control: Return- and outside-air dampers, outside-air filter, fully modulating electronic-control system with adjustable mixed-air thermostat and automatic changeover through adjustable enthalpy-control device.

M. Low Ambient Control: Head-pressure control, designed to operate at temperatures as low as 0 deg F (minus 18 deg C).

N. Thermostat: Programmable, automatic changeover electronic; with heating setback and cooling setup with 7-day programming. Thermostat shall be same make as rooftop unit.

O. Operating Controls:

1. Control Outputs: 2-stage heating, 2-stage cooling; and automatic or continuous fan operation and economizer damper operation.
2. Control Sensors: Return-air-temperature sensor, fan airflow-proving switch, dirty-filter switch, discharge-air-temperature sensor, room-temperature sensor, and night-setback-override switch.
3. Control Features: Day/occupied modes for high or low enthalpy and night/unoccupied mode.

2.3 ROOF CURBS

A. Prefabricated 14-gauge galvanized steel insulated with corrosion-protection coating, gasketing, factory-installed wood nailer, according to NRCA standards.

1. Curb Height: Minimum 12 inches (305 mm).
2. Isolation Curb: Rigid upper and lower steel structure with vibration isolation springs and vertical and horizontal restraints; with elastomeric waterproof membrane. 2-inch (50-mm) static deflection.

2.4 MOTORS

A. Refer to Division 15 Section "Motors" for general requirements for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

C. Motors and drives shall be factory mounted with entire assembly balanced before shipment. Motors shall be of the open drip-proof type and shall be mounted on an adjustable motor base properly attached to the unit housing. Units scheduled as variable volume to have motors suitable for variable frequency drives. Motors 15 HP and below shall be equipped with adjustable sheaves. Motors 20 HP and larger shall be equipped with fixed drives to handle scheduled

conditions, and suppliers shall provide a drive “change-out” to meet actual job conditions if required.

D. Motor efficiency to be equal to or greater than ASHRAE 90.1 Standards.

2.5 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate capacity according to ARI Standards.

1. Sound Power Level Ratings: Comply with ARI Standards.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roof for compliance with requirements for conditions affecting installation and performance of rooftop units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install units according to manufacturer's written instructions.

B. Install units level and plumb, maintaining manufacturer's recommended clearances.

C. Coordinate outside air intake locations with exhaust fans and plumbing vents.

D. To protect the equipment during construction and for the purpose of testing and balancing, contractor shall provide a complete set of temporary filters. These temporary filters shall be of glass fiber in a heavy cardboard frame with suitable retainers to hold the media in place. After air systems have been cleaned, tested and approved, these temporary filters shall be removed and replaced with clean 2” thick extended media throwaway filters equal to FARR 30/30.

E. Curb Support: Install roof curb on roof structure, level, according to NRCA's written installation instructions. Install and secure rooftop units on curbs and coordinate roof penetrations and flashing with roof construction.

F. Unit Support: Install unit on structural curbs and level. Coordinate wall penetrations and flashing with wall construction.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping to allow service and maintenance.
2. Gas Piping: Conform to applicable requirements of Division 15 Section "Natural Gas Piping." Connect gas piping to burner, full size of gas train inlet, and provide union with sufficient clearance for burner removal and service.

B. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination in roof mounting frames. Where indicated, terminate return-air duct through roof structure and insulate space between roof and bottom of unit.

C. Electrical: Conform to applicable requirements in Division 16.

D. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL Standards.

3.4 FIELD VERIFICATION

A. Verify that installation is as indicated and specified.

B. Complete manufacturer's installation and startup checks and perform the following:

1. Level unit on roof curb and flash curbs to unit and to roof.
2. Inspect for visible damage to unit casing.
3. Inspect for visible damage to furnace combustion chamber.
4. Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
5. Verify that clearances have been provided for servicing.
6. Check that labels are clearly visible.
7. Clean furnace flue and condenser and inspect for construction debris.
8. Verify that controls are connected and operable.
9. Remove shipping bolts, blocks, and tie-down straps.
10. Verify that filters are installed.
11. Adjust vibration isolators.
12. Connect and purge gas line.
13. Check that burner and controls are suitable to operate at temperatures as low as minus 40 deg F (minus 40 deg C).
14. Check acoustic insulation.
15. Check operation of barometric dampers.

C. Check fan-wheel rotation for correct direction without vibration and binding.

D. Adjust fan belts to proper alignment and tension.

E. Start unit according to manufacturer's written instructions.

1. Perform starting of refrigeration in summer only.
2. Complete startup sheets and attach copy with Contractor's startup report.

F. Check and record performance of interlocks and protection devices; verify sequences.

G. Operate unit for an initial period as recommended or required by manufacturer.

H. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency. Adjust pilot to stable flame.

1. Check for backdraft under full operation.

I. Adjust and check high-temperature limits.

J. Check internal isolators.

K. Check outside-air damper for proper stroke and interlock with return-air dampers.

L. Check controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

M. Verify operation of remote panel, including pilot-light operation and failure modes. Check the following:

1. High-limit heat exchanger.
2. Warm-up for morning cycle.
3. Freezestat operation.
4. Free-cooling mode, outside-air changeover.
5. Alarms.

N. After starting and performance testing, change filters, vacuum heat exchanger and cooling and condenser coils, lubricate bearings, adjust belt tension, and check operation of power vents.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
2. Review data in the maintenance manuals. Refer to Division 1.
3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION 15782

SECTION 15784

THRU-WALL PACKAGED AIR-CONDITIONING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged, freestanding or through-the-wall, terminal air-conditioning and heat-pump units, and their accessories and controls.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, weights, furnished specialties, and accessories for each model indicated.

B. Shop Drawings: Detail layout and installation of wall penetrations.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

C. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 1.

D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

A. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Code for Mechanical Refrigeration."

B. Energy Efficiency Ratio: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

C. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings."

D. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

1. The Terms "Listed" and "Labeled": As defined in the National Electrical Code, Article 100.

E. Comply with NFPA 70.

1.5 COORDINATION

A. Coordinate layout and installation of units and wall construction where unit penetrates wall or is supported by it.

1.6 WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period, Compressors: Manufacturers standard, but not less than 5 years after date of Substantial Completion.
2. Warranty Period, Heat Exchangers: Manufacturers standard, but not less than 10 years after date of Substantial Completion.

PART 2 - PRODUCTS

PART 3 - MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Amana Corp.
2. Carrier Corp.; Carrier Air Conditioning Div.
3. LG
4. Trane Company (The); North American Commercial Group.

3.2 MANUFACTURED UNITS

A. Description: Packaged, self-contained, through-the-wall heat pump terminal units with room cabinet, electric refrigeration system, heating, and temperature controls; fully charged with refrigerant and filled with oil.

B. Cabinet: 0.052-inch- (1.321-mm-) thick, galvanized steel with removable front panel with concealed latches.

1. Mounting: Wall with wall sleeve.
2. Finish: Baked enamel.
3. Discharge Grille and Access Door: Punched-louver discharge grilles allowing 4-way discharge air pattern, with hinged door in top of cabinet for access to controls.
4. Sub-base: Enameled steel with adjustable leveling feet and adjustable end plates, with factory-installed and -wired, fused disconnect switch and receptacle sized for unit.
5. Wall Sleeves: 0.064-inch- (1.626-mm-) thick, galvanized steel with polyester finish.
6. Louvers: Stamped aluminum with clear-anodized finish.

C. Refrigeration System: Direct-expansion indoor coil with capillary restrictor, hermetically sealed compressor with internal spring isolation, external isolation, permanent-split-capacitor motor, and overload protection. Include the following:

1. Outdoor coil and fan.

2. Coaxial tube-in-tube condenser with water-regulating valve.
3. Accumulator.
4. Capillary restrictor and constant-pressure expansion valve.

D. Air System: Forward-curved, centrifugal, indoor fans with permanent-split-capacitor motor, permanent washable filters, and positive-pressure ventilation damper with concealed manual operator.

E. Electric-Resistance Heating Coil: Nickel-chromium wire, electric-resistance heating elements with contactor and high-temperature-limit switch.

F. Condensate Dispersion System: The system shall remove condensate from indoor cooling operation by throwing water directly on the outdoor coil for rapid evaporation and increased cooling efficiency.

G. Outdoor Fan: Forward curved, centrifugal with separate permanent-split-capacitor motor.

H. Outdoor Fan: Propeller type with separate permanent-split-capacitor motor.

3.3 CONTROLS

A. Control Module: Unit-mounted adjustable thermostat with heat anticipator, off-heat-auto-cool switch, and high-low fan switch.

B. Low Ambient Lockout Control: Prevents cooling cycle operation below 40 deg F (5 deg C), outdoor-air temperature.

3.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Factory test to comply with ARI Standards.

B. Unit Performance Ratings: Factory test to comply with ARI Standards.

PART 4 - EXECUTION

4.1 INSTALLATION

A. Install units according to manufacturer's written instructions.

B. Coordinate installation of wall sleeves in finished wall assembly; seal and weatherproof.

4.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. Install piping to allow service and maintenance.
2. Condensate Drain: Make indirect connection at nearest floor or equipment drain.

B. Electrical: Connect units to wiring systems and to ground as indicated and instructed by manufacturer.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL Standards.

4.3 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

4.4 FIELD VERIFICATION

A. After installation, check the following:

1. Unit is level on base and is flashed in exterior wall.
2. Unit casing has no visible damage.
3. Compressor, air-cooled condenser coil, and fans have no visible damage.
4. Labels are clearly visible.
5. Controls are connected and operable.
6. Shipping bolts, blocks, and tie-down straps are removed.
7. Filters are installed and clean.
8. Drain pan and drain line are installed correctly.
9. Controls are suitable to operate at temperatures as low as minus 40 deg F (- 40 deg C).
10. Acoustic insulation is present.

B. Check fan-wheel rotation for correct direction without vibration and binding.

C. Start unit according to manufacturer’s written instructions.

D. After starting and performance test, change filters.

END OF SECTION 15784

SECTION 15815

METAL DUCTS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sheet Metal Materials.
2. Duct Liner.
3. Sealant Materails.
4. Hangers and Supports.
5. Duct Fabrication.

B. Related Sections:

1. Section 07840 - Firestopping: For fire-resistant sealants for use around duct penetrations and fire-damper installations in fire-rated floors, partitions, and walls.
2. Section 08310 - Access Doors: For wall- and ceiling-mounted access doors for access to concealed ducts.
3. Section 15081 - Duct Insulation: For duct insulation.
4. Section 15820 -Duct Accessories: For dampers, sound-control devices, duct-mounted access doors and panels, turning vanes, and flexible ducts.
5. Section 15850 - Air Inlets and Outlets.
6. Section 15950 - Testing, Adjusting, and Balancing: For air balancing and final adjusting of manual-volume dampers.

1.2 DEFINITIONS

A. Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168.

1.3 SYSTEM DESCRIPTION

A. Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. Changes to layout or configuration of duct system must be specifically approved in writing by the Engineer of Record. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

1.4 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data:

a. For duct liner and sealing materials.

2. Welding Certificates: Copies of certificates indicating welding procedures and personnel comply with requirements in "Quality Assurance" Article.

3. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
4. Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

1.5 QUALITY ASSURANCE

A. Welding Standards: Qualify welding procedures and welding personnel to perform welding processes for this Project according to AWS D1.1, "Structural Welding Code--Steel" for hangers and supports; AWS D1.2, "Structural Welding Code--Aluminum," for aluminum supporting members; and AWS D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.

C. Comply with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems," unless otherwise indicated.

D. Comply with NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations," Chapter 3, "Duct System," for range hood ducts, unless otherwise indicated.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store stainless-steel sheets with mill-applied adhesive protective paper maintained through fabrication and installation.

PART 2 PRODUCTS

2.1 SHEET METAL MATERIALS

A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653, G90 coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

B. Carbon-Steel Sheets: ASTM A 366, cold-rolled sheets; commercial quality; with oiled, exposed matte finish.

C. Stainless Steel: ASTM A 480, Type 316, sheet form with No. 4 finish for surfaces of ducts exposed to view; and Type 304, sheet form with No. 1 finish for concealed ducts.

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 36-inch length or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 DUCT LINER

A. General: Comply with NFPA 90A or NFPA 90B and NAIMA's "Fibrous Glass Duct Liner Standard."

B. Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.

1. Thickness: 1 inch.
2. Thermal Conductivity (k-Value): 0.26 at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread rating of 25 and smoke-developed rating of 50, when tested according to ASTM C 411.
4. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.

5. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
   a. Tensile Strength: Indefinitely sustain a 50-lb- tensile, dead-load test perpendicular to duct wall.
   b. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch into airstream.
   c. Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.

2.3 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

1. Joint and Seam Tape: 2 inches wide; glass-fiber fabric reinforced.
2. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant, formulated with a minimum of 75 percent solids.
3. Flanged Joint Mastics: One-part, acid-curing, silicone, elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.4 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for building materials.

1. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
2. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

B. Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.

1. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.
2. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

D. Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

1. Supports for Galvanized-Steel Ducts: Galvanized steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel support materials.

2.5 RECTANGULAR DUCT FABRICATION

A. General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

1. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
2. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

B. Fabricate range hood exhaust ducts with 0.0598-inch-thick, carbon-steel sheet for concealed ducts and 0.0500-inch-thick stainless steel for exposed ducts. Weld and flange seams and joints. Comply with NFPA 96.

2.6 SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS

A. Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness are prohibited.

B. Apply adhesive to liner facing in direction of airflow not receiving metal nosing.

C. Butt transverse joints without gaps and coat joint with adhesive.

D. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

E. Do not apply liners in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

F. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely around perimeter; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.

G. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profile or are integrally formed from duct wall. Fabricate edge facings at the following locations:

1. Fan discharge.
2. Intervals of lined duct preceding unlined duct.

H. Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire-damper sleeve.

2.7 ROUND DUCT FABRICATION

A. Round Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

2.8 ROUND SUPPLY AND EXHAUST FITTING FABRICATION

A. 90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.

B. Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

C. Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate bend radius of die-formed, gored, and pleated elbows one and one-half times elbow diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

1. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
2. 90-Degree, Two-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material-handling classes A and B; and only where space restrictions do not permit using 1.5 bend radius elbows. Fabricate with single-thickness turning vanes.
   Round Elbows, 8 Inches and Smaller: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.and 90 degrees, unless space restrictions require a mitered elbow. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.
3. Round Elbows, Larger Than 14 Inches: Fabricate gored elbows, unless space restrictions require a mitered elbow.
4. Die-Formed Elbows for Sizes through 8 Inches and All Pressures: 0.040 inch thick with two-piece welded construction.
   Round Elbows, 9 through 14 Inches: Fabricate gored or pleated elbows for 30, 45, 60,

2.9 KITCHEN GREASE EXHAUST DUCTWORK

A. The kitchen grease exhaust ductwork shall be constructed of black steel not less than 16 ga. up to 4 sq. ft. area, 14 ga. above 4 sq. ft. or as required by local codes with continuous grease-tight and water-tight welds at all joints and seams.

B. The system shall be so constructed that no grease will become pocketed in any portion thereof and shall slope at not less than that prescribed by local codes, back to the hood. Where permitted by local codes, provide approved duct grease residue trap when minimum slopes are not provided due to restricted clearance.

C. Openings in duct shall conform to code requirements and shall be provided for complete and thorough cleaning of duct system.

D. Air velocity in the duct shall be not less than 2000 fpm nor more than 2500 fpm.

E. Connection to hood shall be made above the finished ceiling unless shown otherwise on the drawings.

F. All connections to fans shall be bolted flanged type and shall be gasketed with a resilient gasket not less than 3/8" thick, for fume-tight seal and for vibration absorption. Gasket shall be of a material impervious to grease and be NPFA approved as fire and leak proof.

G. All kitchen hood exhaust ducts shall have fire rated insulation or enclosure as required to meet all code requirements. Method shall be approved by governing authorities having jurisdiction prior to installation.

2.10 KITCHEN DISHWASHER EXHAUST DUCTWORK

A. Dishwasher exhaust systems shall be constructed of not less than 18 gauge stainless steel, or as required by local codes, welded liquid tight and drained to eliminate condensate. Slope duct to the dishwasher and provide trap at dishwasher for condensation with 3/4" drain line to a floor drain.

PART 3 EXECUTION

3.1 DUCT INSTALLATION, GENERAL

A. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts, fittings, and accessories.

B. Construct and install each duct system for the specific duct pressure classification indicated.

C. Install round ducts in lengths not less than 12 feet, unless interrupted by fittings.

D. Install ducts with fewest possible joints.

E. Install fabricated fittings for changes in directions, changes in size and shape, and connections.

F. Install couplings tight to duct wall surface with a minimum of projections into duct.

G. Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.

H. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

I. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.

J. Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

K. Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults, electrical equipment spaces and enclosures, and through elevator equipment rooms.

M. Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least 1-1/2 inches.

N. Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Section 15820 "Duct Accessories." Firestopping materials and installation methods are specified in Section 07840 "Firestopping."

3.2 SEAM AND JOINT SEALING

A. General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Pressure Classification Less Than 2-Inch wg: Transverse and longitudinal joints.

C. Seal externally insulated ducts before insulation installation.

D. Materials: 3M Brand No. 800.

3.3 HANGING AND SUPPORTING

A. Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Support horizontal ducts within 24 inches of each elbow and within 48 inches of each branch intersection.

C. Support vertical ducts at a maximum interval of 16 feet and at each floor.

D. Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

3.4 CONNECTIONS

A. Connect equipment with flexible connectors according to Section 15820 "Duct Accessories."

B. For branch, outlet and inlet, and terminal unit connections, comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

C. Leakage Test: Perform tests according to SMACNA's "HVAC Air Duct Leakage Test Manual."

3.5 ADJUSTING

A. Refer to Section 15950 "Testing, Adjusting, and Balancing" for detailed procedures.

3.6 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect the system. Vacuum interior as well as exterior of ducts before final acceptance to remove dust and debris.

END OF SECTION 15815

SECTION 15820

DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes:

1. Manual-Volume Dampers.
2. Fire Dampers.
3. Turning Vanes.
4. Duct-Mounted Access Doors.
5. Flexible Connectors.
6. Flexible Ducts.
7. Accessories.

B. Related Sections:

1. Section 08310 - Access Doors: For wall- and ceiling-mounted access doors and panels.
2. Section 15850 - Air Inlets and Outlets.
3. Section 13850 - Fire Alarm and Detection Systems: For duct-mounted fire and smoke detectors.

1.2 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data: For the following:

a. Manual-volume dampers.
b. Fire dampers.
c. Duct-mounted access doors.
d. Flexible ducts.

2. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:

a. Special fittings and manual- and automatic-volume-damper installations.
b. Fire damper installations, including sleeves and duct-mounted access doors and panels.

3. Product Certificates: Submit certified test data on dynamic insertion loss; self-noise power levels; and airflow performance data, static-pressure loss, dimensions, and weights.

1.3 QUALITY ASSURANCE

A. NFPA Compliance: Comply with the following NFPA standards:

1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Sheet Metal and Air Conditioning Contractors National Association, Inc. manuals (SMACNA) except where details or notes on drawings indicate otherwise.

1. HVAC Construction Standards Metal and Flexible.
2. Fire Damper and Heat Stop Guide for Air Handling Systems.

C. Underwriters Laboratories (UL) Standard for Safety UL 181, UL 555.

1.4 EXTRA MATERIALS

A. Furnish extra materials described in Section 01790 “Spare Parts and Materials” that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Manual Volume Dampers.

a. Ruskin (816-761-7476)
b. Air Balance (419-865-5000)
c. Prefco (800-437-6653)

2. Fire Dampers.

a. Ruskin (816-761-7476)
b. Air Balance (419-865-5000)
c. Prefco (800-437-6653)

3. Flexible Connectors.

a. Vent Fabrics, Inc. (800-621-1207)
b. Ward Duct Connectors (412-258-0500)
c. Vent Products Co. (800-368-8368)

4. Flexible Ducts.

a. General Environment Inc.
b. Clevaflex. Ltd. (216-941-6505)
c. H.K. Porter.

2.2 MANUAL-VOLUME DAMPERS

A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.

1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
2. Roll-Formed Steel Blades: 0.064-inch- thick, galvanized, sheet steel.
3. Blade Axles: Nonferrous.
4. Tie Bars and Brackets: Galvanized steel.

C. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch thick zinc-plated steel, and a 3/4-inch hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.3 FIRE DAMPERS

A. General: Labeled to UL 555.

B. Fire Rating: One and one-half hour unless noted otherwise.

C. Frame: SMACNA Type B with blades out of airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

D. Mounting Sleeve: Factory- or field-installed galvanized, sheet steel.

1. Minimum Thickness: 0.052 inch or 0.138 inch thick and length to suit application.
2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.

E. Mounting Orientation: Vertical or horizontal as indicated.

F. Blades: Roll-formed, interlocking, 0.034 inch thick, galvanized, sheet steel. In place of interlocking blades, use full-length, 0.034 inch thick, galvanized steel blade connectors.

G. Horizontal Dampers: Include a blade lock and stainless-steel negator closure spring.

H. Fusible Link: Replaceable, 165 F rated as indicated.

I. Provide access door in duct adjacent to each fire damper.

2.4 TURNING VANES

A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

B. Manufactured Turning Vanes: Fabricate of 1-1/2 inch wide, curved blades set 3/4 inch o.c.; support with bars perpendicular to blades set 2 inches o.c.; and set into side strips suitable for mounting in ducts.

2.5 DUCT-MOUNTED ACCESS DOORS

A. General: Fabricate doors airtight and suitable for duct pressure class.

B. Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.

C. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch butt or piano hinge and cam latches.

D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

E. Insulation: 1-inch thick, fibrous-glass.

2.6 FLEXIBLE CONNECTORS

A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

B. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 2-3/4 inch wide, 0.028 inch thick, galvanized, sheet steel. Select metal compatible with connected ducts.

C. Transverse Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches wide attached to two strips of 4-3/8 inch wide, 0.028 inch thick, galvanized, sheet steel Select metal compatible with connected ducts.

D. Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.

1. Minimum Weight: 26 oz./sq. yd.
2. Tensile Strength: 480 lbf/inch in the warp, and 360 lbf/inch in the filling.
3. Minimum Movement: 2 inches.

2.7 FLEXIBLE DUCTS

A. General: Comply with UL 181, Class 1.

B. Flexible Ducts, Uninsulated: Corrugated aluminum. For use on dryer vents only.

C. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch thick, glass-fiber insulation around a continuous inner liner.

1. Reinforcement: Steel-wire helix encapsulated in inner liner.
2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
3. Inner Liner: Polyethylene film.

D. Pressure Rating: 6-inch wg positive, 1/2-inch wg negative.

2.8 ACCESSORIES

A. Louvers:

1. Centrifugal Roof Ventilators:

    a. Carnes Co. 9608-845-6411)
    b. Cook (Loren) Co. (417-869-6474)
    c. Greenheck Fan Corp. (715-359-6171)

2. Attic Ventilators:

    a. Carnes Co. (608-845-6411)
    b. Cook (Loren) Co. (417-869-6474)
    c. Greenheck Fan Corp. (715-359-6171)

3. Ceiling-Mounted Ventilators:

    a. Carnes Co. (608-845-6411)
    b. Cook (Loren) Co. (417-869-6474)
    c. Greenheck Fan Corp. (715-359-6171)
    d. Broan-Nutone (800-548-0790)
    e. Matsushita Electric Corp. of America, Panasonic (201-348-7000)

2.2 CENTRIFUGAL ROOF VENTILATORS

A. Description: Belt-driven or direct-drive centrifugal fans, as indicated, consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

B. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.

C. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

D. Belt-Driven Drive Assembly: Resiliently mounted to the housing, with the following features:

1. Fan Shaft: Turned, ground, and polished steel drive shaft keyed to wheel hub.
2. Shaft Bearings: Permanently lubricated, permanently sealed, self-aligning ball bearings.
3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
4. Fan and motor isolated from exhaust air stream.

E. Accessories: The following items are required as indicated:

1. Variable-Speed Controller: Solid-state control to reduce speed from 100 percent to less than 50 percent. (Direct drive fans only).
2. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit.
3. Bird Screens: Removable 1/2-inch mesh, aluminum or brass wire.
4. Dampers: Counterbalanced, parallel-blade, backdraft dampers mounted in curb base; factory set to close when fan stops.
5. Roof Curbs: Galvanized steel; mitered and welded corners; 2-inch- thick, rigid, fiberglass insulation adhered to inside walls; and 2-inch wood nailer. Size as required to suit roof opening and fan base.
6. Configuration: Built-in cant and mounting flange.
7. Overall Height: 12 inches. Minimum.

2.3 CEILING-MOUNTED VENTILATORS

A. Description: Centrifugal fans designed for installing in ceiling or wall, or for concealed in-line applications.

B. Housing: Galvanized steel lined with acoustical insulation.

C. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

D. Grille: Steel, louvered grille with flange on intake and thumbscrew attachment to fan housing.

E. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

F. Variable-Speed Controller Mounted on Fan Housing: Solid-state control to reduce speed from 100 percent to less than 50 percent.

G. Sound Level: Maximum of 1.5 Sones in Guestroom Toilets

H. Accessories: Manufacturer's standard roof jack or wall cap, and transition fittings.

2.4 ATTIC VENTILATORS

A. Description: Wall mounted, direct drive, propeller fan consisting of housing, wheel, motor drive, thermostat.

B. Housing: Heavy gauge aluminum dome with insect screen, splash guard, heavy gauge aluminum flashing.

C. Motor Drive: Thermally protected, permanently protected motor.

D. Wheel: Aluminum propeller and hub construction.

E. Thermostat: Single stage line voltage thermostat with 55°to 130°F. range, bimetal actuated.

2.5 MOTORS

A. Refer to Section 15090 "Motors" for general requirements for factory-installed motors.

B. Motor Construction: NEMA MG 1, general purpose, continuous duty, Design B.

C. Enclosure Type: The following features are required as indicated:

1. Open dripproof motors where satisfactorily housed or remotely located during operation.

2.6 FACTORY FINISHES

A. Sheet Metal Parts: Prime coat before final assembly.

B. Exterior Surfaces: Baked-enamel finish coat after assembly.

C. Aluminum Parts: No finish required.

2.7 SOURCE QUALITY CONTROL

A. Testing Requirements: The following factory tests are required as indicated:

1. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings From Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA Seal.
2. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements of installation tolerances and other conditions affecting performance of the power ventilators. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install power ventilators according to manufacturer's written instructions.

B. Support units using the vibration-control devices indicated. Vibration-control devices are specified in Section 15070 "Mechanical Sound, Vibration, and Seismic Control."

1. Secure roof-mounted fans to roof curbs with cadmium-plated hardware.

a. Installation of roof curbs is specified in Division 7 Sections.

2. Suspend units from structural steel support frame using threaded steel rods and vibration isolation springs.
3. Ceiling Units: Suspend units from structure using steel wire or metal straps.

C. Install units with clearances for service and maintenance.

D. Label units according to requirements specified in Section 15075 "Mechanical Identification."

3.3 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors.

B. Electrical: Conform to applicable requirements in Division 16 Sections.

C. Grounding: Ground equipment. Tighten electrical connectors and terminals, including grounding connections, according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Provide services of a factory-authorized service representative to supervise the field assembly of components and installation of fans, including duct and electrical connections, and to report results in writing.

3.5 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Adjust belt tension.

C. Lubricate bearings.

3.6 CLEANING

A. After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.
B. Clean fan interiors to remove foreign material and construction debris. Vacuum clean fan wheel and cabinet.

3.7 COMMISSIONING

A. Final Checks before Startup: Perform the following operations and checks before startup:

1. Verify that shipping, blocking, and bracing are removed.
2. Verify that unit is secure on mountings and supporting devices and that connections for piping, ducts, and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnects.
3. Perform cleaning and adjusting specified in this Section.
4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
6. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in the fully open position.
7. Disable automatic temperature-control operators.

B. Starting procedures for fans are as follows:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated RPM.
2. Measure and record motor voltage and amperage.

C. Shut unit down and reconnect automatic temperature-control operators.

D. Refer to Section 15950 "Testing, Adjusting, and Balancing" for procedures for air-handling-system testing, adjusting, and balancing.

E. Replace fan and motor pulleys as required to achieve design conditions.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

1. Conduct training as specified in Section 01820 "Training".
2. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive.

END OF SECTION 15833

SECTION 15850

AIR INLETS & OUTLETS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Diffusers
2. Registers
3. Grilles
4. Louvers

B. Related Sections:

1. Section 15820 - Duct Accessories.
2. Section 15950 - Testing, Adjusting, and Balancing.

1.2 DEFINITIONS

A. Diffuser: Circular, square, or rectangular air distribution outlet, generally located in the ceiling and comprised of deflecting members discharging supply air in various directions and planes and arranged to promote mixing of primary air with secondary room air.

B. Grille: A louvered or perforated covering for an opening in an air passage, which can be located in a sidewall, ceiling, or floor.

C. Register: A combination grille and damper assembly over an air opening.

1.3 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data: For each model indicated, include the following:

a. Data Sheet: For each type of air outlet and inlet, and accessory furnished; indicate construction, finish, and mounting details.
b. Performance Data: Include throw and drop, static-pressure drop, and noise ratings for each type of air outlet and inlet.
c. Schedule of diffusers, registers, and grilles indicating drawing designation, room location, quantity, model number, size, and accessories furnished.
d. Assembly Drawing: For each type of air outlet and inlet: indicate materials and methods of assembly of components.

1.4 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.

B. NFPA Compliance: Install diffusers, registers, and grilles according to NFPA 90A, "Standard for the Installation of air-conditioning and Ventilating Systems."

PART 2 PRODUCTS

2.1 MANUFACTURED UNITS

A. Diffusers, registers, and grilles (As scheduled on Drawings):

1. Approved Manufacturers:

a. Titus (214-699-1030)
b. Carnes (608-845-6411)
c. Krueger (520-295-8500)

B. Exterior Louvers:

1. Avendra, LLC Preferred Manufacturers:

a. None.

2. Approved Manufacturers:

a. Ruskin Manufacturing (816-761-7476)
b. American Warming & Ventilating Co. (419-865-5000)
c. Arrow United Industries (570-746-1888)

3. Provide storm proof exterior wall louvers; size as indicated on Drawings.
4. Louvers shall be AMCA certified for zero water penetration and maximum 1/8-inch pressure drop at a free area velocity of 900 fpm.
5. Louvers shall be 4” deep constructed of 0.081” thick 6063-TS extruded aluminum complete with ½” aluminum screen in removable frame.
6. Frames shall be box type for masonry construction and flange type for frame construction.
7. Louver shall have a factory baked enamel prime finish ready to accept full paint to match adjacent surfaces.
8. Louvers shall be minimum 4” deep, storm proof, extruded aluminum, drainable, with ½” square mesh aluminum screen on interior face.

2.2 SOURCE QUALITY CONTROL

A. Testing: Test performance 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. Do not proceed with installation until 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 practicable. For units installed in lay-in ceiling panels, locate units in the center of the panel. Where architectural features or other item conflict with installation notify Owner’s Representative for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connection 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 15850

SECTION 15900

HVAC INSTRUMENTATION AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Control Panels
2. Thermostats
3. Actuators
4. Dampers
5. Wiring

B. Related Sections:

1. Section 15940 - Sequence of Operation
2. Section 16120 - Conductors and Cables
3. The provision of 120 and 208 line voltage and 24 volt low voltage wiring, conduit, installed in accordance with National Fire Protection Association (NFPA) 70, “National Electric Code” and Division 16 of these specifications.

1.2 SYSTEM DESCRIPTION

A. Electric system consists of thermostats, actuators, final control elements, and accessories to control mechanical systems.

1.3 SUBMITTALS

A. Submit “Letter of Conformance” in accordance with Section 01330 indicating specified items selected for use in Project with the following supporting data:

1. Product Data:

a. Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
b. Each control device labeled with setting or adjustable range of control.

2. Shop Drawings: For each system to be controlled, prepare a drawing which includes a system flow diagram, control diagram, sequence of operation and schedule of components. Control diagrams shall be complete with end-to-end connections of wiring from component terminal.
3. Operation and Maintenance Data: Submit information for all products in accordance with the requirements of Specification Section 01830.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an approved installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

1.6 COORDINATION

A. Coordinate location of thermostats and other exposed control sensors with plans and room details before installation.

1.7 TRAINING

A. Submit in accordance with the requirements of specification Section 01820.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Approved Manufacturers:

1. Electric Systems:

a. By selected equipment manufacturer.

2.2 THERMOSTATS

A. Combination Thermostat and Fan Switches: Line-voltage or low voltage thermostat with two-, three-, or four-position, push-button or lever-operated fan switch.

1. Label switches "FAN ON-OFF," "FAN HIGH-LOW-OFF," "FAN HIGH-MED-LOW-OFF." Provide unit for mounting on two-gang switch box.

B. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

C. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.

1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.
2. Dead Band: Maximum 2 deg F.

D. Room Thermostat Cover Construction: Manufacturer's standard locking covers.

E. Room thermostat accessories include the following:

1. Insulating Bases: For thermostats located on exterior walls.
2. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.
3. Adjusting Key: As required for calibration and cover screws.
4. Aspirating Boxes: For flush-mounted aspirating thermostats.
5. Set-Point Adjustment: 1/2-inch-diameter, adjustment knob.

2.3 ACTUATORS

A. Electric Motors: Spring-return type operators, sized to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
2. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
3. Temperature Rating: Minus 22 to plus 122 deg F.
4. Damper Operator Mounting: Mount damper operators where accessible for maintenance.

a. If located outside the duct or casing, mount operators on a 14 gauge reinforced support plate arranged to allow insulation between the support plate and the face of the duct or casing.
b. Brace damper operators rigid to show no deflection or movement over the full range of the damper stroke.

2.4 DAMPERS

A. Dampers: Factory fabricated AMCA-rated opposed blade design of extruded aluminum, galvanized steel, with metallic antifriction nonferrous bearings.

1. Blades shall be secured to 1/2-inch diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
2. Operating Temperature Range: From minus 40 to plus 200 deg F.
3. Pressure Rating: Rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4 inches wg when damper is being held by torque of 50 in. x lbf when tested according to AMCA 500D.
4. Shafts and Bearings: Provide cadmium plated steel shafts in permanently lubricated bronze sleeve bearings or permanently lubricated ball bearings.
5. Blade: Reinforced or ribbed blades shall not exceed 8 inches in width nor 48 inches in length.

a. Blades shall be constructed of 16 gage (minimum) galvanized steel or extruded aluminum.
b. Flat or un-reinforced blades will not be acceptable.
c. Damper sections exceeding 4 feet in width or 4 feet height shall be constructed with multiple frames and linkages.

6. Frames: Construct frames of factory welded 13 gage (minimum) galvanized steel hot dipped after construction or bolted extruded aluminum frames.

    a. Dampers larger than 8 square feet in area shall have corner bracing gussets at each corner welded to the damper frame.

7. Linkages: Provide linkages to uniformly transmit damper operating forces to each damper blade.

    a. Construct linkages of galvanized or cadmium plated steel or stainless steel.
    b. Bearings and joints shall be ball and socket or sleeve bearings of brass, bronze or stainless steel, with plated bolts and locking nuts.

8. Seals: Provide mechanically attached elastomer or neoprene blade tip seal along the full length of each blade edge and flexible stainless steel seals along damper blade ends where the blades abut the frame. Adhesives or staples will not be acceptable.
9. Damper Mounting: Mount dampers to casings and ductwork in conformance with SMACNA standards. Provide welded or bolted galvanized steel structural supports for dampers larger than 20 square feet. Through bolt damper frames to structural supports.
10. Submit information showing leakage and flow characteristics, and schedule showing sizes, locations and actuators.

2.5 WIRING

A. General: Provide a complete system of electric wiring for temperature control apparatus including control power transformers and wiring to the transformer primary.

B. Insulation Level: Control circuit conductors which run in the same conduit as power circuit conductors shall have the same insulation level as adjacent power conductors.
C. NFPA 70: All wiring shall conform to the requirements of the NFPA 70.

D. Wiring: Wire for low voltage AC shall be minimum 300 volt insulated copper No. 18 AWG or larger conforming to NFPA 70, Type MTW, THHN or TFFN.

1. For low voltage DC and an electronic circuit carrying less than 0.5 amperes, cables of two or more conductors not smaller than No. 18 AWG solid copper or No. 18 AWG solid copper if not shielded may be used in lieu of individual wires.
2. Cables carrying analog signals shall be shielded.
3. Cables shall be terminated in solder or screw type terminal strips.
4. Cables shall not be tapped at any intermediate points.
5. All wire shall not be color coded or numbered for identification. Identify as indicated on shop drawings and “As-Built” drawings.
6. Wire terminating in screw type terminal strips shall have pressure connectors conforming to UL 486A, “Wire Connectors and Soldering Lugs for Use With Copper Conductors”, or UL 486B, “Wire Connectors for Use With Aluminum Conductors”.
7. Wire terminations without connectors or travelling pressure pads will not be accepted.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that duct-, pipe-, and equipment-mounted devices and wiring are installed before proceeding with installation.

3.2 INSTALLATION

A. Install equipment level and plumb.

B. Verify location of thermostats and other exposed control sensors with plans and room details before installation, unless otherwise indicated on the mechanical, electrical, or architectural drawings. Locate all wall mounted devices 60 inches above the floor.

C. Install guards on thermostats in the following locations:

1. Where indicated on drawings.

D. Install damper motors on duct exterior. Do not locate operators exposed to outdoor temperatures. Arrange actuators to “Fail Safe” in the event of power failure.

E. Install labels and nameplates to identify control components according to Section 15075 "Mechanical Identification."

3.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 16.

B. Install building wire and cable according to Section 16120 "Conductors and Cables."

C. Install signal and communication cable according to Division 16.

1. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
2. Install exposed cable in raceway.
3. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
4. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
5. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

F. All wall-mounted space sensors such as thermostats shall be securely anchored to an electrical box. Do not mount devices directly to the wall surfaces.

G. Identification: Labor or color code each filed wire and conduit at each controller and controlled device.

1. Identification shall be permanent and not subject to fading.
2. Permanently mark terminal blocks at wire termination points.

3.4 FIELD QUALITY CONTROL

A. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.

C. Replace damaged or malfunctioning controls and equipment.

1. Start, test, and adjust control systems.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

3.5 DEMONSTRATION AND TRAINING

A. Demonstration: Include start-up, automatic and manual operation, and emergency modes of use in accordance with the prescribed sequence of operations. Should the HVAC system demonstration fail to operate properly, the system shall be repaired, recalibrated, and retested as necessary.

B. Train Owner's maintenance personnel to adjust, operate, and maintain control systems and components.

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Conduct training as specified in Section 01820 "Training".

3.6 POST OCCUPANCY ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three 2-hour on-site Project visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes, adjust sensors and controls to suit actual conditions, and assist in the diagnostics of HVAC problems.

END OF SECTION 15900

SECTION 15940

SEQUENCE OF OPERATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Control Sequences For HVAC Systems, Subsystems, And Equipment.

B. Related Sections:

1. Section 15900 - HVAC Instrumentation and Controls.

1.2 SEQUENCE OF OPERATIONS

A. (PTAC) Package Terminal Air Conditioning Units.

1. Service: As shown on the drawings.
2. Integral (remote) thermostat shall cycle fan, compressor and electric heat to maintain space set point temperature.
3. Remove temperature limiters.

B. Public Toilet Room Exhaust.

1. The exhaust fan shall run continuously, 24 hours per day.

C. Guest Room Bathroom Exhaust.

1. The exhaust fan shall run continuously, 24 hours per day.

F. Packaged Unit Make-up Air Unit

1. System consists of DX packaged unit for 100% outside / make-up air. The unit will take 100% outside air and condition to neutral temperature (74 degrees, adjustable) and humidity(50% RH, adjustable). Neutral fresh air will be delivered to corridor to provide outside air to pressurize corridor and rooms and provide conditioned air to corridor and guest rooms.

G. Make-up Air Unit Operation – General

1. Make-up unit is DX packaged unit with DX cooling coil, digital modulating compressor on lead circuit, modulating hot gas reheat control, and electric heater with 6 stages of control.
2. Unit will be supplied with microprocessor based control system including an electronic supply air temperature controller, a supply air sensor to be located in supply air duct for staging of compressors and reheat control, and an outside air temperature and humidity sensor to be located in outside ambient air. All temperature and humidity setpoints will be adjustable through the use of a hand held service tool or a permanently wall mounted “System Manager” interface control panel.

3. Unit to handle and treat 100% outside air. Outside air to be pre-conditioned by this unit and ducted to corridor. Unit to supply air temperature to corridor in the range of 74 degrees and 50% RH.

H. Outside air damper control

1. 100% outside air damper in unit to be fully open when unit fan is on, fully closed when unit fan is off. Motor shall be spring return to ensure closing of outdoor air damper during periods of unit shut down or power failure.

I. Cooling operation

1. When outside air conditions are above 74 degrees and outside air dewpoint is below setpoint, unit compressors will be energized to cool the outside air to 74 degrees F (adjustable).

J. Dehumidification Operation

1. When outside air conditions are above 55 degrees and outside air dewpoint is above setpoint, unit will operate in dehumidification mode. Compressors will be locked on to produce 50 to 55 degree air to dehumidify the air. Hot gas re-heat will reheat 50 to 55 degree air to 74 degrees F (adjustable). Lag circuit to include hot gas bypass valve to be energized when low pressure is detected to eliminate evaporator coil freeze-up. Lead circuit to include digital modulating compressor to modulate to match capacity required at all conditions including low sensible/high latent load conditions without the need of hot gas bypass.

K. Ventilation Mode

1. When outside air conditions are below 74 degrees and above 60 degrees and outside air dewpoint is below setpoint, unit will operate in ventilation mode with no cooling or heating operating.

L. Heating Operation

1. Compressors will be locked out below 55 degrees F.
When outside air conditions are below 55 degrees, electric heat will be staged to heat supply air to 74 degrees.

END OF SECTION 15940

SECTION 15950

TESTING, ADJUSTING, AND BALANCING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Balancing airflow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC and plumbing equipment.
4. Setting quantitative performance of HVAC and plumbing equipment.
5. Verifying that automatic control devices are functioning properly.
6. Reporting results of the activities and procedures specified in this Section.
7. Adjustment of recirculating domestic hot water return system.
8. Verify performance of package terminal air conditioning units.

B. Related Sections:

1. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
2. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

1.2 REFERENCES

A. AABC: Associated Air Balance Council.

B. AMCA: Air Movement and Control Association.

C. NEBB: National Environmental Balancing Bureau.

D. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

C. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

D. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

E. Report Forms: Test data sheets for recording test data in logical order.

F. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

G. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

H. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

I. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

J. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

K. Test: A procedure to determine quantitative performance of a system or equipment.

L. Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

1.4 SUBMITTALS

A. Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

B. Contract Documents Examination Report: Within 45 days from the Contractor’s Notice to Proceed, submit 2 copies of the Contract Documents Review Report as specified in Part 3 of this Section.

C. Submittals Examination Report: Prior to the start of duct or piping fabrication, submit 2 copies of the Submitted Examination Report as specified in Part 3 of this Section.

D. Certified Testing, Adjusting, and Balancing Reports: Submit 2 copies of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

1.5 QUALITY ASSURANCE

A. Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

B. Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
2. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

C. Testing, Adjusting, and Balancing Reports: Use testing, adjusting, and balancing standard forms from AABC's "National Standards for Testing, Adjusting and Balancing" or NEBB's "Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems".

D. Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

E. Testing, Adjusting, and Balancing Conference: Meet with the Owner's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days advance notice of scheduled meeting time and location. As a minimum include the following agenda items:

1. Submittal distribution requirements.
2. Contract Documents examination report.
3. Testing, adjusting, and balancing plan.
4. Work schedule and Project site access requirements.
5. Coordination and cooperation of trades and subcontractors.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

B. Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 EXECUTION

2.1 EXAMINATION

A. Examine Contract Documents to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment and submit "Contract Documents Examination Report".

1. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.
3. Examine Engineer's design data, including HVAC and Plumbing system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC and Plumbing systems and equipment controls.

B. Examine approved submittal data of HVAC and Plumbing systems and equipment including sheet metal duct fabrication and plumbing piping shop drawings to ensure that the distribution system is reasonably complete and sufficiently designed to accurately balance the complete building. Submit “Submitting Examination Report”.

1. Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

1. Examine HVAC and Plumbing systems and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.
2. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.
3. Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
4. Examine terminal units to verify that they are accessible and their controls are connected and functioning.
5. Examine plenum ceilings, utilized for return air, to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.
6. Examine heat-transfer coils for clean and straight fins.
7. Examine equipment for installation and for properly operating safety interlocks and controls.
8. Examine automatic temperature system components to verify the following:

    a. Dampers, and other controlled devices operate by the intended controller.
    b. Dampers are in the position indicated by the controller.
    c. Integrity dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in variable-air-volume terminals.
    d. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.
    e. Sensors are located to sense only the intended conditions.
    f. Sequence of operation for control modes is according to the Contract Documents.
    g. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
    h. Interlocked systems are operating.
    i. Changeover from heating to cooling mode occurs according to design values.

D. Examine project record documents described in Section 01785 “Project Record Documents”.

E. Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

2.2 PREPARATION

A. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

B. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Automatic temperature-control systems are operational.
3. Equipment and duct access doors are properly located, sized, and securelly closed.
4. Verify that smoke and fire dampers are open.
5. Isolating and balancing valves are open and control valves are operational.
6. Access to balancing devices is provided.
7. Windows and doors can be closed so design conditions for system operations can be met.

2.3 GENERAL TESTING AND BALANCING PROCEDURES

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC national standards and this Section or in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

B. Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, balancing, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

C. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project. Plastic plugs with retainers may be used to patch drilled holes in ductwork and housings.

2.4 FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES

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 single line diagrams of systems' "as-built" duct layouts and domestic hot water distribution.

C. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

D. Check the airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

F. Verify that motor starters are equipped with properly sized thermal protection.

G. Check dampers for proper position to achieve desired airflow path.

H. Check for airflow blockages.

I. Check condensate drains for proper connections and functioning.

J. Check for proper sealing of air-handling unit components.

2.5 CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES

A. The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems.

B. Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
b. Measure static pressure directly at the fan outlet or through the flexible connection.
c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

2. Measure static pressure across each air-handling unit component.

a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.

3. Measure static pressures entering and leaving other devices such as sound traps, heat recovery equipment, and air washers under final balanced conditions.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Adjust fan speed higher or lower than design with the approval of the Owner’s Representative. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating modes to determine the maximum required brake horsepower.

C. Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.

a. Where sufficient space in sub-mains and branch ducts is unavailable for Pilot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust sub-mains and branch ducts to design airflows within specified tolerances.

D. Measure terminal outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

E. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

1. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
2. Adjust patterns of adjustable outlets for proper distribution without drafts.

2.6 MOTORS

A. Motors, ALL: Test at final balanced conditions and record the following data:

1. Manufacturer, model, and serial numbers.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating if high-efficiency motor.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

2.7 CONDENSING UNITS

A. Verify proper rotation of fans and measure entering- and leaving-air temperatures. Record compressor data.

2.8 HEAT-TRANSFER COILS

A. Electric-Heating Coils: Measure the following data for each coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperatures at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kW at full load.
6. Fuse or circuit-breaker rating for overload protection.

2.9 TEMPERATURE TESTING

A. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor and outdoor wet- and dry-bulb temperatures every other hour for a period of 2 successive 8-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

2.10 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Verify operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Verify free travel and proper operation of control devices such as damper and valve operators.

F. Confirm interaction of electrically operated switch transducers.

G. Confirm interaction of interlock and lockout systems.

H. Verify main control supply-air pressure and observe compressor and dryer operations.

I. Record voltages of power supply and controller output. Determine if the system operates on a grounded or nongrounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

2.11 TOLERANCES

A. Set HVAC system airflow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
2. Air Outlets and Inlets: 0 to minus 10 percent.

B. Set plumbing system water flow rates within the following tolerances:

1. Domestic Hot Water Recirculation Flow Rate: 0 to minus 10 percent.

2.12 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

1. Include a list of the instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to the certified field report data, include the following:

1. Pump curves.
2. Fan curves.
3. Manufacturers' test data.
4. Field test reports prepared by system and equipment installers.
5. Other information relative to equipment performance, but do not include approved Shop Drawings and Product Data.

D. General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

1. Title page.
2. Name and address of testing, adjusting, and balancing Agent.
3. Project name.
4. Project location.
5. Owner’s name and address.
6. Engineer's name and address.
7. Contractor's name and address.
8. Report date.
9. Signature of testing, adjusting, and balancing Agent who certifies the report.
10. Summary of contents, including the following:

    a. Design versus final performance.
    b. Notable characteristics of systems.
    c. Description of system operation sequence if it varies from the Contract Documents.

11. Nomenclature sheets for each item of equipment.
12. Data for terminal units, including manufacturer, type size, and fittings.
13. Notes to explain why certain final data in the body of reports vary from design values.
14. Test conditions for fans and pump performance forms, including the following:

    a. Settings for outside-, return-, and exhaust-air dampers.
    b. Conditions of filters.
    c. Cooling coil, wet- and dry-bulb conditions.
    d. Other system operating conditions that affect performance.

E. System Diagrams: Include schematic layouts of air distribution systems and domestic hot water distribution systems. Present with single-line diagrams and include the following:

1. Quantities of outside, supply, return, and exhaust airflows.
2. Duct, outlet, and inlet sizes.
3. Location of manual volume control dampers.
4. Water flow meter.
5. Balancing valve sizes/locations.

F. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data: Include the following:

    a. System identification.
    b. Location.
    c. Make and type.
    d. Model number and size.
    e. Manufacturer's serial number.
    f. Arrangement and class.
    g. Sheave make, size in inches and bore.
    h. Sheave dimensions, center-to-center and amount of adjustments in inches.

2. Motor Data: Include the following:

    a. Make and frame type and size.

b. Horsepower and rpm.
c. Volts, phase, and hertz.
d. Full-load amperage and service factor.
e. Sheave make, size in inches and bore.
f. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
g. Number of belts, make, and size.

3. Test Data: Include design and actual values for the following:

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

G. Air Handling Test Reports.

H. Gas-Fired Heat Apparatus Test Reports; i.e., unit heaters, duct furnaces, domestic water heaters.

I. Electric Coil Test Reports; i.e., electric baseboards, electric unit heaters, electric cabinet heaters.

J. Duct Traverse Reports.

K. Air Terminal Device Reports; i.e., diffusers/registers/grilles.

L. Package Terminal Air Conditioning Test Reports; including equipment leveling to ensure condensate is pitched to building exterior.

M. Plumbing Pump Test Reports including recirculating hot water and sump pumps.

N. Instrument Calibration Reports.

2.13 ADDITIONAL TESTS

A. Within 90 days of completing testing, adjusting, and balancing, perform additional testing and balancing to verify that balanced conditions are being maintained throughout and to correct unusual conditions.

B. Seasonal Periods: If initial testing, adjusting, and balancing procedures were not performed during near-peak summer and winter conditions, perform additional inspections, testing, and adjusting during near-peak summer and winter conditions.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions, Division 1 Specification Sections and all relevant documents shall form a part of this Division of the Specifications, and shall be incorporated in this Section and each Division 16 Section hereinafter as if repeated verbatim herein. All conditions imposed by these documents shall be applicable to all portions of the work under this Division. Certain specific paragraphs of said references may be referred to hereinafter in this Division. These references are intended to point out specific items to the Contractor, but in no way relieve him of the responsibility of reading and complying with all relevant parts of the entire Specification.

B. The Contractor shall examine and coordinate with all Contract Drawings and Specifications, and all Addenda issued. Failure to comply shall not relieve him of responsibility. The omission of details of other portions of the work from this Division shall not be used as a basis for a request for additional compensation.

C. The specific features and details for other portions of the work related to the construction in progress or to the adjacent building shall be determined by examination at the site.

1.2 SCOPE OF WORK

A. The requirements contained in this Section apply to all work performed under Division 16 of these Specifications.

B. The work covered by this Division of the Specifications comprises the furnishing of labor, material, equipment, transportation, tools and services, and performing operations required for, and reasonably incidental to, the installation of the work in accordance with the applicable Contract Documents, and subject to the terms and conditions of the Contract.

C. Refer to other Divisions of the Specifications for related work.

1.3 DEFINITION OF "CONTRACTOR"

A. Where the word "Contractor" is used under any Section of this Division of the Specifications, it shall mean the Contractor engaged to execute the work included under that Section, even though this Contractor may be technically described as a Subcontractor, or an authorized representative.

B. If the Contractor, engaged to execute a portion of the work, employs a Subcontractor to perform some of that work, he shall be completely responsible for the proper execution of this Subcontractor's work, in full conformity with the Contract Documents.

1.4 RESPONSIBILITY OF THE CONTRACTOR

A. The Contractor shall be responsible for all work of every description in connection with this Division of the Specifications. The Contractor shall specifically and distinctly assume, and does so assume, all risk for damage or injury from whatever cause to property or person used or employed on or in connection with this work and of all damages or injury to any person or property wherever located, resulting from an action or operation under the Contract in connection with the work, and undertake the responsibility to defend the Owner against all claims on account of any such damage or injury.

B. The Contractor will be held responsible for the satisfactory execution and completion of the work in accordance with the true intent of the Contract Documents. The Contractor shall provide without extra charge all incidental items required as part of the work, even though it may not be specifically indicated. If the Contractor has reason for objecting to the use of any material, equipment, device or method of construction as indicated, the Contractor shall make report of such objections to the Owner's Representative, obtain proper approval and adjustment to the Contract, and shall proceed with the work.

1.5 TERMINOLOGY

A. Whenever the words "furnish", "provide", "furnish and install", "provide and install", and similar phrases occur, it is the intent that the materials, equipment and devices described be furnished, installed and connected under this Division, complete for operation, unless specifically noted to the contrary.

B. It is also the intent, unless specifically noted to the contrary, that all materials, equipment and devices described and specified under this Division of the Specifications be similarly furnished, installed and connected under this Division, whether or not a phrase as described in the preceding paragraph has been actually included.

C. Whenever the words “Owner’s Representative” occurs, it is intended to refer to the Architect, Engineer and/or specific Owner’s Representative responsible for or capable of providing the necessary direction pertaining to the referenced issue.

1.6 ORDINANCES, PERMITS AND CODES

A. It shall be the Contractor's duty to perform the work and provide the materials covered by these specifications in conformance with all ordinances and regulations of all authorities having jurisdiction.

B. All work herein shall conform to all applicable laws, ordinances and regulations of the local utility companies.

C. The Contractor shall obtain and pay for all permit and connection fees as required for the complete installation of the specified systems, equipment, devices and materials.

D. The Contractor shall obtain permits, plan checks, inspections and approvals applicable to the work as required by the regulatory authorities. Fees and costs of any nature whatsoever incidental to these permits, inspections and approvals shall be assumed and paid by the Contractor. The pro-rata costs, if any, for utilities serving this property will be paid for by the Owner and shall not be included as part of this Contract.The work shall be in accordance with, but shall not be limited to,

the requirements of:

1. National Fire Protection Association
2. National Electrical Code
3. National Safety Code
4. State of Oklahoma Safety Code
5. City of Ardmore Building Codes
6. State of Oklahoma Building Codes

E. Codes and standards referred to are minimum standards. Where the requirements of the Drawings or Specifications exceed those of the codes and regulations, the Drawings and Specifications govern.

1.7 MATERIALS, EQUIPMENT AND DEVICE DESCRIPTION

A. Materials, equipment and devices shall be of the best quality customarily applied in quality commercial practice, and shall be the products of reputable manufacturers. Each major component shall bear a nameplate giving the name and address of the manufacturer, and the catalog number or designation of the component.

B. Materials, equipment and devices furnished under this Division of the Specifications shall be essentially the standard product of the specified manufacturer, or where allowed, an alternate manufacturer. Where two or more units of the same kind or class of a specific item are required, these shall be the products of a single manufacturer; however, the component parts of the item need not be the products of one manufacturer.

C. In describing the various materials, equipment and devices, in general each item will be described singularly, even though there may be a multiplicity of identical items. Also, where the description is only general in nature, exact sizes, duties, space arrangements, horsepower requirements and other data shall be determined by reference to the Contract Documents.

D. Space allocations for materials, equipment and devices have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer whether indicated or not. The Contractor shall verify that all materials, equipment and devices proposed for use on this project are within the constraints of the allocated space.

1.8 QUALITY ASSURANCE

A. Materials, equipment and devices shall be new and of the quality specified, and shall be free from defects at the time of installation. Materials, equipment and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall not be repaired at the job site, but shall be replaced with new materials, equipment or devices identical with those damaged, unless specifically approved otherwise by the Owner's Representative.

B. Wherever a UL standard has been established for a particular type of material, equipment or device, each item of such material, equipment or device provided on this project shall meet the requirements of the UL standard in every way, and shall be UL listed and labeled.

1.9 REFERENCE STANDARDS

A. Materials, equipment, devices and workmanship shall comply with applicable local, county, state and national codes, laws and ordinances, utility company regulations and industry standards.

B. In case of differences between building codes, state laws, local ordinances, industry standards, utility company regulations and the Contract Documents, the most stringent shall govern. The Contractor shall promptly notify the Owner's Representative in writing of any such difference. Should the Contractor perform any work that does not comply with local codes, laws and ordinances, industry standards or other governing regulations, the work shall be corrected of noncompliance deficiencies with the Contractor bearing all costs.

C. In addition to the aforementioned ordinances, industry standards published by the following organizations shall apply:

AABM - American Association of Battery Manufacturers
ADA - American's with Disabilities Act
AIA - American Institute of Architects
ANSI - American National Standards Institute
ASTM - American Society for Testing and Materials
CBM - Certified Ballast Manufacturers Association
ETL - Electrical Testing Laboratories
FM - Factory Mutual
ICEA - Insulated Cable Engineers Associated
IEEE - Institute of Electrical and Electronic Engineers
IES - Illuminating Engineering Society
IRI - Industrial Risk Insurance
NBS - National Bureau of Standards
NEC - National Electrical Code
NECA - National Electrical Contractors Association
NEMA - National Electrical Manufacturers Association
NESC - National Electrical Safety Code
NETA - National Electrical Testing Association
NFPA - National Fire Protection Association
UL - Underwriters Laboratories

D. Where the Contract Documents exceed the above requirements, the Contract Documents shall govern. In no case shall work be installed contrary to or below the minimum legal standards.

1.10 DRAWINGS AND SPECIFICATIONS

A. The interrelation of the Drawings (including the schedules) and the Specifications are as follows:

1. The Drawings establish quantities, locations, dimensions and details of materials, equipment and devices. The schedules on the Drawings indicate the capacities, characteristics and components.
2. The Specifications provide written requirements for the quality, standard and nature of the materials, equipment, devices and construction systems.

B. The Drawings and Specifications shall be considered as being compatible; therefore, the work called for by one and not by the other shall be furnished and installed as though called for by both. Resolution of conflicts between Drawings and Specifications shall be as follows:

1. If the Drawings and Specifications disagree in themselves, or with each other, the Contractor's pricing shall be based on furnishing and installing the most expensive combination of quality and quantity of work indicated. In the event of this type of disagreement, the resolution shall be determined by the Owner's Representative.
2. The Contractor shall be responsible for bringing any conflicts in the Drawings and the Specifications to the attention of the Owner's Representative immediately, prior to any work being performed.
3. In general, if there is conflict between the Drawings and Specifications, the Drawings shall govern the Specifications.
4. Where the Specifications do not fully agree with schedules on the Drawings, the schedules shall govern. Actual numerical dimensions indicated on the Drawings govern scale measurements and large scale details govern small scale drawings.
5. Materials, equipment and devices called for on the Drawings and not indicated herein, shall be completely provided and installed as though it were fully described herein.
6. Materials, equipment and devices called for herein shall be completely provided and installed, whether or not it is fully detailed, scheduled or indicated on the Drawings.

C. The Contractor shall examine the Drawings and Specifications of the other portions of the work for fixtures and finishes in connection with this work. The Contractor shall carefully examine the Drawings to determine the general construction conditions, and shall familiarize himself with all limitations caused by such conditions.

D. When discrepancies exist between scale and dimension, or between the Drawings of the various portions of the work, they shall be called to the attention of the Owner's Representative for further instruction, whose instructions shall be final and binding and work promptly resumed without any additional cost to the Owner.

E. Review the construction details of the building(s) as illustrated on the Drawings of the other portions of the work, i.e., architectural, structural, civil, landscape, etc., and be guided thereby. Route conduits and set all boxes as required by the pace of the general construction.

F. The Drawings diagrammatically show the sizes and locations of the various equipment and devices, and the sizes of the major interconnecting wires, without showing exact details as to elevations, offsets, control wiring and other installation requirements. Carefully layout the work at the site to conform to the architectural and structural conditions, to avoid obstructions and to permit proper grading of pipe associated with other portions of the work. In cooperation with other Contractors, determine the exact location of equipment and devices and connections thereto by reference to the submittals and rough-in drawings, and by measurements at the site. Make minor relocations necessitated by the conditions at the site, or directed by the Owner's Representative, without additional cost to the Owner.

G. The Drawings and Specifications are intended to describe and illustrate systems which will not interfere with the structure of the building(s), fit into the available spaces, and insure complete and satisfactory operating installations. Prepare installation drawings as required for all critical areas illustrating the installation of the work in this Division as related to the work of all other Divisions and correct all interferences with the other portions of the work or with the building structures before the work proceeds.

H. The Drawings do not indicate the existing electrical installations other than to identify modifications or extensions thereto. Visit the site and ascertain the conditions to be met and the work to be accomplished in removing and modifying the existing work, and in installing the new work. Failure to comply with this shall not constitute grounds for any additional payment in connection with removing or modifying any part of the existing installation or installing any new or temporary work under this Division.

1.11 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 of the Specifications.

B. Process product data and shop drawings to insure that the proposed materials, equipment and devices conform to the requirements of the Contract Documents, and that there are no omissions or duplications. Provide layouts, fabrication information and data for systems, materials, equipment and devices proposed for the project.

C. Submittals shall be provided for review and approval on all systems, equipment, devices and materials proposed for use on this project. Submittals shall include, but not be limited to, the following:

1. Lighting and Appliance Panelboards
2. Switchboard
3. Distribution Panelboards
4. Disconnect Switches
5. Circuit Breakers and Fuses
6. Materials: conduit, conductors, connectors, supports, etc.
7. Lighting Fixtures, Lamps and Control Systems/Devices
8. Wiring Devices
9. Fire Alarm System

D. The product data shall not consist of manufacturer's catalogs or cut sheets that contain no indication of the exact item offered. The submission on individual items shall designate the exact item offered.

E. Do not submit detailed quantitative listings of materials, equipment and devices. It is the Contractor's responsibility to provide proper sizes and quantities to conform with Contract Documents.

F. Assemble submittals on related items procured from a single manufacturer in bound brochures or other suitable package form, rather than submitting a multiplicity of loose sheets.

G. Prepare shop drawings whenever equipment proposed varies in physical size and arrangement from that indicated thus causing rearrangement of equipment space, where tight spaces require extreme coordination between this work and other work, where called for elsewhere in these Specifications and where specifically requested by the Owner's Representative. Shop drawings shall be prepared at a scale of not less than 1/4 inch equals 1 foot.

H. The Contractor shall sign the submittal as an indication of compliance with the Contract Documents. If there are any deviations from the Contract Documents, he shall so indicate on the submittal. Any deviations not so indicated shall be cause for rejection and removal of the non-complying equipment at the Contractor’s expense.

1.12 SUBSTITUTIONS

A. Where a single manufacturer is mentioned by trade name or manufacturer's name, unless specifically noted otherwise, it is the only manufacturer that will be accepted.

B. Where multiple manufacturers are listed, none other than those manufacturers will be accepted.

C. Manufacturers not listed will be considered for substitution prior to bid only. The substitute manufacturer shall submit a complete copy of the appropriate technical specification section minimum seven (7) business days prior to bid with each sub-paragraph noted with the comment, "compliance", "deviation", "alternate" or “not applicable”. In the case of non-primary, vendor-supplied items, the name of the sub-vendor supplying said item, including model number, shall be indicated.

1. By noting the term "compliance" or "C", it shall be understood that the manufacturer is in full compliance with the item specified and will provide exactly the same with no deviations.
2. By noting the term "deviation" or "D", it shall be understood that the manufacturer prefers to provide a different component in lieu of that specified. Manufacturer shall indicate all deviations.
3. By noting the term "alternate" or "A", it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner. An alternate shall be fully described as to what the manufacturer proposes to provide.
4. By noting the term “not applicable” or “N/A”, it shall be understood that the specified item is not applicable to the project.

D. It shall be understood that space allocations have been made on the basis of present and known future requirements and the dimensions of items of equipment or devices of a particular manufacturer whether indicated or not. If any item of equipment or device is offered in substitution which differs substantially in dimension or configuration from that indicated on the Drawings or specifications, provide as part of the submittal 1/4 inch equals 1 foot scaled drawings showing that the substitute can be installed in the space available without interfering with other portions of the work or with access for operations and maintenance in the completed project.

E. Where substitute equipment or devices requiring different arrangement or connections from that indicated is accepted by the Owner's Representative, install the equipment or devices to operate properly and in harmony with the intent of the Contract Documents, making all incidental changes in piping, ductwork or wiring resulting from the equipment or device selection without any additional cost to the Owner. The Contractor shall pay all additional costs incurred by other portions of the work in connection with the substituted equipment or device.

F. The Owner's Representative reserves the right to call for samples of any item of material, equipment or device offered in substitution, together with a sample of the specific item when, in their opinion, the quality of the item and/or the appearance is involved, and it is deemed that an evaluation of the item may be better made by visual inspection.

G. When any request for a substitution of material, equipment or device is submitted and rejected, the item named in the Contract Documents shall be furnished. Repetitive submittal of substitutions for the same item will not be considered.

1.13 INSTALLATION DRAWINGS

A. Prepare installation drawings for coordinating the work of this Division with the work of other Divisions, to illustrate its concealment in finished spaces, to avoid obstructions, and to demonstrate the adaptability of any item of material, equipment or device in the space upon which the Contract Documents are based.

B. Use these drawings in the field for the actual installation of this work. Provide three (3) copies, not for approval, to the Owner's Representative for his information, review and record.

1.14 WORKMANSHIP AND INSTALLATION

A. In no case shall the Contractor provide a class of material, equipment, device or workmanship less than that required by the Contract Documents or applicable codes, regulations, ordinances or standards. All modifications which may be required by a local authority having legal jurisdiction over all or any part of the work shall be made by the Contractor without any additional charge. In all cases where such authority requires deviations from the requirements of the Drawings or Specifications, the Contractor shall report same to the Owner's Representative and shall secure his approval before the work is started.

B. The work shall be performed by properly licensed technicians skilled in their respective trades. All materials, equipment and devices shall be installed in accordance with the recommendations of the manufacturer and in the best standard practice to bring about results of a first class condition.

C. The NECA "Standards of Installation" as published by the National Electrical Contractors Association shall be considered a part of these Specifications, except as specifically modified by other provisions contained in these Specifications.

1.15 INSPECTION OF SITE

A. The accompanying drawings do not indicate existing installations other than to identify modifications of and extensions thereto. The Contractor shall visit the site, inspect the installations and ascertain the conditions to be met and the work to be performed. Failure to comply with this shall not constitute ground for any additional payments in connection with removing or modifying any part of the existing installations and/or installing any new work under this Division.

B. Review construction details of the adjacent building presently under construction during the site inspection and include all work required to modify the existing installations and install new materials, comprising a part of the installation. Review all construction details of the new building as illustrated on the drawings and be guided thereby.

1.16 WARRANTY

A. All materials, equipment, devices and workmanship shall be warranted for a period of one year from the date of acceptance by the Owner's Representative for beneficial use by the Owner, except that where specific equipment is noted to have extended warranties. The warranty shall be in accordance with AIA Document A201. The Contractor shall be responsible for the proper registration of these warranties so that the Owner can make all proper claims should future need develop.

B. The Contractor shall furnish to the Owner's Representative for transmittal to the Owner, the name, address and telephone number of those persons responsible for service on systems and equipment covered by the warranty.

1.17 OPERATION PRIOR TO ACCEPTANCE

A. When any equipment is operable, and it is to the advantage of the Contractor to operate the equipment, the Contractor may do so provided that he properly supervises the operation, and retains full responsibility for the equipment operated. Regardless of whether or not the equipment has or has not been operated, the Contractor shall clean the equipment properly, make required adjustments and complete punch list items before final acceptance by the Owner.

1.18 INSTRUCTION OF OWNER'S PERSONNEL

A. Provide the services of competent engineers and/or technicians acceptable to the Owner's Representative to instruct other representatives of the Owner in the complete and detailed operation of each item of equipment or device of all the various electrical systems. These instructions shall be provided for whatever periods may be necessary to accomplish the desired results. Upon completion of these instructions, the Contractor shall obtain a letter of release, acknowledged by the Owner or his authorized representative, stating the dates on which the various kinds of instruction were given, and the personnel to whom the instructions were given.

B. The Contractor shall be fully responsible for proper maintenance of equipment and systems until the instructions have been given to the Owner's personnel and the letter of release acknowledged.

C. In providing the instructions to the Owner's personnel, the written operating and maintenance manuals shall be followed in all instances, and the Owner's personnel shall be familiarized with such manuals. Operating and maintenance manuals used for instructions shall include wiring diagrams, manufacturer's operating and maintenance instructions, parts lists (with sources identified), and other data as appropriate for each system.

1.19 SCHEDULE AND SEQUENCE OF WORK

A. The Contractor shall meet and cooperate with the Owner and Owner's Representative to schedule and sequence this work so as to insure meeting scheduled completion dates and avoid delaying other portions of the work. Work requiring special sequencing shall be at no additional cost to the Owner and shall have no impact on the schedule.

1.20 INSTALLATION INSPECTIONS AND CERTIFICATIONS

A. Obtain timely inspections of the installation by the regulatory authorities. Remedy any deficiencies to the satisfaction of the inspecting official.

B. Upon final completion of the work, obtain certificates of acceptance from the regulatory authorities. Deliver the certificates to the Owner's Representative for transmission to the Owner.

1.21 EQUIPMENT INSTALLATION

A. Install equipment and devices in a manner to permit access to all surfaces or components, requiring such access, without the need to disassemble other unrelated parts of the work.

B. Equipment specified to be factory assembled and tested prior to shipment shall not be disassembled at the job site and reassembled at its final location. Apparatus not so specified may be disassembled and reassembled in the proper location.

C. Furnish all scaffolding, rigging and hoisting required for the installation of all the work.

1.22 CONCRETE HOUSEKEEPING PADS

A. Concrete housekeeping pads shall be provided for all floor mounted equipment, unless noted or required otherwise.

B. All pads shall be not less than 3-1/2" high and extend a maximum 3" beyond the actual equipment size. Coordinate the proper size of the pad with the equipment furnished. Pads shall be poured in forms built of new dressed lumber with corners chamfered using sheet metal or triangular wood strips nailed to the form. Use 6 x 6 No. 3 mesh for reinforcing. Install heavy duty adjustable anchor bolts, set in the form and positioned using templates, prior to pouring concrete. After the equipment is set on the pad, the equipment shall be aligned, leveled and fully grouted to the pad and all void spaces shall be filled with a non-shrinking grout.

C. Perform all concrete work specified to be provided under this Division in strict accordance with the applicable provisions of Division 3, CONCRETE.

1.23 SLEEVES

A. Each conduit, regardless of material, which passes through a concrete slab, masonry wall, or roof or portion of the building structure shall be free from the structure and shall pass through a sleeve.

B. All sleeves shall be constructed from electrical-metallic tubing or equivalent weight galvanized steel tubing and shall be flush on both sides of the surface penetrated, unless noted otherwise. All sleeves penetrating the roof areas shall extend a minimum 10 inches above the roof with approved weatherproof counterflashing attached to the conduit above the roof. All sleeves penetrating floors shall extend a minimum of 6 inches above the finished floors. The sleeves shall be sized to allow free passage of the conduit to be inserted.

C. Sleeves passing through walls or floors on or below grade or in moist areas shall be constructed of galvanized rigid steel and shall be designed with a suitable flange in the center to form a waterproof passage. After the conduit has been installed in the sleeves, the void space around the conduit shall be caulked and filled with an asphalt-base compound to insure a waterproof penetration. Jute twine caulking shall not be used due to susceptibility to termite infestation.

1.24 ESCUTCHEONS

A. In each finished space, provided a chromium plated, sectional escutcheon on each conduit, or hanger rod penetrating a wall, floor or ceiling.

B. Size escutcheons and collars to fit snugly around conduit and rods.

C. Where required, provide escutcheons with set screws so that they fit snugly against the finished surface.

1.25 ACCESS PANELS

A. Provide wall and ceiling access panels for unrestricted access to all concealed electrical equipment items and devices installed behind furrings, chases or non-removable suspended ceilings.

B. Access panels shall be UL listed and labeled as required to suit the fire rating of the surface in which installed, with mounting straps, concealed hinges, screwdriver locks, 180 degree open door design, 16 gauge steel construction and door and frame finished in prime coat finish. Panels shall be 12-inch by 12-inch minimum size, but shall be larger as the access requirement of the concealed electrical equipment item or device increases.

1.26 SEALING OF PENETRATIONS

A. All penetrations in horizontal or vertical fire-rated construction shall be sealed using approved fire-rated sealing materials equivalent to the following:

1. Foam: Dow Corning 3-6548 RTV silicone foam, liquid component Part 4 (black) and liquid component Part B (off-white).
2. Sealant: Dow Corning 96-081 RTV silicone adhesive sealant.
3. Damming Materials: Mineral fiberboard, mineral fiber matting, mineral fiber putty, plywood or particle board, as selected by applicator.

B. Preparation: Remove combustible materials and loose impediments from penetration opening and involved surfaces. Remove free liquid and oil from penetration surfaces.

C. Installation: In accordance with manufacturer's instructions, install damming materials and sealant to cover and seal penetration openings; inject foam mixtures into openings.

D. In addition to the Dow Corning products, equal products by Spec Seal Firestop Products, 3M Fire Barrier or CS240 Firestop are acceptable.

1.27 PROTECTION OF APPARATUS

A. At all times take every precaution to properly protect apparatus from damage due to dust, dirt, water, etc. or from damage due to physical forces. Include the erection of temporary shelters as required, to adequately protect any apparatus stored at the site, the cribbing of any apparatus directly above the construction, and the covering of apparatus in the incomplete building with tarpaulins or other protective covering. Failure on the part of the Contractor to comply with the above to the entire satisfaction of the Owner's Representative will be sufficient cause for the rejection of the pieces of apparatus in question.

B. Responsibility for the protection of apparatus extend also to existing apparatus involved in this Division of the work, whether such apparatus is designated to be used temporarily and later removed, or is to be reused as a part of the permanent installation. Erect temporary sheltering structures, provide temporary bracing and supports, or cover equipment as required or directed to afford proper protection for that equipment.

C. The Contractor shall protect this work and the work of all other Contractors from damage by his work or workmen and shall make good any damage thus caused. He shall also be responsible for the proper protection of his equipment, machinery, materials and accessories delivered and installed on the job.

1.28 INSTALLATION OF CONTROL AND OPERATING DEVICES

A. The highest operable part of controls (light switches, dimmer switches, emergency power off devices, etc.), receptacles (electrical and communications) and other operable devices shall be 48" above finish floor. The lowest operable part shall be no less than 15" above finished floor. For purposes of uniformity, unless noted otherwise, the top of a device shall be maximum 48" AFF and the bottom of a device shall be minimum 15" AFF. Refer to the electrical symbols list on the Drawings for specific requirements.

B. Visual alarm appliances shall be placed 80" above finished floor (the highest floor level within a space) or 6" below the ceiling, whichever is lower.

1.29 INSTALLATION AND CONNECTION OF OTHER DIVISION'S EQUIPMENT

A. Verify the electrical requirements of all equipment furnished under other Divisions, separate contracts, or by the Owner. Install conduit, power wiring, control wiring, devices, etc. as required for complete operation of all equipment.

1.30 OPTION TO RELOCATE OUTLETS AND RELATED DEVICES

A. The location of power, data and telephone outlets, wall switches and other related devices may be relocated at the Owner's option, at no additional cost to the Owner, to a point within 10 feet of their present location provided the Contractor is notified prior to installation.

1.31 COOPERATION AND CLEAN-UP

A. It shall be the responsibility of the Contractor to cooperate fully to keep the job site in a clean and safe condition. Upon the completion of the job, the Contractor shall immediately remove all of his tools, equipment, surplus materials and debris.

B. After the installation is complete, and before the equipment is energized, clean the interior and exterior of all equipment thoroughly. Clean equipment, removing all debris, rubbish and foreign materials. Each component shall be cleaned and all dust and other foreign material removed. Components shall be cleaned of oxidation. The inside and outside of all switchgear shall also be wiped clean with a lemon-oil rag after all other cleaning is complete.

C. Any portion of the work requiring touch-up finishing shall be so finished to equal the specified finish on the product.

1.32 RECORD DRAWINGS AND DOCUMENTATION FOR OWNER

A. The Contractor shall obtain at his own expense a complete set of blueline prints on which to keep an accurate record of the installation of all materials, equipment and devices covered by the Contract. The Contractor shall record up to date information at least once a week and retain the set of prints on site for periodic review by the Architect/Engineer. The record drawings shall indicate the location of all equipment and devices, and the routing of all systems. If the Contractor prepared large scale installation drawings of electrical rooms, conduit routing, busduct, routing, etc., these drawings or reproducible sepias therefrom shall be revised as required to accurately illustrate the actual installation. All conduit buried in concrete slabs, walls and below grade shall be located by dimension; both horizontally and by vertical elevation, unless a surface mounted device in each space indicates the exact location.

B. Upon anticipated completion of the job, obtain one complete reproducible set of the original drawings on which to neatly, legibly and accurately transfer all project related notations and deliver these record drawings to the Architect/Engineer at job completion before final payment and delivery to the Owner. This information shall be delivered prior to final acceptance.

C. The Contractor shall accumulate in duplicate during the job progress, the following data prepared in indexed 3-ring looseleaf, hard-back binders sized for 8-1/2 inch by 11 inch sheets. No binder shall exceed 3-1/2 inches thick. This data shall be turned over to the Owner's Representative for review and subsequent delivery to the Owner prior to final acceptance.

1. Warranties, guarantees and manufacturer's directions on material, equipment and devices covered by the Contract.
2. Approved lighting fixture brochures, wiring diagrams and control diagrams.
3. Copies of approved submittals and shop drawings.
4. Operating instructions and recommended maintenance procedures for major apparatus.
5. Copies of all other data and/or drawings required during construction.
6. Repair parts list of major apparatus, including name, address and telephone number of local supplier or representative.
7. Tag charts and diagrams hereinbefore specified.

1.33 FINAL OBSERVATION

A. The purpose of the final observation is to determine whether the Contractor has completed the construction in accordance with the Contract Documents and that in the Owner Representative's opinion the installation is satisfactory for final acceptance by the Owner.

B. It shall be the responsibility of the Contractor to assure that the installation is ready for final acceptance prior to calling upon the Owner's Representative to make a final observation.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 16010

SECTION 16050

SITE ELECTRICAL

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of all site electrical work.

B. The site electrical work shall include, but not be limited to, the furnishing and installation of necessary materials and making arrangements for:

1. The connection of electrical utility.
2. Underground conduit.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

1.4 REFERENCE STANDARDS

A. National Electrical Code (NEC), Article 300

B. Service installation standards of the serving utility company(s).

PART 2 - PRODUCTS

2.1 ELECTRICAL SERVICE

A. Coordination: The location of the service entrance shall be coordinated with all other trades. Provide materials and equipment required to connect the electrical service.

B. Materials: Provide materials in accordance with other Sections of these Specifications.

PART 3 - EXECUTION

3.1 GENERAL

A. Underground installation of more than one conduit shall be in a duct arrangement as indicated. All conduits shall be laid so joints are staggered. All bends and stub-ups shall be rigid steel.

B. Pour a red colored concrete envelope 3" thick over utility service conduits. Where conduits cross a driveway, road or parking area, reinforcing rods shall be installed.

C. Perform excavation, shoring, backfilling and concrete work in connection with electrical work in accordance with other Divisions of the Specifications.

D. All conduit shall be sloped away from the building to negate water entering the building through the conduit system.

3.2 UTILITIES

A. The locations, elevations and voltage of electrical lines included within the area of this work are indicated on the Drawings or in the Specifications in accordance with information received by the Architect/Engineer and Owner.

B. The Contractor shall examine the site and shall verify, to his own satisfaction, the location and elevation of all utilities, and shall adequately inform himself as to their relation to the work.

C. Existing utility lines not indicated but encountered during construction shall be protected, relocated or capped as directed by the Architect/Engineer. All precautions shall be exercised to prevent damage to existing lines not shown, but should work become necessary, it must be authorized prior to execution except in an emergency situation.

D. Before beginning excavations of any nature whatsoever, the Contractor shall make an attempt to locate all underground utilities of every nature occurring within the bounds of the area to be excavated. The Contractor shall then proceed with caution in his excavation work so that no utility shall be damaged with a resultant loss of service.

E. Should a damage result to any utility through the Contractor's negligence or failure to comply with the above directive, he shall be liable for such damage and for all expense incurred in the expeditious repair or replacement of such damaged utilities.

F. Repair of damaged utilities shall be to a condition equal to or better than the adjacent undamaged portion of such utility and to the complete satisfaction of the Architect/Engineer and Owner.

END OF SECTION 16050

SECTION 16110

SYSTEMS OF RACEWAYS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of all raceway systems included in this project.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Galvanized Rigid Steel Conduit (GRC): Rigid steel conduit shall be galvanized, constructed of high-grade raw steel piping, galvanized inside and outside, conforming in all respects with Federal Specification WW-C-581-E, ANSI C80-1 and UL 6. Zinc coating shall be applied by the hot-dip, galvanizing process and shall be of uniform thickness not only on the inside and outside surfaces of the conduit but also on the threads of the conduit. Conduit shall be dipped in a chromic acid bath so as to form a corrosion-resistant protective coating of zinc chromate over the hot-dipped galvanized surface. Each conduit length shall be threaded and equipped with a coupling on one end and a thread protector on the other end.

B. Intermediate Metal Conduit (IMC): IMC shall be constructed of high-grade steel tubing, galvanized inside and outside and conforming in all respects with Federal Specification WW-C-581-E and UL 1242. Zinc coating shall be applied by the hot-dip, galvanized process and shall be of uniform thickness not only on the inside and outside surfaces of the conduit, but also on the threads of the conduit. Each conduit length shall be equipped with a coupling on one end and a thread protector on the other end.

C. Electrical Metallic Tubing (EMT): EMT shall be constructed of high-grade steel, manufactured specifically to standards assuring maximum welding characteristics and ductility. EMT shall conform in all respects to Federal Specification WW-C-563-A, ANSI C80-3 and UL 797. The exterior galvanized coat of zinc shall be of uniform thickness applied by the electro-galvanized

process. The interior surface of each tube shall be uniformly coated with a thick, tough, elastic coating of enamel. EMT shall be dipped in chromic acid bath so as to form a corrosion resistant protective coating of zinc chromate over the galvanized surface.

D. Rigid Nonmetallic Conduit: Rigid nonmetallic conduit shall be polyvinyl chloride (PVC). PVC conduit shall be rigid, Schedule 40, heavy-wall, high-impact, conforming in all respects to the applicable requirements of Federal Specification W-C-1094-A, NEMA TC-2, and UL 651. PVC conduit shall be joined with PVC couplings of the solvent cement type to provide complete watertight joints. Conduit systems shall be UL listed for direct burial and exposed use, and shall be in conformance with the NEC.

E. Flexible Metal Conduit: Shall be manufactured of spirally-wound, mild steel strip material having a hot-dip galvanized coating and meeting requirements of UL 1 for flexible metal conduit.

F. Liquidtight Flexible Metal Conduit: Shall be manufactured exactly as specified for flexible metal conduit and, in addition, shall have a copper grounding strand and factory-applied neoprene jacket. Liquidtight flexible conduit shall meet the requirements of UL 360. For branch circuits in raised floor areas provide blue or gray jacketed liquidtight flexible conduit.

2.2 COUPLINGS AND TERMINATORS

A. For Galvanized Rigid Steel and Intermediate Metal Conduit: Shall be factory-made threaded couplings of same material as the conduit.

1. Molded nylon insulating bushing at all boxes and cabinets, with locknuts inside and outside box or cabinet. In wet locations, watertight hubs shall be used for conduit entry into enclosures.
2. Nylon insulated grounding bushing on all conduits where grounding bushings are required, with locknuts inside and outside the enclosure. In wet locations, watertight hubs shall be used for conduit entry into enclosures.

B. For Electrical Metallic Tubing

1. Steel set screw couplings.
2. Steel set screw box connectors with nylon insulated grounding bushing, or box connector locknut, and nylon insulated grounding bushing on all tubing where grounding bushings are required.

C. For Flexible Metal Conduit

1. Couplings at connections between flexible and rigid conduit.
2. Nylon insulated throat, steel connectors at box or cabinet terminations.

D. For Liquidtight Flexible Metal Conduit

1. Adapters at connections between flexible and rigid conduit.
2. Nylon insulated throat, steel connectors at box or cabinet terminations.

E. Expansion Joints in Conduit: O.Z./Gedney, Type AX with internal ground and external bonding jumper.

F. Wire Support Bushings: Provide for vertical runs as required by the NEC. Select for the conductor

size involved.

1. For conductors NO. 8 AWG and smaller provide galvanized, non-insulating type.
2. For conductors No. 6 AWG and larger provide O.Z./Gedney, Type R, insulating type.

2.3 JUNCTION AND PULL BOXES

A. Junction and pull boxes 100 cubic inches in volume and smaller shall be standard outlet boxes. Larger junction and pull boxes shall be constructed from code gauge sheet steel with overlapped riveted or welded corners and with edges turned to receive trim. Covers shall be same gauge as box and shall be screw fastened. Boxes over 864 square inches shall be sectionalized. Boxes shall be factory-fabricated from galvanized steel to prevent corrosion.

B. Size boxes in accordance with the requirements of the NEC. Boxes shall be no smaller than 4 inches square and 1-1/2 inches deep with covers accessible at all times. Set boxes on concealed conduits with covers flush with the finished wall or ceiling line. Provide junction and pull boxes of appropriate dimensions for conduits and conductors noted, where shown and where necessary for the installation and pulling of cables and wires. Install covers on junction boxes and condulets after wiring and connections are completed.

2.4 OUTLET BOXES

A. Outlet boxes shall be UL listed, and of sizes and types required for the application.

B. Boxes Recessed in Construction: Sheet steel boxes, unless noted or required otherwise. Boxes shall be no lighter than 14 gauge and shall be galvanized after fabrication. Set so face of box will finish flush with building surface.

1. For Lighting Fixture Outlets: 4 inch square with raised fixture ring.
2. For Wall Switches, Receptacles, and Communication Use: 4 inch square, one-piece; no sectional boxes permitted. Use boxes with plaster rings in all plastered walls where wall thickness permits. Use boxes less than 1-1/2 inch deep only in locations where deep boxes cannot be accommodated by construction.

C. Boxes Used Outdoors or in Damp/Wet Locations: Cast metal boxes (iron and alloy) with gasketed covers and threaded hubs.

2.5 PULL CORD (OR WIRES)

A. Provide a nylon cord, with a tensile strength of not less than 200 pounds, in each empty conduit to facilitate the future installation of conductors. Plastic tags shall be incorporated for identification.

2.6 WIREWAYS AND AUXILIARY GUTTERS

A. Wireways shall be constructed in accordance with UL 870. Every component including lengths, connectors, and fittings shall be UL listed and labeled. Provision shall be included in the construction to allow screwing the hinged cover closed without the use of parts other than the standard lengths, fittings, and connectors. It shall also be possible to seal the cover in the closed position with a sealing wire.

B. Wireways shall be constructed with/without knockouts, as required. Enclosure type shall be as required by conditions encountered.

C. Gutters and Wireways shall be suitable for "lay-in" conductors. Connector covers shall be permanently attached so that removal is not necessary to utilize the lay-in feature.

D. All sheet metal parts shall be provided with a rust-inhibiting phosphatizing coating and gray baked enamel finish. All hardware shall be plated to prevent corrosion. All screws installed toward the inside shall be protected by spring nuts or otherwise guarded to prevent wire insulation damage.

E. All connectors shall be slip-in type with self-retained mounting screws. All hangers shall be two-piece with hook-together feature to permit pre-assembly of wireway and hanger bottom plate before hanging on pre-installed upper bracket.

2.7 SURFACE METAL RACEWAY

A. Surface metal raceway shall be UL listed and labeled; shall be used together with couplings, clips, bushings, straps, connectors, connection covers, elbows, boxes, extension boxes, fixture boxes, extension adapters, blank covers and all other required fittings; shall be of the proper size to accommodate the conductors to be installed therein in each case.

PART 3 - EXECUTION

3.1 INSTALLATION OF UNDERGROUND CONDUIT

A. Install underground conductors in plastic conduit, unless noted or specified otherwise. Install at least 30 inches below finished grade, unless noted otherwise, on a bed of sand not less than 3 inches deep. Cover raceways with 9 inches of sand before continuing backfill. Assemble and install raceways in accordance with manufacturer's instructions. Make joints with couplings and solvent welding cement. Fabricate long radius bends with proper heating equipment. Bends showing signs of overheating or flattening are unacceptable. Bends less than 10 feet radius shall be made with rigid steel as described herein. Ream ends of all conduit before joining.

B. Install plastic conduit on non-metallic interlocking spacers securely anchored to prevent movement during backfilling.

C. Where conduit enters into or under a building and turns up out of the earth or turns up into pole bases or concrete pads, change from plastic to rigid galvanized steel conduit below grade. Do not extend any plastic conduit into, under or within a building. Make similar change from plastic to rigid galvanized steel conduit at connections to underground pull or junction boxes and at all bends.

D. All steel conduit in earth shall be rigid galvanized steel conduit. Wrap conduit with 3M 0.020-inch thick No. 52 "Scotchrap" vinyl plastic tape, half lapped to give a double thickness wrap. Remove all oil, grease and dirt from conduit with a suitable solvent, and clean and dry conduit before wrapping. If conduit is pre-wrapped in the shop and then cut and jointed on the job, wrap all joints on the job, overlapping pipe wrapping 3 inches on both sides of joint.

E. Metal conduits shown to be concrete encased shall be rigid galvanized steel. At the Contractor's option, corrosion protected conduits may be used; installation shall comply with manufacturer's recommendations.

At a minimum, provide a pullbox of appropriate size every 500 feet of straight run and at every 90 degree bend. Perform tensile strength calculations for the conductor to be pulled to determine if pullboxes are required more frequently.

3.2 INSTALLATION OF BUILDING CONDUIT

A. All conduits installed within the building shall conform to requirements of this Section.

B. Run all conductors of every description in conduits unless noted or specified otherwise.

C. In above grade locations all conduits shall be galvanized rigid steel or intermediate metal conduit where installed exposed in damp or wet locations, installed in concrete, when exposed to physical damage or where utilized for conductors over 600 volts. When installed in concrete conduit may be PVC. Elsewhere conduit shall be EMT.

D. In areas where there are no suspended ceilings, run all conduits parallel/perpendicular to building surface planes.

E. Conduits shall be of such size and so installed that the conductors may be drawn through without injury or excessive strain, shall be secured at cabinets and boxes, with galvanized locknuts, both inside and outside, and shall have appropriate bushings inside. Bushings shall be insulating type or insulating type with bonding ground clamps where grounding bushings are required.

F. Join galvanized rigid steel and intermediate metal conduit with threaded couplings. Threaded conduits shall be reamed after threading, and shall be kept tightly closed at each end, and shall be kept in dry locations during construction. Conduits shall be swabbed out before conductors are pulled.

G. Conduits piercing roof membrane shall be flashed as specified in Division 7.

H. Ground metallic conduits as required by the NEC.

I. Provide a green grounding conductor in all conduits including PVC conduits sized as required by the NEC.

J. Install raceways continuous from outlet box to outlet box, or cabinet, with a maximum of 150 feet between pull points. The number of equivalent 1/4 bends between pull points shall not exceed that required by the NEC.

K. Do not install raceways within three (3) inches of hot water pipes, except where crossings are unavoidable, and then keep raceways at least 1 inch from insulation on the pipe. When possible, avoid installing raceways directly above, or in close proximity to objects operating at high temperatures.

L. In damp or wet locations, make every effort to avoid installing raceways in a manner which will create moisture traps. Seal both ends of raceways with an approved sealing compound to prevent moisture condensation within the raceways.

M. In systems operating at more than 300 volts between phase conductors, and where different phase conductors are to be run to a common outlet box, provide substantial barriers between adjacent devices in the box so that two different phase wires will not be in the same compartment.

N. Join EMT with the specified type of couplings. At EMT terminations, provide insulated throat, box

connectors and locknuts.

O. Provide an expansion joint in each raceway run which is buried in, or rigidly secured to, the building construction on opposite sides of a building expansion joint, and in each long straight run of raceway which may be subject to excessive expansion.

P. Wherever raceways pass through floors, walls, penetrations, or other partitions, or through sleeves in floors, walls or other partitions, carefully fill any space between the outside of the raceway and the building material to prevent passage of air, water, smoke, and fumes. Filling material shall be a UL listed, intumescent sealant having fire/smoke resistive quality.

Q. Conduits utilized throughout the project shall not be smaller than 3/4 inch for feeders, multiple branch circuit homeruns and homeruns of conductors large than No. 12. Individual branch circuit wiring for No. 12 conductors shall be acceptable in ½" conduit, i.e. 2#12, 1#12G, ½" C.

3.3 INSTALLATION OF PULL AND JUNCTION BOXES

A. Size all pull and junction boxes in accordance with the NEC. Use larger sizes than required by code where job conditions so indicate.

B. Fasten all boxes securely to the building construction, independent of conduit systems.

C. On concealed conduit systems where boxes are not otherwise accessible, set boxes flush with finished surfaces for access, and provide overlapping covers.

3.4 INSTALLATION OF OUTLET BOXES

A. Terminate conduits at a metal outlet box at each outlet or device. All boxes shall conform to the NEC.

3.5 INSTALLATION OF PULL CORD (OR WIRES)

A. Provide a pull cord (or wire) in every empty raceway, not containing conductors to be installed under this Division, to facilitate future installation of wiring. Cord shall be free from splices and shall have 12 feet of exposed length at each end. Coil and identify each end of each line with plastic tag bearing complete information as to the purpose of the raceway and the location of its other end.

3.6 INSTALLATION OF CONDUIT HANGERS AND SUPPORTS

A. Furnish and install all hangers and supports required by the raceway systems. Refer to Section 16190 for additional requirements.

B. Support all above-grade electrical conduits from the building construction. Support conduits running vertically or horizontally along walls with galvanized malleable iron one-hole clamps. Carry individually supported horizontal conduits 1-1/4 inch and larger on suspension hangers.

C. Where multiple raceways are run vertically or horizontally at the same elevations, they shall be supported on trapezes formed of sections of metal framing, suspended on rods. Size trapeze members, including the suspension rods, based on the support required for the number, size, and

loaded weight of the conduits. Space them as required for the smallest conduit to be supported.

D. Locate hangers and trapezes to support horizontal raceways without appreciable sagging. Hanger spacing shall not exceed NEC requirements, or recommendations of the NECA "Standard of Installation".

E. Where local branch circuit conduits smaller than 1-1/4 inch are installed above metal lath and plaster ceilings or mechanically suspended dry ceilings of the non-removable type, they may be supported on ceiling runner channels. Where multiple conduits are passing through they shall be supported on trapeze hangers.

F. Where local branch circuit conduits smaller than 1-1/4 inch are installed above removable type dry ceilings, support them on suitable hanger rods with metal clips at a distance above the ceiling sufficient to permit removal of ceiling panel and lighting fixtures. (Do not secure them to ceiling hanger rods.) Locate such conduits so as not to hinder access to mechanical equipment through ceiling panels. Where multiple conduits are passing through they shall be supported on trapeze hangers.

G. Where support anchors are required, establish their type and locate in concrete construction before concrete is poured, if possible. Fit each hanger rod with a nut at its upper end, and set nut in a universal concrete insert in the form. Where supported weight exceeds holding strength of a single insert, pass rods through top slot of inserts and interlock with reinforcing steel. Also, where particularly heavy loads are to be supported, suspend hanger rod or rods from a structural angle spanning two or more inserts and securely bolted thereto to distribute the weight.

3.7 INSTALLATION OF SURFACE METAL RACEWAY

A. Firmly secure raceway components to building surfaces using plastic expansion shields and flathead sheet metal screws for plaster, plastic expansion shields and flathead wood screws for drywall or masonry lead expansion shields for brick, cinder block and concrete construction.

B. Raceways shall be run perpendicular and parallel to building surfaces with boxes set plumb and square.

3.8 SEGREGATION OF WIRING SYSTEMS

A. Segregation of wiring systems shall not be compromised by the use of common pullboxes, wireways, cabinets or any other type of enclosure.

B. The raceway system for each feeder shall be a separate system completely fault isolated from all other raceway systems.

C. The raceway system for the branch circuits of each panelboard shall be a separate system completely fault isolated from all other raceway systems.

END OF SECTION 16110

SECTION 16120

SYSTEMS OF CONDUCTORS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of the systems of conductors and cables for power and lighting service and for other systems included in this project, including related accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

B. Submittal data for conductors and cables shall include, but not be limited to, the following:

1. Complete physical properties of the conductors and cables.
2. Ampacity for use intended.
3. Allowable stresses and requirements for installations, including bend radii, linear stress, and other pertinent data.

PART 2 - PRODUCTS

2.1 SYSTEMS OF CONDUCTORS - 600 VOLTS OR LESS

A. Wire (for installation within conduit or raceway)

1. Provide conductors of stranded soft-drawn annealed copper, 98% conductivity, new building wire, insulated in accordance with the requirements of the NEC for the several services involved. Insulation shall be rated not less than 600-volt. Conductors shall be Type "THWN" or "THHN/THWN". Solid conductors shall be utilized for wire size No. 12 and smaller.
2. Temperature ratings of conductors shall generally be 75 degrees C. For high temperature applications, the temperature ratings shall be in accordance with the NEC for the ambient condition.

B. Connectors: Make splices and connections in conductors using UL connectors.
   1. Stranded Conductors: UL listed, solderless, bolted pressure or compression connectors. Connectors shall be of proper sizes to match conductor sizes.
   2. Solid Conductors: UL listed, bolted pressure or spring connectors. Connectors shall be of proper sizes to match conductor sizes.
   3. Motor Lead Pigtails: UL listed, crimp lugs with through-bolt fasteners between lugs. Lugs shall be of proper sizes to match conductors. Proper sized dies and tools shall be furnished to apply connectors.
   4. Lighting Fixture Taps: Electrical spring connectors as specified for solid conductors.
   5. Ground Connections: Burndy ground clamps or connectors of a type suitable for and having a UL listing for grounding applications.

C. Identification Tags: Nylon band with marking pad equivalent to Thomas and Betts Series TY-553M.

D. Metal Clad Cable

   1. Metal Clad Cable: Type MC metal clad cable shall consist of factory assembled insulated conductors enclosed in a metallic sheath of interlocked galvanized steel strip manufactured in accordance with UL Standard 1569. The insulated conductors shall have an operating temperature of 90 degree C and shall be covered by a high dielectric strength assembly tape. Type MC cable shall be capable of passing UL's 70,000 BTU vertical tray flame test and the two hour through-penetration flame test in compliance with UL 1479. Type MC cable shall be as manufactured by AFC or equal.
   2. Super Neutral MC Cable: Shall be utilized for multiple branch circuit cable feeding non-linear type loads. Cable shall include oversized neutral and isolated ground.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

A. Pull no conductors into conduits until all work of a nature which may cause injury to conductors is completed.

B. Before any wire is pulled into any conduit, thoroughly swab the conduit to remove all foreign material and to permit the wire itself to be pulled into a clean, dry conduit. Utilize wire pulling lubricants to facilitate the pulling of conductors.

C. Exercise care in handling and installing cables to avoid damage. Carefully form cables in equipment pull boxes. Form bends in cables larger than the minimum radii shown in the cable manufacturer's published data for minimum bends such that bends will not reduce the cable life.

D. Run feeders in continuous lengths, without joints or splices, insofar as practicable. Make joints in branch circuits only where circuits divide.

E. Do not use gutters of panelboards as raceways, junction boxes, or pull boxes for conductors not terminating in said panelboards.

F. Run conduits for emergency power conductors separate from all other wiring.

G. Make splices and terminations in cables with kits and instructions provided by the kit manufacturer. Each splice shall equal the integrity of the cable electrically and environmentally.

H. Color Coding: Color coding shall be continuous for the entire length of conductors, and shall be permanent and readily distinguished after installation. Color coding of conductors shall be:

1. Neutral conductors: White for 120 volt systems.
2. Grounding conductors: Green for equipment ground and green with yellow striping/tracing for isolated ground. Provide an equipment grounding conductor in each conduit; bond to each device, box and light fixture.
3. Phase conductors in 208-volt systems: Black, Red and Blue for Phases A, B, and C, respectively.
4. Use other colors as necessary to identify controls and other special circuits, or to match existing building color schemes.
5. Where specified colors of insulated wire and cable are unavailable, such conductors shall be color coded as specified at pull boxes, support boxes, outlet boxes, panelboards, switchboards, and other terminal and splicing points by means of double wrapped tape minimum 3" long with heat shrink clear plastic sleeve over tape.

I. Bundling Conductors: Bundle conductors in switchboards, panelboards, cabinets, and the like, using nylon traps, made for the purpose. Bundle conductors larger than No. 10 in individual circuits. Smaller conductors may be bundled in larger groups.

3.2 INSTALLATION OF CONDUCTORS 600 VOLTS OR LESS

A. Install all conductors in raceways, unless specifically noted otherwise.

B. Sizes

1. No conductors shall be smaller than No. 12, except for signal or control circuits.
2. For receptacle and motor branch circuits, conductors shall be No. 12 minimum.
3. A maximum of six (6) current carrying conductors shall be permitted in a conduit. For receptacles and electronic ballasted lighting branch circuits, the neutral shall be considered a current carrying conductor.
4. For home runs on 120-volt, 20-ampere branch circuits, where length of run from panelboard to first outlet exceeds 100 lineal feet, use No. 10 conductors; where length of run is 100 lineal feet or less, use No. 12 conductors.
5. For multiple branch circuit homeruns for 120 volt, 20 ampere receptacle branch circuits, utilize a neutral conductor one size larger than the phase conductors. For individual branch circuit homeruns of either voltage the neutral conductor may be the same size as the phase conductor, but not less.
6. Termination of multiple branch circuit conductors on circuit breakers is not acceptable.

C. Use length of flexible metal conduit (inclusive of MC cable) more than 6 feet long at final connections to all motors, transformers, generators, and similar devices subject to movement because of vibration or mechanical adjustment. Use 3/8" by 6'-0" flexible metal conduits for final connections to recessed lighting fixtures. Use liquidtight flexible metal conduit, with appropriate connections, in damp or wet locations, in mechanical equipment rooms, at motor or equipment location at or near pumps, and when installed outdoors.

3.3 WIRE PULLING

A. Pull Cord in Empty Raceways: Provide in every empty raceway, not containing conductors, a suitable pull cord to facilitate future installation of wiring. Cord shall be free from splices and shall have ample exposed length at each end. All lines shall be nylon cord with a tensile strength not less than 200 pounds. Pull wires are not acceptable.

B. Provide suitable installation equipment to prevent abrasion and cutting of conductors by raceways during the pulling of conductors. Use ropes of polyethylene, nylon or other suitable non-metallic material to pull in feeders. Metallic ropes are prohibited.

C. Attach pulling lines to conductors by means of insulated woven basket grips or by pulling eyes attached directly to conductors. Do not use rope hitches, or bare steel basket grips. All conductors to be installed in a single conduit shall be pulled in simultaneously.

D. All cable pulling lubricants shall be UL listed, of non-conducting type, and shall be certified by their manufacturer to be non-injurious to the insulation on which they are used.

E. Do not use cable pulling lubricants on conductors of ungrounded circuits which are electrically monitored by ground detector system, since such lubricant may increase the capacities to ground of these conductors.

END OF SECTION 16120

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, material, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of wiring devices, including related systems and accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

1.4 REFERENCE STANDARDS

A. The wiring devices specified herein shall be designed, manufactured, tested and installed according to the latest version of the following standards:

1. National Electrical Manufacturers Association (NEMA) WD-1
2. Federal Specification (FS) WC-596
3. Federal Specification (FS) WS-896
4. Underwriters Laboratories (UL)

B. All wiring devices shall be UL listed.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Pass & Seymour

B. Hubbell

C. Leviton

D. General Electric

2.2 RECEPTACLES

A. General

1. Receptacles shall be standard or decorative style as indicated herein. They shall be constructed of high-impact resistant thermoplastic material with a nylon face and thermoplastic back body. Unless noted otherwise, they shall be 2-pole, 3-wire with a green equipment ground screw or an automatic grounding system attached to the strap.

2. Receptacle color shall be white unless noted otherwise.

B. Specification Grade

1. Specification Grade receptacles shall be standard style. The face shall be constructed of a high-impact resistant thermoplastic. The contacts shall be a triple wipe, T-slot, one-piece copper alloy design. The device shall have a green ground screw or an automatic grounding system attached to the strap. The device shall be 20-ampere, 125-volts, NEMA configuration 5-20R, back and side-wired.

C. Special purpose receptacles shall be of the specific NEMA configuration indicated on the Drawings.

D. Ground Fault Circuit Interrupter (GFCI)

1. GFCI receptacles shall be a feed-through type wired for single receptacle protection thus not affecting receptacles downstream on the same circuit. They shall be UL rated Class 1 with 5-milliampere ground fault trip level and a 20-ampere feed-through rating. GFCI receptacles shall be NEMA configuration 5-20R.

2.3 SWITCHES

A. General

1. Switches shall be toggle or decorative rocker type as indicated herein.. The body of the switch shall be made of an arc-resistant thermoset material. All toggle switch handles shall be constructed of a thermoplastic material. All rocker switch handles shall be constructed of a thermoset material. All wall switches shall be of the quiet AC type.
2. Switches shall be SPST, DPST, 3-way or 4-way as indicated on the Drawings.
3. Switch color shall be white unless noted otherwise.

B. Specification Grade

1. Specification Grade switches shall be toggle type. The contact arms shall be made of one-piece copper alloy material. The switch shall include a green ground screw attached to the mounting strap. The switch shall be 20-ampere, 120/277-volts AC, horsepower rated, back and side-wired.

C. Incandescent Wallbox Dimmers

1. Manufacturer

a. Lutron

2. Performance

a. All devices shall be capable of operating at rated capacity without adversely affecting design lifetime.
b. All devices shall mount individually in a single gang switchbox. Devices shall be gangable without removing side sections or derating capacity.
c. Devices shall operate in an ambient temperature range of 0ºC (32ºF) to 40ºC (104ºF).
d. All dimmers and switches shall incorporate an air gap switch which shall be accessible without removing the faceplate. The air gap switch shall be capable of meeting all applicable requirements of UL 20 for air gap switches in incandescent dimmers.
e. All dimmers and switches shall provide power-failure memory. Should power be interrupted and subsequently returned, the lights will come back on to the same levels set prior to the power interruption. Restoration to some other default level is not acceptable, unless noted otherwise.
f. Dimmers and switches shall not be susceptible to damage or loss of memory due to static discharge.
g. Dimmers and switches shall be tested to withstand voltage surges of up to 600V and current surges of up to 200A without damage per ANSI/IEEE std. C62.41-1980.
h. Dimmers and switches shall meet the UL 20 limited short circuit test requirement for snap switches.

3. Dimmer Controls

a. Dimmer control of light intensity shall be via a linear slide.
b. Linear slide dimmer shall provide intensity and on/off control with movement of slider. This shall apply to single pole and 2-location dimmers.
c. Dimmer shall include voltage compensation circuitry that adjusts the firing angle of the dimmer in such a manner as to compensate light output for variations in the AC line voltage. Dimmers in which the firing angle is merely held constant with varying AC line voltage shall not be acceptable.
d. All dimmers shall provide a smooth and continuous Square Law Dimming curve.
e. Dimmers shall utilize a filtering network to minimize interference with properly installed radio, audio and video equipment.
f. Dimmer control slider shall be captured.
g. All dimmers shall meet UL 20 and be appropriately marked.

4. Switches

a. All dimmer related on/off switches shall be single pole, 3-Way and 4-Way configuration as indicated on the Drawings.
b. Switch rating shall be 20A, 120 VAC, for tungsten or inductive loads.

5. Wall Plates

a. Wall plates shall include mounting frame for proper device alignment and faceplate attachment.
b. Wall plates shall be constructed of high impact, scratch-resistant ABS plastic. Color shall be ivory unless noted otherwise.

c. Wall plates shall snap on to device with no visible means of attachment.
d. Heat fins shall not be visible on front of device.
e. At locations with multiple devices, one seamless, multi-gang faceplate shall be provided. Coordinate proper switch box size and wall plate type.

2.4 WALL PLATES

A. Wall plates shall be provided for all switches, receptacles, blanks, telephone and special purpose outlets. The wall plates shall be of suitable configuration for the device for which it is to cover with color matched mounting screws. Color of the wall plates shall match the device, unless noted otherwise.

B. Wall plates shall be plastic. They shall be thermoplastic, non-combustible and high-impact resistant. They shall be P-line smooth plates.

C. Weatherproof: Wiring devices in wet and damp locations shall be installed with a hinged outlet cover/enclosure clearly marked “Suitable for Wet Locations While in Use” and “UL Listed”. There shall be a gasket between the cover/enclosure and the mounting surface, and between the hinged cover and mounting plate/base to assure proper seal. The cover/enclosure shall employ stainless steel mounting hardware and be constructed of impact resistant polycarbonate. The cover/enclosure shall be specification grade as manufactured by Taymac Corporation or equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRING DEVICES

A. Each wiring device shall be mounted in a metallic outlet box. In general, devices in finished spaces shall be flush mounted and devices in unfinished spaces, i.e. mechanical and electrical equipment rooms, shall be surface mounted. Verify the requirements of all spaces with the Architect.

B. Wall Plates

1. Each device shall have a cover plate appropriate for the application.
2. Cover plates shall be installed true and plumb with building lines, mortar joints and architectural features.
3. Adjacent devices shall be mounted under a common cover plate suitable for the application.

C. Mount receptacles and special systems outlets above finish floor to the device centerline, unless noted or required otherwise.

D. Place conductor under wiring device screw terminals and draw up snugly.

E. Mount switches above finish floor to the device centerline and 6" from a door strike, unless noted or required otherwise.

F. Grounding continuity shall be maintained between devices and metallic raceway system in addition to the green equipment grounding conductor run with circuit conductors. Care shall be taken when installing receptacles having an isolated ground pole so as to not bond the

equipment ground conductor to the conduit system.

G. Wire each receptacle using correct polarity (i.e., neutral to neutral terminal, etc.).

H. Mount receptacles throughout the project with ground pole at the top of the configuration when mounted vertically, on the right when horizontally mounted.

I. All exterior wiring devices shall be provided with a weatherproof cover/enclosure. Exterior receptacles shall be GFCI type.

J. Derate dimmer capacity as required by the manufacturer if side sections are removed.

K. Run a separate neutral wire for each phase of a three phase system when dimmers are installed on multiple phases and for each dimmer when multiple dimmers are installed on the same phase.

END OF SECTION 16140

SECTION 16160

CABINETS AND ENCLOSURES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of electrical cabinets and enclosures, including all related systems and accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

1.4 REFERENCE STANDARDS

A. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

B. NEMA ICS 4 - Terminal Blocks for Industrial Control Equipment and Systems.

C. ANSI/NFPA 70 - National Electrical Code.

D. UL 50 - Electrical Cabinets and Boxes.

1.5 REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified and shown.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Hoffman Engineering Company.

B. Square D Company.

2.2 HINGED COVER ENCLOSURES

A. Construction: NEMA 250, Type 1 and 3R steel enclosure.

B. Covers: Continuous hinge, held closed by flush latch operable by key.

C. Interior: Provide interior metal panel for mounting terminal blocks and electrical components; finish with white enamel.

D. Enclosure Finish: Manufacturer's standard enamel. When required, field painting shall be as specified by Division 9.

2.3 CABINETS

A. Boxes: Galvanized steel with gray baked enamel finish.

B. Box Size: As required or indicated.

C. Fronts: Steel, flush or surface type indicated with concealed hinge, and flush lock keyed to match branch circuit panelboard. Finish with gray baked enamel. When required, field painting shall be as specified by Division 9.

D. Provide metal barriers to separate compartments containing control wiring operating at less than 50 volts from power wiring.

E. Provide accessory feet for free-standing equipment.

2.4 TERMINAL BLOCKS

A. Terminal Blocks: ANSI/NEMA ICS 4.

B. Power Terminals: Unit construction type with closed back and tubular pressure screw connectors, rated 600 volts.

C. Signal and Control Terminals: Modular construction type, suitable for channel mounting, with tubular pressure screw connectors, rated 300 volts.

D. Provide ground bus terminal block, with each connector bonded to enclosure.

2.5 EXTRA MATERIALS

A. Provide two of each cabinet key.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Verify that surfaces are ready to receive work.

B. Install products in accordance with manufacturer's instructions.

C. Install enclosures and boxes plumb. Anchor securely to wall and structural supports at each corner.

D. Install cabinet fronts plumb.

END OF SECTION 16160

SECTION 16190

SUPPORTING DEVICES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Division for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, material, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of supporting devices, including related systems and accessories.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Unistrut Corp.

B. B-Line Systems, Inc.

C. Midland Ross-Kindorf

2.2 MATERIALS

A. Suspension Hangers

1. Suspension hangers for individual conduit runs shall be zinc plated formed steel type.

B. Vertical Supports

1. Malleable iron one hole pipe straps shall be used for vertical runs.

C. Clamps

1. Beam clamps shall be used for bar joists and beams.

D. Anti-Vibration Hangers

1. Anti-vibration hangers shall be combination type having a double deflection neoprene element in series with a steel coil spring; double deflection of 0.30"; steel coil spring shall be selected from a 1" static deflection series with a minimum additional travel to solid of ½"; spring diameters shall be large enough to permit 15 degree angular misalignment of the rod connecting the hanger to the ceiling support without rubbing the hanger box.

E. Light Fixture Hangers

1. Refer to Section 16500

F. Corrosive Areas: PVC; at factory apply a minimum of 10-mil-thick PVC coating, bonded to metal, inside and outside.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hangers

1. Approved hangers and stiff leg supports shall be installed in quantity and size as required to carry the weight of raceway and contents and shall be arranged to prevent vibration transmission to the building and allow for raceway movement.
2. Hangers shall be supported by means of uncoated solid steel rods which are threaded to allow vertical adjustments. Lock nuts shall be provided in sufficient number and location to lock all rod adjustments permanently at the adjusted height. Two lock nuts shall be used unless the nut tightens against a threaded socket. Minimum rod diameters shall be as follows:

NOMINAL CONDUIT SIZE	ROD DIAMETER
1/2" through 2"	1/4"
2-1/2" through 3"	3/8"
4" and 5"	1/2"

3. Hanger spacing shall be as required for proper and adequate support raceway, but in no case shall be less than one hanger per 8'-0" of raceway length except that conduit less than 1" diameter shall be supported at least every 6'-0".
4. Where numerous conduits are run parallel to one another, they may be supported from a trapeze type hanger arrangement with strut bottom.
5. Anti-vibration type hangers shall be provided for equipment as required to minimize vibration and/or as directed by the Architect/Engineer.

B. Supports

1. Support of hangers shall be by means of sufficient quantities of individual after set steel expansion shields, or beam clamps attached to structural steel.
2. Stiff-legs shall be furnished and installed in cases where support from overhead structure is not possible.

3. Ceiling mounted lighting fixtures shall be supported from the building structure at two opposite corners. The Contractor shall provide fixture hangers to properly interface with the ceiling system.
4. Furnish and install complete any additional structural support steel, brackets, fasteners, etc., as required to adequately support all raceway and equipment.
5. Support of hangers from concrete slabs shall be by means of sufficient quantity of "U" brackets attached with after set expansion shields and bolts.
6. Support of hangers from concrete tees shall be by means of sufficient quantity of angle iron brackets attached with after set expansion shields and bolts.

END OF SECTION 16190

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, material, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of electrical identification, including related accessories.

B. Provide electrical identification for the following:

1. Panelboards, motor starters, contactors, disconnect switches, circuit breakers and other electrical equipment with nameplate identifying the item of equipment and the equipment serving the same.
2. Raceways, junction boxes and pull boxes.
3. Wiring devices.
4. Wiring.
5. Three phase motor rotation.

1.3 SUBMITTALS

A. Submit product data in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Brady

B. Panduit

C. Thomas & Betts

2.2 IDENTIFICATION

A. Nameplates

1. Nameplates shall be black engraved surface on white core for normal power circuits and red engraved surface on white core for emergency power circuits.

2. Provide for each distribution panelboard, branch circuit panelboard, transformer and any other similar equipment furnished under this Division identification as to its given name, voltage and origination of service. Examples are as follows:

'HA' 480Y/277V FED FROM 'DPA'	'DPA' 480Y/277V FED FROM 'MSA'
'LA' 208Y/120V FED FROM 'TLA'	'TLA' 75 KVA, 480V to 208Y/120V FED FROM 'HA'

3. Provide for each motor starter enclosure, circuit breaker enclosure, disconnect switch and any other similar equipment furnished under this Division, identification as to the specific load that it serves and the origination of service. Examples are as follows:

'CHP-1' FED FROM 'MCC-1'	'AHU-1' FED FROM 'DPA'

4. Provide for each feeder protective device in each distribution panelboard and any other similar equipment furnished under this Division, identification as to the specific load that it serves.
5. Nameplates shall be laminated, white core, plastic with beveled edges, minimum 1/16 inch thick. Lettering shall be machine-engraved, not less than 1/4" high, cut through the black or red surface to the white core.

B. Junction Boxes and Pull Boxes

1. Identification shall be with a black permanent marking pen on the top of 4" x 4" junction box covers or on the back of an outlet box cover plate identifying the branch circuits and systems within the conduit. Pull boxes shall be provided with a nameplate stating voltage and system served.

C. Wiring Device Wall Plates

1. On the back side of wiring device wall plates identify with a black permanent marking pen the panelboard and branch circuit number the device is served from.

D. Wire Markers

1. Wire markers for identification of wiring shall be self-adhesive type having letters and numerals indicating serving equipment and feeder or branch circuit number.

E. Rotation Tags

1. Rotation tags shall be brass or aluminum securely attached to equipment.

PART 3 - EXECUTION

3.1 PREPARATION

A. Surfaces to receive labels or nameplates shall be carefully prepared in accordance with the manufacturer's instructions and recommendations.

3.2 NAMEPLATES

A. Nameplates shall be properly attached to identify panelboards, feeder circuit breakers, disconnect switches, pull boxes and other similar equipment furnished under this Division.

3.3 WIRE MARKERS

A. Wire markers shall be applied to each conductor or cable within panelboards, motor starter enclosures, circuit breaker enclosures, disconnect switches, cabinets, junction boxes, pull boxes, and other similar equipment identifying the serving equipment and feeder or branch circuit from which the conductors originate.

END OF SECTION 16195

SECTION 16310 - ENGINE GENERATOR

1.0 GENERAL REQUIREMENTS

1.1 **Scope** - This section includes the installation of all mechanical and electrical items required for the proper operation of a Contractor-furnished engine generator set, accessories and Contractor-furnished items. The items to be installed shall include the engine generator set, engine exhaust system, load bank, load bank controller, day tank, battery charger, and bypass/transfer switches, etc.

1.2 **Applicable Documents** - The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only. Current revisions of the applicable documents and codes shall be utilized for all work completed under this contract.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM) -

ASTM A53	1988 (Rev. A) Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
ASTM A126	1984 Gray Iron Castings for Valves, Flanges, and Pipe Fittings
ASTM A181/A181M	1987 Forgings, Carbon Steel, for General Purpose Piping
ASTM A193/A193M	1989 Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
ASTM A194/A194M	1988 (Rev. A) Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
ASTM A234/A234M	1989 Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures
ASTM A307	1988 (Rev. A) Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

FEDERAL SPECIFICATIONS (FS) -

TT-E-489	Enamel, Alkyd Glass (for Exterior and Interior Surfaces)
TT-P-636	Primer Coating, Alkyd, Wood and Ferrous Metal
WW-P-406	Pipe, Steel (Seamless and Welded) (for Ordinary Use)

MANUFACTURERS' STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS) -

MSS SP-70	1984 Cast Iron Gate Valves, Flanged and Threaded Ends
MSS SP-80	1987 Bronze Gate, Full Port Ball and Check Valves

1.3 **Related Requirements**- Section 16050, "Electrical Work," applies to this section with the additions and modifications specified herein.

1.4 **Submittals** –

a. Piping, Valves, and associated materials.

b. Test data and reports.

2.0 MATERIALS

2.1 **General** – The referenced rules, regulations, and specifications shall be considered as minimum requirements. They shall not relieve the Contractor from furnishing and installing higher grades of material and workmanship than are specified herein or when so required by the specification drawings.

2.2 **Materials** - Where the drawings indicate (diagrammatically or otherwise), the work intended and the functions to be performed (even though some minor details are not shown) the Contractor shall furnish all equipment and materials. The Contractor shall be responsible for taking the necessary actions to ensure that all equipment, material, and installation work are coordinated with, and are compatible with the architectural, electrical, mechanical, and structural plans. All materials and equipment to be used shall comply with all contract requirements. Materials furnished by the Contractor under this specification shall be new and the standard product of the manufacturer's latest designs that comply with the specification requirements. Wherever standards have been established by Underwriters Laboratories, Inc., the material shall bear the UL label.

2.3 **Workmanship** - All installation work shall be done by competent and experienced Mechanics and Electricians regularly engaged in this type of work in conformance with established standards. The workman shall have a current license to engage in this type of work. Departures from exact dimensions shown in the drawings are permitted to avoid conflict or difficulty in placement of the dimensioned item, provided all other contract and proposal requirements are met, and the Site Representative approval is obtained.

2.4 **Engine Accessories** - To be provided by the Contractor:

a. Foundation bolts, nuts, isolators, and sleeves for engine generator set.
b. Chocks and shims for installation and leveling of engine generator set sub-base, if applicable.
c. Electrical terminations.

2.5 **Exhaust System** - Provide exhaust system for the engine. Field installed piping shall be in accordance with the manufacturer's requirements. Include piping, fittings, and expansion joints necessary to interconnect equipment with the engines.

2.5.1 **Exhaust Piping**: Provide piping for the engine complete with necessary fittings, flanges, gaskets, bolts, and nuts. Pipe shall be lap-welded, or seamless steel pipe conforming to ASTM A53. Exhaust piping shall be Schedule 40 pipe for 12 inch and smaller sizes and for larger sizes shall have wall thickness not less than 0.375 inch. Exhaust piping shall slope away from engine. Flanges shall be 150-pound slip-on forged steel welding flanges conforming to ANSI B16.5, with material in accordance with ASTM A181/A181M, Grade I. Fittings shall be butt-welded conforming to ASTM A234/A234M, with wall thickness same as adjoining piping. Built-up miter welded fittings may be used. Fittings shall be of same material as pipe. Miter angles of each individual section shall not

exceed 22.5 degrees total and not more than 11.25 degrees relative to the axis of the pipe at any one cut. Gaskets for piping shall be high temperature asbestos-free material suitable for the service. Bolting material for exhaust flanges shall be alloy-steel bolt-studs conforming to ASTM A193/A193M and alloy-steel nuts conforming to ASTM A194/A194M. Bolts shall be sufficient length to obtain full bearing on the nuts and shall project not more than two full threads beyond the nut.

2.6 Fuel System –

a. Fuel Pipe - ASTM A 53; Type E, Electric-Resistance Welded or Type s, Seamless; Grade B; Schedule 40; black.
b. Fittings – Black malleable iron, 150 pound, threaded, ANSI B16.3
c. Valves – ASME B16.33, 125 psig, cast-iron body, bronze plug, straightaway pattern, square head, tapered-plug type, and threaded ends. Designed for repacking when fully opened. Equipped with packing suitable for intended service, gland followers, and having pressure/temperature rating note less than design criteria. Valves shall be UL listed for use with petroleum fuels.
d. Solenoid Valve - 120 VAC, 60 Hz, Class B, continuous-duty molded coil; UL labeled and designed for use with petroleum fuel (Diesel #2). Operating temperature of 32°F to 125°F ambient and a maximum operating pressure and pressure differential of 125 psig. Valve position is normally closed.
e. Strainers – Bronze, cast-iron, or semi-steel, designed for same working pressure as indicated for fittings and valves. Strainers shall be Y type.

2.7 Bolts, Studs, and Nuts -

a. For Temperatures Up to 450° F: Material for bolts or studs shall be ASTM A307, Grade B, and for nuts ASTM A194/A194M, Grade 2. Threads and dimensions for bolts or studs shall comply with ANSI B18.2.1 for square head dimensions.
b. For Temperatures Over 450° F: Material for bolts or studs shall be ASTM A193/A193M, Grade B7, and for nuts ASTM A194/A194M, Grade 7. Threads and dimensions for bolts or studs shall comply with ANSI B18.2.1 for square head dimensions and shall comply with ANSI B18.2.1 for square head dimensions and with ANSI B1.1 coarse thread series, for 1 inch and smaller.

2.8 Wire and Cable - Provide wire and cable required for a complete electrical system as shown. Comply with the requirements specified in Section 16050, "Electrical Work."

3.0 EXECUTION

3.1 General - Installation shall be in strict accordance with manufacturer's instructions. Provide labor, tools, equipment, and other necessities for erection and installation of the equipment. Use cribbing and shoring as required to protect construction from moving-in damage. Protect flooring and finished surfaces with heavy planking. After equipment has been installed, remove shoring and repair damage to floors and other parts of the building. Furnish the services of one or more Diesel-Generator representative or technician, experienced in the installation and operation of the type of systems being provided, to supervise the installation.

3.2 **Installation of Engine Generator Set** - Install engine generator set on a concrete foundation. Provide vibration isolators to isolate vibrations from the engine generator set to the foundation. The engine generator bedplate shall be mounted on six vibration isolators, Caldyn part no. RJSD 1022K 7855 or approved equal. Install and anchor the isolators to the floor according to the isolator manufacturer's instructions.

3.3 **Equipment Supports and Installation** - Provide devices to support equipment not supported on the engine generator structural steel sub-base as required. Fabricate the required supports of structural steel sections, plates or rods, and arrange to provide rigid and sturdy support. Provide connections and fasteners required between equipment supports and building structures.

3.4 **Piping** - Piping extensions from the engine generator and sub-base to remote cooling systems and fuel oil systems are Contractor-furnished and, unless stated otherwise, fabrication, assembly, welding, soldering, and brazing shall conform to ANSI B31.1. Arrange piping to provide a workable arrangement, with convenient access to valves and specialty items. Maintain adequate clearance between runs of piping to permit access around adjacent pipe for dismantling, repair, and maintenance of valves. Piping shall be straight, plumb, and run direct as possible. Do not install piping over electrical equipment. Install piping by competent and skilled workmen.

3.4.1 **Shop Fabrication** - Shop fabricate pipe to the greatest extent possible. Plug ends of piping and openings prior to shipment to plant site.

3.4.2 **Welding** - Preparing, bending, cleaning, and welding of piping shall conform to ANSI B31.1. Welds shall be visually examined and meet acceptance standards of ANSI B31.1.

3.4.3 **Field Cleaning** - Before placing in position, clean the inside of black steel pipe by rapping along its full length to loosen sand, mill scale, and other foreign matter. Pipe 2 inch and larger shall have a wire brush of a diameter larger than that of the inside of the pipe drawn through its entire length several times. Before final connections are made to apparatus, wash out interior of coolant piping with water. Blow out air, fuel, and lubricating oil lines with 80-to-100 psi dry air or nitrogen.

3.4.4 **Provisions for Expansion** - Provide for expansion of piping subject to temperature change by using suitable flexible piping connectors expansion joints, bends, ball joints, offsets, and loops in a manner that will prohibit development of excessive stresses between anchor points or at equipment connections. Use bends, loops, and offsets wherever practical to prevent overstressing of piping systems due to thermal expansion and to provide adequate flexibility. A piping system may be cold sprung by an amount no greater than 50 percent of the total linear expansion to alleviate end thrusts and moments. Method of cold springing shall be as approved.

3.4.5 **Reducing Fittings** - Use for changes in pipe size except where taps are permitted. Use of bushings is prohibited. In horizontal mains containing liquids, use eccentric reducers.

3.4.6 **Unions or Flanges** - Place where necessary to permit easy connection of piping and apparatus. Provide each connection having valves with screwed ends with a union. In long lines inside buildings, place unions or flanges not farther apart than 100 feet, except in pipe lines of welded construction where unions or flanges shall be placed as indicated.

3.4.7 **Valves** - Install in positions accessible for operation and repair. Install stems preferably in a vertical position with hand wheels or operators on top, or install in a horizontal position. Do not install hand wheels on stop valves below the valve. Install globe valves with flow direction from below the disk.

3.4.8 **Connections to Equipment** - Make piping connections to equipment shown and provide reducers, increasers, unions, and valves to make a complete installation. Make connections to equipment with dielectric unions or flanged joints. Valves shall be the same size as the piping in which they are installed.

3.4.9 **Joints** -

a. Flanged Joints: Face pipe flanges true to line and thoroughly clean before assembly. Gasket faces shall be free of burrs or bruises. Make up flanged joints prior to completing the last weld in connecting piping. Coat bolt threads with a mixture of equal parts of graphite and boiled linseed oil or with an approved commercial coating.
b. Screwed Joints: Use graphite pipe-joint compound conforming to MIL-T-5544; apply to male threads only. Red or white lead and zinc compound conforming to MIL-T-22361 may be used, except lead compounds are prohibited in potable water lines. Piping shall be free of fins and burrs. Ream pipe ends or file out to size of bore; remove chips.

3.4.10 **Pipe Sleeves** - Provide where pipes and tubing pass through masonry metal, or concrete walls, floors, roofs, and partitions. Sleeves in outside walls above grade, in floor, or in roof slabs shall be steel pipe. Sleeves in floor slabs shall extend 3 inches above the finished floor. Firmly pack space between the pipe or tubing and the sleeve with oakum and caulk on both ends of the sleeve with elastic cement, except for sleeves in the plant operating floor which shall be free of packing and elastic cement.

3.4.11 **Wall Pipes** - Provide cast iron wall pipes for piping passing through underground exterior walls and install in a manner to ensure a watertight connection between the wall and casting. Wall pipes shall have flanged ends conforming to ANSI B16.1, Class 125. Extend flanged ends beyond wall to permit bolting of flanges to connecting piping.

3.4.12 **Slope, Drainage, and Ventilating**.- Slope piping to permit complete drainage. Install drain valves at low points in piping. Drain valves shall be 1/2 inch gate valves for pipe lines smaller than 3 inches and 3/4-inch gate valves for lines 3 inches and larger, except where specified sizes are shown. Drain valves shall be of the same class as the piping drained. Install vent valves at high points in piping. Vent valves shall be 1/2-inch globe valves.

3.4.13 **Flashing** - Flashing and counter flashing for pipes and supports passing through exterior walls above ground and through roof shall conform to details as indicated.

3.4.14 **Anchors, Guides, and Supports** - Anchor and support piping in a manner such that expansion and contraction will take place in the desired direction. Prevent vibration by use of vibration dampers and prevent undue strains on equipment served. Hangers used for support of piping of 2-inch pipe size and larger shall be the type permitting adequate adjustment after erection while still supporting the load. Provide supports to adequately carry weight of lines and to maintain proper alignment. Provide inserts and sleeves for supports in concrete where necessary, and in new construction place before concrete is poured.

3.5 **Piping Tests** - Test piping system after lines have been cleaned. Test piping systems at a pressure of 1.5 times the design working pressure, and in no case less than 100 psi. Hydrostatically test piping, except for air, oil, and gas, using water not exceeding 100° F. Test air, oil, and gas lines with clean, dry air or nitrogen. In all tests, remove gauges, traps, and other apparatus which may be damaged by the test pressure, or valve off before the tests are made. Install a calibrated test pressure gauge in the system to observe loss in pressure. Brush joints in piping system tested with air with a soapy water solution to check for leaks. Maintain the required test pressure for a sufficient length of time to enable inspection of joints and connections. Rectify defects which develop during testing, and retest piping systems until they show no defect or weakness and are tight.

3.6 **Engine Exhaust System** - The Contractor shall install the contractor-furnished exhaust silencer (muffler) on the engine generator set. The muffler shall be covered with a minimum of 1-1/2-inch pipe insulation, calcium silicate thermal insulation, wrapped with 6 ounce fiberglass cloth and cover with an aluminum alloy jacket. Engine generator exhaust flexible connection shall not be insulated.

3.6.1 **Exhaust Pipe** - The engine exhaust pipe furnished by the Contractor shall be black steel pipe conforming to Federal Specification WW-P-406, Weight A, Class 1, threaded to accommodate the threaded flanged couplings furnished with the exhaust silencer (muffler) and flexible metal, exhaust pipe.

3.6.2 **Exhaust Pipe Hangers** - Hangers shall be spaced in no case more than 6 feet apart on straight runs of pipe and not more than 12 inches from any change in direction of the exhaust pipe.

3.6.3 **Exhaust Pipe Support** - Engine generator exhaust pipe supports consisting of threaded rods suspended from the building frame. The exhaust pipe shall be suspended from rods by clevis or split ring hangers with adjustable turnbuckle pipe clamps. The pipe hangers shall fit snugly around the insulation. Protect insulation at suspension points by a sheet metal protection shield, 12 inches minimum length by one-half the circumference of the insulation.

3.6.4 **Exhaust Flexible Connection** – A contractor furnished flexible section of pipe shall be installed by the Contractor between the rigid exhaust pipe and the engine generator. Provide flanged connections of the size and type recommended by the engine generator manufacturer for the connection to rigid piping. In no case shall the flexible section be used to correct misalignment between the engine manifold and the exhaust piping. Contractor shall follow all written manufacturer's instructions for the installation of the flexible piping.

3.7 **Engine Cooling System** - In order to prevent damage to the engine immersion heater, the Contractor shall fill the cooling system before the set is connected to commercial power. Add a sufficient amount of ethylene glycol type anti-freeze to protect the engine from freezing down to -30°F and an approved rust inhibitor to the cooling water.

3.8 **Fuel System** – Install the fuel system (including day tank if applicable) as shown on the drawings and in accordance with the manufacture's written instructions, NFPA 30, 37 and UL 80,142. Provide all necessary piping, valves, strainers, and electrical connections required for a complete system. Piping between the tank, day tank, and engine generator shall be protected from vibration by flexible piping a minimum of 18 inches in length. Connection to the furnished E/G shall be in accordance with manufacturer's instructions.

3.9 **Wiring** - The Contractor shall install all switches, breakers, distribution panels, and control cabinets, as required, in accordance with the applicable paragraphs of 16050. The Contractor shall run all conduits, lay-in-duct, and wiring between the transfer switch, generator control cabinet, distribution panel(s), battery charger, load bank controller, and remote radiator in accordance with the installation drawings and manufacturer drawings. The Contractor shall identify all switches and cabinets with nameplate on the front of each item of equipment, the function, voltage, and phase of the piece of equipment.

3.10 **Starter Batteries** - Dry charged batteries shall be furnished with the Engine Generator. The Contractor will be required to provide electrolyte prior to charging. During construction period, follow manufacturer's instructions for protection from environmental damage.

3.11 **Paint Touch-Up** - The Contractor shall touch up all rust spots and scratches on the engine generator and associated equipment. Rusted areas shall be sanded down and primed with Primer Coating, Alkyd, Wood and Ferrous Metal conforming to Federal Specification TT-P-636. The areas shall then be painted with Alkyd Gloss Enamel conforming to Federal Specification TT-E-489, matching the existing paint on the engine generator and associated equipment, as near as is possible.

4.0 QUALITY ASSURANCE

4.1 **General** - The Contractor shall be responsible for placement of the engine generator set. The instructions relative to the installation, and the placing in operation of the engine generator set as contained in the Operator's Manual or Instruction Book, furnished with the set, shall be followed. The spare parts, special tools, and instruction book(s) furnished with the set shall remain in the engine generator room.

4.2 **Phase Rotation** - The Contractor shall make certain that the phase rotation of the generator is compatible with that of the incoming commercial lines. Phase angle tests shall be made and submitted to the Site Representative for approval. Submit 6 copies of test reports to the Site

Representative for approval prior to equipment connections. Test reports shall include type of test equipment, date of test, test results, and signature of the person conducting the test.

4.3 **Operational Test** - Notify the Site Representative, in writing a minimum of 14 days in advanced, to arrange for operational/startup testing. The Contractor shall connect the engine generator set, ready to operate, provide and fill the crank-case with the specified grade of oil, provide coolant and fill the cooling system. Contractor shall not attempt to start the engine generator until the installation has been completely checked by a certified Manufacturer Representative. Startup testing shall be performed jointly by the Manufacturer's Representative, Site Representative and the Contractor. The Contractor shall perform any necessary labor required to correct deficiencies found during testing. Testing takes approximately 8 hours.

4.4 **Delivery, Storage, and Handling** -

4.4.1 **General** - All items and materials shall be Contractor-furnished. The Contractor shall furnish all materials, labor, equipment, and transportation necessary to satisfy the requirements specified in this Division and/or indicated on the drawings.

4.4.2 **Care and Handling -** The Contractor shall provide protection for the engine generator and associated equipment from weather, dust, and physical damage. He shall also be liable for all damage while transporting or handling the engine generator, associated equipment, and to the building while installing it until final inspection and acceptance.

*** * *End of Section 16310* * ***

SECTION 16425

SWITCHBOARD

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification Sections apply to Work covered by this Section.

B. Comply with other Division 16 Sections, as applicable. Refer to other Divisions for coordination of the Work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of switchboard indicated, including all related systems and accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

B. Shop Drawings shall indicate front and side enclosure elevations with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of horizontal bus bars per phase, neutral and ground; one-line diagrams; equipment schedule; and switchboard instrument details.

1.4 REFERENCE STANDARDS

A. A. Switchboards and overcurrent protection devices referenced herein shall designed and manufactured according to the latest version of the following standards:

B. ANSI/NFPA 70 - National Electrical Code (NEC).

C. ANSI/IEEE C12.1 - Code for Electricity Metering.

D. ANSI C39.1 - Electrical Analog Indicating Instruments.

E. ANSI C57.13 - Instrument Transformers.

F. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

G. NEMA KS 1 - Enclosed Switches.

H. NEMA PB 2 - Deadfront Distribution Switchboards.

I. NEMA PB 2.1 - Proper Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or Less.

J. NEMA PB 2.2 - Application Guide for Ground Fault Protective Devices for Equipment.

K. UL 50 - Cabinets and Boxes

L. UL 98 - Enclosed and Dead Front Switches

M. UL 489 - Molded Case Circuit Breakers

N. UL 891 - Dead-Front Switchboards

O. UL 943 - Ground Fault Circuit Interrupters

P. UL 977 - Fused Power Circuit Devices

Q. Federal Specification W-C-375B/Gen - Circuit breakers, molded case, branch circuit and service.

R. Federal Specification W-C-870 - Fuseholders (for plug and enclosed cartridge fuses)

S. Federal Specification W-S-865 - Enclosed Knife Switch

1.5 QUALITY ASSURANCE

A. Furnish products listed and classified by Underwriters Laboratories Incorporated and in accordance with the reference standards previously indicated.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products in conformance with manufacturer's recommended practices as outlined in applicable Installation and Maintenance Manuals.

B. Each switchboard section shall be delivered in individual shipping splits for ease of handling. They shall be individually wrapped for protection and mounted on shipping skids.

C. Inspect and report concealed damage to carrier within their required time period for repair or replacement.

D. Store in a clean, dry space. Maintain factory protection and/or provide an additional heavy canvas or heavy plastic cover to protect structure from dirt, water, construction debris, and traffic. Where applicable, provide adequate heating within enclosures to prevent condensation.

E. Handle in accordance with NEMA PB 2.1 and manufacturer's written instructions. Lift only by lifting means provided for this express purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.7 ENVIRONMENTAL REQUIREMENTS

A. A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.8 MAINTENANCE MATERIALS

A. Provide one (1) set of installation and maintenance instructions with each switchboard. Instructions shall be easily identified and affixed within the incoming or main section of the line-up.

1.9 WARRANTY

A. Manufacturer shall warrant equipment to be free from defects in materials and workmanship for a period of one (1) year from date of final acceptance by the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Square D

B. General Electric

C. Cutler-Hammer/Westinghouse

D. Siemens

2.2 GENERAL

A. Short Circuit Current Rating: Switchboards shall have a minimum short circuit current rating as indicated on the Drawings in RMS symmetrical amperes at the maximum AC voltage indicated.

B. Future Provisions: All unused spaces provided, unless otherwise specified, shall be fully equipped for future devices, including all appropriate connectors and mounting hardware.

C. Switchboard enclosure shall be NEMA Type 1 - general purpose.

1. Align switchboard sections at front and rear.
2. Switchboards shall be of deadfront construction.
3. Switchboard frames shall be of formed UL gauge steel rigidly bolted together to support all cover plates, bussing and component devices during shipment and installation.
4. Steel base channels shall be bolted to the frame to rigidly support the entire shipping section for moving on rollers and floor mounting.
5. Each switchboard section shall have an open bottom and an individually removable top plate for installation and termination of conduit.
6. Switchboard enclosures shall be painted on all exterior surfaces. The paint finish shall be an ANSI standard medium light gray.
7. All front covers shall be screw removable with a single tool and all doors shall be hinged with removable hinge pins.
8. Top and bottom conduit areas shall be clearly indicated on shop drawings.

D. Provide engraved laminated nameplates for each switchboard and each overcurrent protective device in accordance with Section 16195.

E. Bus composition shall be plated copper. Plating shall be applied continuously to all bus work. The switchboard bussing shall be based on 1000A per square inch. The phase and neutral (for 4-wire systems) through-bus shall have an ampacity as indicated. For 4-wire systems, the neutral shall be of equivalent ampacity as the phase bus bar. Full provisions for the addition of future sections shall be provided. Bussing shall include all necessary hardware to accommodate splicing for future additions.

F. Bus connections shall be bolted with Grade 5 bolts and conical spring washers.

G. Ground bus shall be copper and shall be sized per NFPA 70 and UL 891 and shall extend the entire length of the switchboard. Provisions for the addition of future sections shall be provided as previously indicated.

H. Accessibility shall be only from the front of the switchboard.

2.3 INCOMING MAIN SECTION DEVICES

A. Main Circuit Breaker (Rated at 100%)

1. Thermal magnetic molded case circuit breaker.
    a. Main circuit breaker shall be fixed, individually mounted.
    b. Power terminals shall be provided to accommodate either cable or bolted bus connections.

2.4 DISTRIBUTION DEVICES

A. Feeder Circuit Breakers

1. Thermal magnetic molded case circuit breaker(s)
    a. Group mounted 15A through 1200A.
    b. Branch circuit breaker(s) shall be group mounted on a common pan or rail assembly.
    c. Circuit breaker(s) shall be mounted in the switchboard to permit installation, maintenance and testing without reaching over line side bussing.
    d. The interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide isolation to the entire length of bus.
    e. There shall be one (1) continuous bus bar per phase; each bus bar having a pair of exposed longitudinal edge portions providing non-specific mounting means for branch circuit breaker(s).
    f. The entire interleaved assembly shall be contained between the two (2) U-shaped steel channels, permanently secured to a galvanized mounting pan by tamper-resistant fasteners.
    g. Circuit breaker(s) shall not require additional external mounting hardware. Circuit breaker(s) shall be held in the mounted position by a self-contained bracket secured to the mounting pan by fasteners. Each individual circuit breaker shall be capable of being mounted independently. Circuit breaker(s) of different frame sizes shall be capable of being mounted across from each other without means of a common bucket.
    h. Line side circuit breaker connections shall be jaw type.

2.5 THERMAL MAGNETIC TRIP MOLDED CASE CIRCUIT BREAKERS

A. Branch Circuit Breakers

1. Circuit protective devices shall be molded case circuit breaker(s). Circuit breaker(s) shall have minimum short circuit current ratings as indicated on the drawings. Ampere ratings shall be as indicated on the drawings. The manufacturer shall submit one set of published Ip and I^2t let-through curves with the submittal.
2. Circuit breakers shall be UL listed for reverse connection without restrictive line and load markings, and be suitable for mounting in any position.
3. Circuit breaker(s) shall be constructed in accordance with the following standards:
   a. UL 489
   b. NEMA AB1
   c. Federal Specification W-C 375B/GEN
   d. IEC 157-1
   e. BS4752
4. Circuit breaker(s) shall be constructed using glass reinforced insulating material providing superior dielectric strength. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
5. Each circuit breaker shall have common tripping of all poles and shall be trip-free.
6. The circuit breaker(s) shall be Quick-Make, Quick-Break with an overcenter toggle operating mechanism. Shall not be able to be teased into a neutral position.
7. Breaker handle and faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.
8. Circuit breaker(s) shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.
9. Handle position shall provide local trip indication.
10. Circuit breaker escutcheon shall have international I/O markings, in addition to standard on/off markings. Circuit breaker handle accessories shall provide provisions for locking handle in the “on” or “off” position.
11. Each circuit breaker shall be equipped with a push-to-trip button to mechanically operate the circuit breaker tripping mechanism.
12. Circuit breaker(s) shall be applied on systems where the available short circuit current on the line side of the device is less than or equal to the interrupting rating of the circuit breaker.
13. Trip System:
    a. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.
    b. All circuit breakers shall have factory sealed thermal trip elements. The thermal trip system shall be true RMS sensing and thermally responsive to protect circuit conductor(s) in a 40 degree C ambient temperature. Thermal elements shall be ambient compensating above 40 degrees C to provide consistent protection to circuit conductions.
    c. Circuit breaker(s) with frame sizes greater than 100 amperes shall have variable magnetic trip elements which are set by a single adjustment to simultaneously adjust the instantaneous trip point in all poles.
14. Terminations:
    a. All lugs shall be UL listed to accept solid and/or stranded copper conductors only. Lugs shall be suitable for 75 degree C rated wire. Lug body shall be bolted in place.

b. All circuit breakers shall be UL listed to accept field installable/removable mechanical type lugs.
c. All circuit breakers shall be suitable for bus connection.

2.6 ELECTRONIC POWER MONITORING

A. General

1. Provide solid-state, multi-function power monitoring system/device with digital display.
2. Provide a display to monitor main circuit breaker only.

B. Power Monitor

1. The electronic power monitor shall accept inputs from industry standard instrument transformers (120VAC secondary PT's and 5A secondary CT's).
2. All setup parameters required by the power monitors shall be stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.
3. The power monitor shall also maintain in nonvolatile memory a maximum and minimum value for each of the instantaneous values reported as well as the time and date of the highest peak for all of the peak demand readings.
4. The following instantaneous readings shall be reported by the power monitor:
   a. Current, per phase RMS ±1.0%
   b. Current, 3-phase average RMS ±1.0%
   c. Current, apparent RMS ±1.0%
   d. Voltage, phase-to-phase & phase-to-neutral ±1.0% e. Power factor, per phase ±2.0%
   e. Power factor, 3-phase total ±2.0%
   f. Real power, 3-phase total ±2.0%
   g. Reactive power, 3-phase total ±2.0%
   h. Apparent power, 3-phase total ±2.0%
   i. Frequency ±0.5%
5. The following demand readings shall be reported by the power monitor:
   a. Average demand current, per phase
   b. Peak demand current, per phase
   c. Average demand, real power
   d. Peak demand, real power
6. The following energy readings shall be reported by the power monitor:
   a. Accumulated energy
   b. Accumulated reactive energy

C. Power Monitor Installation

1. The power monitor shall be installed by the switchboard manufacturer.
2. All control power, CT, PT, and communications wire shall be factory wired and harnessed within the switchboard lineup.

D. Certification Description

1. All equipment included as part of the power monitoring shall be UL Listed or UL recognized.

2.7 ACCESSORIES

A. For switchboards installed outdoors only, provide thermostatically-controlled electric heaters in each section, sized to prevent condensation under expected weather conditions. Provide terminals for separate source connection of heater power circuit with a voltage rating of 277 volts.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine area to receive switchboard to provide adequate clearance for switchboard installation.

B. Check that concrete housekeeping pads are level and free of irregularities.

C. Start work only after unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install switchboard in accordance with manufacturer's written instructions and the NEC.

3.3 FIELD QUALITY CONTROL

A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure, using a megger, the insulation resistance of each bus section phase to phase and phase to ground for one minute each, at minimum test voltage of 1000 volts DC; minimum acceptable value for insulation resistance is 1 megohms. Refer to manufacturer's written instructions for specific testing procedures.

C. Check tightness of accessible bolted bus joints using calibrated torque wrench per manufacturer's recommended torque values.

3.4 ADJUSTING

A. Adjust all operating mechanisms for free mechanical movement per manufacturers specifications.

B. Tighten bolted bus connections in accordance with manufacturer's instructions.

C. Adjust circuit breaker trip and time delay settings to values as directed by the Engineer.

3.5 CLEANING

A. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 16425

1.5 QUALITY ASSURANCE

A. Panelboards shall be manufactured in accordance with standards previously listed.

1.6 DELIVERY, STORAGE AND HANDLING

A. Inspect and report concealed damage to carrier within their required time period for repair or replacement.

B. Handle carefully to avoid damage to panelboard internal components, enclosure, and finish.

C. Store in a clean, dry environment. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect enclosures from dirt, water, construction debris, and traffic.

1.7 OPERATIONS AND MAINTENANCE MATERIALS

A. Manufacturer shall provide installation instructions and NEMA Standards Publication PB 1.1 (Operations and Maintenance Manual) with each panelboard.

1.8 WARRANTY

A. Manufacturer shall warrant specified equipment free from defects in materials and workmanship for a period of one (1) year from the date of final acceptance by the Owner.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Square D

B. General Electric

C. Cutler-Hammer/Westinghouse

D. Siemens

2.2 POWER DISTRIBUTION PANELBOARDS

A. Circuit Breaker Distribution Panelboards

1. Interior

a. Shall be rated 600 volts AC or 250 volts DC maximum. Continuous main current ratings shall be as indicated on the Drawings. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67.
b. Provide UL Listed short circuit current ratings as indicated on the Drawings.

c. The panelboard interior shall have three flat bus bars stacked and aligned vertically with glass reinforced polyester insulators laminated between phases. The molded polyester insulators shall support and provide phase isolation to the entire length of bus. There shall be one (1) continuous bus bar per phase; each bus bar having a pair of exposed longitudinal edge portions providing non-specific mounting means for main and branch circuit breakers specified herein.

d. The bussing shall be fully rated with sequentially phased branch distribution. Panelboard bussing rated 100 - 600 amperes shall be plated Copper. Bussing rated 800 amperes and above shall be plated copper. The entire interleaved assembly shall be contained between two (2) U-shaped steel channels, permanently secured to a galvanized steel mounting pan by tamper-resistant fasteners.

e. Interior trim shall be of dead-front construction to shield user from all energized parts. Main breakers up to 800 amperes shall be vertically mounted. Main breaker and main lug interiors shall be field convertible for top or bottom incoming feed.

f. Equipment ground bar shall be bonded. Ground bar shall be copper. Solid neutral shall be equipped with a full capacity grounding strap for service entrance applications.

g. Metal nameplates shall contain system information, catalog number or factory order number. Nameplate shall be secured to the dead-front with rivets or screws. Sticker or foil nameplates are not acceptable. Interior wiring diagram, neutral wiring diagram, UL listed label and short circuit current rating shall be displayed on the interior. Leveling provisions shall be provided for flush mounted applications.

2. Molded Case Circuit Breakers - Mains and Branches

a. Common Characteristics

1) Circuit breakers shall be constructed in accordance with the following standards:

a) UL 489
b) Federal Specification W-C-375B/GEN
c) NEMA AB1
d) IEC 157-1

2) Circuit breakers shall be molded case constructed using glass reinforced polyester insulating material providing superior dielectric strength. Current carry components shall be completely isolated from the handle and the accessory mounting area.

3) Circuit breakers shall have an overcenter, trip-free, toggle operating mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.

4) Circuit breakers shall have a push-to-trip button for maintenance and testing purposes.

5) Circuit breaker escutcheon shall have International I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the "ON" or "OFF" position.

6) Breaker faceplate shall indicate rated ampacity. Breaker faceplate shall indicate UL and IEC certification standards with applicable voltage systems and corresponding AIC ratings.

7) Circuit breakers shall be factory sealed and shall have a date code on the face of the circuit breaker. Poles shall be labeled with respective phase designations.

8) Standard construction circuit breakers shall be UL listed for reverse connection without restrictive line or load markings. Circuit breakers shall be suitable for mounting and operating in any position.

9) Circuit breakers shall be equipped with line terminal jaws. In the event of a short circuit condition, the increased magnetic flux shall cause the jaws to grip the supply bus more firmly. Circuit breaker jaws shall be protected by an impact resistant molded shroud.
10) Circuit breakers shall not require any additional external mounting hardware. Circuit breakers shall be held in mounted position by a self-contained bracket secured to the mounting pan by fasteners. Each individual circuit breaker shall be capable of being mounted independently. Circuit breakers of different frame sizes shall be capable of being mounted across from each other.
11) Manufacturer shall provide time/current characteristic trip curves (Ip and I^2T let through curves for true current limiting circuit breakers only) for each type of circuit breaker.
12) Lugs shall be UL listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 75ºC rated wire. Lug body shall be bolted in place, snap-in designs are not acceptable.

a) Thermal Magnetic Molded Case Circuit Breakers

(1) Circuit breakers shall have ampere ratings and minimum short circuit current ratings as indicated on the Drawings.
(2) Circuit breakers shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Thermal elements shall be factory calibrated to operate in a 40ºC ambient environment. Thermal elements shall be ambient compensating above 40ºC.
(3) Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker which allows the user to simultaneously select the desired trip level of all poles.
(4) Standard circuit breakers up to 250 amperes at 600 VAC shall be UL listed with HACR ratings.

3. Enclosures

a. Type 1 Boxes

1) Shall be galvanized steel constructed in accordance with UL 50 requirements.
2) Boxes shall have removable blank endwalls and interior mounting studs. Interior support bracket shall be provided for ease of interior installation.

b. Type 1 Trim Fronts

1) Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI medium/light gray enamel over cleaned phosphatized steel.
2) Trim front shall be 4-piece surface.

2.3 LIGHTING/APPLIANCE PANELBOARDS

A. Lighting and appliance panelboards shall be rated for 240 volts AC maximum, as indicated on the Drawings. Continuous main current ratings shall be as indicated on the Drawings. Minimum short circuit current ratings shall be as indicated on the Drawings.

B. Interior

1. Provide one (1) continuous bus bar per phase. Each bus bar shall have sequentially phased branch circuit connectors suitable for plug-on or bolt-on branch circuit breakers. The bussing shall be fully rated. Panelboard bus current ratings shall be determined by heat-rise tests conducted in accordance with UL 67. Bussing rated 100 - 400 amperes shall be copper. Bussing rated for 600 amperes shall be copper as standard construction. Panelboards shall be suitable for use as Service Equipment when application requirements comply with UL 67 and NEC Articles 230-F and G.
2. All current carrying parts shall be insulated from ground and phase-to-phase by Noryl high dielectric strength thermoplastic or equivalent.
3. Split solid neutral shall be plated and located in the mains compartment up to 225 amperes so all incoming neutral cable may be of the same length. A 200% rated solid neutral shall be provided as indicated on the Drawings and shall be plated copper for non-linear load applications subject to harmonics. 200% rated solid neutral shall be self-certified by manufacturer.
4. Interior trim shall be of dead-front construction to shield user from energized parts. Dead-front trim shall have pre-formed twistouts covering unused mounting space.
5. Metal nameplates shall be secured to dead-front with rivets or screws. Sticker or foil nameplates are not permitted. Interior wiring diagram, neutral wiring diagram, UL listed label and short circuit current rating shall be displayed on the interior.
6. Interiors shall be field convertible for top or bottom incoming feed. Main and sub-feed circuit breakers shall be vertically mounted. Main lug interiors up to 400 amperes shall be field convertible to main breaker. Interior leveling provisions shall be provided for flush mounted applications.

C. Main Circuit Breaker

1. Shall be a molded case circuit breaker.
2. The molded case circuit breaker shall have an overcenter, trip-free, toggle mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have a permanent trip unit with thermal and magnetic trip elements in each pole. Each thermal element shall be factory calibrated to operate in a 40ºC ambient environment. Thermal elements shall be ambient compensating above 40ºC.
3. Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the breaker which allows the user to simultaneously select the desired trip level of all poles. Circuit breaker shall have a push-to-trip button for maintenance and testing purposes.
4. Breaker handle and faceplate shall indicate rated ampacity. Standard construction circuit breakers shall be UL listed for reverse connection without restrictive line or load markings.
5. Circuit breaker escutcheon shall have International I/O markings, in addition to standard ON/OFF markings. Circuit breaker handle accessories shall provide provisions for locking handle in the "ON" or "OFF" position.
6. Lugs shall be UL listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 75ºC rated wire. Lug body shall be bolted in place, snap-in designs are not acceptable.

D. Branch Circuit Breakers

1. Shall be molded case circuit breakers. Breakers shall be UL listed with amperage ratings, interrupting ratings, and number of poles as indicated on the panel schedules.
2. Molded case branch circuit breakers shall have Bolt-on type bus connectors.
3. Circuit breakers shall have an overcenter toggle mechanism which will provide quick-make,

quick-break contact action. Circuit breakers shall have thermal and magnetic trip elements in each pole. Two and three pole circuit breakers shall have an internal common trip crossbar to provide simultaneous tripping.

4. Breakers marked "Remote Controlled" on the panel schedules shall be of the latching type. Circuit breaker contacts shall open when the breaker is in the "OFF" or "TRIPPED" position regardless of the remote signal.
5. There shall be two forms of visible trip indication. The breaker handle shall reside in a "TRIPPED" position between "ON" and "OFF". In addition, there shall be a VISI-TRIP indicator appearing in the clear window of the circuit breaker housing.
6. The exposed faceplates of all branch circuit breakers shall be flush with one another.
7. Lugs shall be UL listed to accept solid or stranded copper conductors only. Lugs shall be suitable for 75ºC rated wire.

E. Enclosures

1. Type 1 Boxes

a. Shall be galvanized steel constructed in accordance with UL 50 requirements.
b. Boxes shall have removable endwalls with knockouts located on one end. Boxes shall have welded interior mounting studs. Interior mounting brackets are not required.

2. Type 1 Trim Fronts

a. Trim front steel shall meet strength and rigidity requirements per UL 50 standards. Shall have an ANSI gray enamel over cleaned phosphatized steel.
b. Trim fronts shall be 1-piece with door. Mounting shall be flush or surface as indicated on the Drawings.
c. Panelboards rated 225 amperes and below shall have flat fronts with concealed door hinges and trim screws. Front shall not removable with the door locked. Panelboards rated above 225 amperes shall have fronts with trim clamps and concealed door hinges. Trim front doors shall have rounded corners and edges shall be free of burrs.
d. Front shall have cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All lock assemblies shall be keyed alike. Two (2) keys shall be provided with each lock. A clear plastic directory card holder shall be mounted on the inside of door.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install panelboards in accordance with manufacturer's written instructions, NEMA PB 1.1 and NEC standards.

B. Anchor panelboards to structure and make branch circuit connections.

C. Coordinate the panelboard bus ratings and circuit breaker coordination rating with the available fault current.

D. Provide engraved laminated nameplates under the provisions of Section 16195.

3.2 FIELD QUALITY CONTROL

A. Inspect complete installation for physical damage, proper alignment, anchorage, and grounding.

B. Measure steady state load currents at each panelboard feeder; rearrange circuits in the panelboard to balance the phase loads within 20% of each other. Maintain proper phasing for multi-wire branch circuits

C. Check tightness of bolted connections, and circuit breaker connections using calibrated torque wrench or torque screwdriver per manufacturer's written specifications.

END OF SECTION 16470

SECTION 16475

OVERCURRENT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, material, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of overcurrent protection devices, including all related systems and accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

B. Product Data: Provide data sheets showing electrical characteristics including time-current curves.

1.4 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code (NEC).

B. NEMA FU 1 - Low Voltage Cartridge Fuses.

C. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.

D. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures.

E. UL 943 - Standard for Ground Fault Circuit Interrupters.

F. IEC 157-1 - Low-Voltage Switchgear and Control Gear Part 1: Circuit Breakers.

G. Federal Specification W-C-375B/GEN - Circuit Breakers, Molded Case; Branch Circuit and Service.

PART 2 - PRODUCTS

2.1 GENERAL

A. Overcurrent protection devices shall be constructed and tested in accordance with NEMA standards and shall be UL listed and labeled.

2.2 SERIES RATINGS

A. Fault current values indicated on the Drawings are based on actual available fault values at each switchboard, panelboard and any other similar equipment. Equipment manufacturers shall provide equipment and protective devices suitably rated for the configurations indicated whether rated for the available fault current indicated or rated for operation for the fault current indicated when applied in series with specific other protective devices.

2.3 CIRCUIT BREAKERS

A. Circuit breaker manufacturer shall be the same as the switchboard/panelboard/motor control center manufacturer.

B. Refer to specific switchboard, panelboard and motor control center specification sections.

2.4 FUSES

A. Acceptable Manufactures

1. Bussmann
2. Gould Shawmut
3. Littelfuse

B. 600 Ampere and Below 600 VAC or Less

1. Fuses shall have 200,000 RMS symmetrical ampere interrupting capacity at 600 VAC or less, current limiting type; time delay characteristics - 10 seconds (minimum) at 500% rated current; UL Class RK1.

C. Above 600 Ampere, 600 VAC or Less

1. Fuses shall have 200,000 RMS symmetrical ampere interrupting capacity at 600 VAC or less; current limiting type; time delay characteristics - 4 seconds (minimum) at 500% rated current; UL Class L.

2.5 SELF-CONTAINED CIRCUIT BREAKER ENCLOSURES

A. Self-contained circuit breaker enclosures shall be padlockable NEMA 1, except for units in damp or wet areas which shall be NEMA 3R enclosure with conduit hubs.

PART 3 - EXECUTION

3.1 INSTALLATIONS

1. Enclosures for self-contained units shall be securely mounted to wall and shall be level and

true. Mounting height shall be plus 54" above finish floor to center of breaker unless otherwise.

2. Furnish a number of spare fuses equaling 10% of quantity installed but not less than three (3) fuses of each type and rating.
3. Install fuses with label oriented such that manufacturer, type and size are easily read.

END OF SECTION 16475

SECTION 16481

ENCLOSED MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of enclosed motor controllers including all related systems and accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

B. Provide catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.

1.4 REFERENCE STANDARDS

A. NFPA 70 - National Electrical Code.

B. NECA "Standard of Installation," published by National Electrical Contractors Association.

C. NEMA AB 1 - Molded Case Circuit Breakers.

D. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.

E. NEMA ICS 6 - Enclosures for Industrial Controls and Systems.

F. NEMA KS 1 - Enclosed Switches.

1.5 REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters Laboratories, Inc.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Siemens

B. Square D

C. General Electric

D. Cutler-Hammer/Westinghouse

2.2 MOTOR CONTROLLER

A. Motor starters shall be across-the-line magnetic type with ratings as indicated. Starters shall be mounted in general purpose enclosures unless otherwise indicated.

B. Across-the-line magnetic starters shall be equipped with double break silver alloy contacts. All contacts shall be replaceable without removing power wiring. The starter shall have straight-through wiring.

C. Coils shall be of molded construction. All coils shall be replaceable from the front.

D. Overload relays shall be the melting alloy type with a replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. The starter shall be inoperative of the thermal unit is removed.

E. Starters shall be suitable for the addition of four external auxiliary contact of any arrangement normally open or normally closed; external auxiliary contacts shall be field convertible.

F. All motor starters, unless noted otherwise, shall be 3-pole, 3-phase, of the NEMA size indicated on the drawings with 3 melting alloy overhead relays, a 3-position "Hand-Off-Auto" (H-O-A) selector switch and a red "On" pilot light in the cover of the enclosure, and a 120 volt control power transformer with secondary fuse.

2.3 COMBINATION MOTOR CONTROLLER

A. Combination Motor Starters shall be of the ratings as indicated. The motor starters shall be across-the-line magnetic type complete with all accessories previously specified. Disconnect switch combination starters shall consist of a visible blade disconnect switch, a motor starter and be fusible or non-fusible as required. Circuit breaker type combination starters shall consist of a circuit breaker and a motor starter. Combination starters shall be mounted in general purpose enclosures unless otherwise indicated.

B. The disconnect handle used on combination starters shall always be in control of the disconnect device with the door opened or closed. The disconnect handle shall be clearly marked as to whether the disconnect device in "On" or "Off" and shall include a two-color handle grip, the black side visible in the "Off" position indicating a safe condition, and the red side visible in the "On" position indicating an unsafe or danger condition.

2.4 MANUAL MOTOR CONTROLLER

A. Manual starters shall consist of a manually operated toggle switch equipped with melting alloy type thermal overload relay. Thermal unit shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed. Contacts shall be double break, silver alloy, visible from both sides of starter. Toggle operator shall be furnished with a handle guard having locking provision. Starter shall include a red pilot light.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install controllers where indicated.

B. Install controllers plumb. Provide supports in accordance with Section 16190.

C. Height: 5 ft to operating handle.

D. Select and install overload heater elements in motor controllers to match installed motor characteristics.

E. Provide engraved plastic nameplates under the provisions of Section 16195.

F. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.2 FIELD QUALITY CONTROL

A. Inspect and test each enclosed controller to NEMA ICS 2.

END OF SECTION 16481

SECTION 16485

CONTACTORS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of contactors, including all related systems and accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

B. Product Data: Include dimensions, size, voltage ratings and current ratings.

1.4 REFERENCE STANDARDS

A. ANSI/NEMA ICS 6 Enclosures for Industrial Controls and Systems

B. NEMA ICS 2 Industrial Control Devices, Controllers, and Assemblies

C. ANSI/NFPA 70 National Electrical Code

1.5 OPERATION AND MAINTENANCE DATA

A. Maintenance Data: Include instructions for replacing and maintaining coil and contacts.

1.6 REGULATORY REQUIREMENTS

A. Furnish products listed and classified by Underwriters' Laboratories.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Siemens

B. Automatic Switch Company (ASCO).

C. Square ‘D’

2.2 POWER LIGHTING CONTACTORS

A. Description: NEMA ICS 2, magnetic lighting contactor.

B. Configuration: Electrically held with continuously rated, encapsulated coils. Mechanically held and electrically operated with encapsulated coils. Standard coil clearing contacts are to be provided so that the contactor coils shall be energized only during the instance of operation.

C. Coil Voltage: 120 volts, 60 Hz, as indicated or required.

D. Poles: As indicated.

E. Contact Rating: Amperes required for all types of ballast and tungsten lighting of resistive heating, and motor loads.

F. Contacts: Totally enclosed, double-break silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring.

G. Wiring: Straight-through wiring with all terminals clearly marked.

H. Enclosure: ANSI/NEMA ICS 6, Type 1 or 3R, as required to meet conditions of installation.

I. Disconnect Means: Contactor shall not provide the disconnecting means in the same enclosure.

J. Accessories

1. Selector Switch: HAND-OFF-AUTOMATIC
2. Auxiliary Contacts: Two, normally open and normally closed, field convertible, field convertible.

2.3 MULTI-POLE LIGHTING CONTACTORS

A. Description: Magnetic lighting contactor.

B. Configuration: Mechanically held and electrically operated with encapsulated coils. Standard coil clearing contacts are to be provided so that the contactor coils shall be energized only during the instance of operation.

C. Coil Voltage: 120 volts, 60 Hz.

D. Poles: As indicated.

E. Contact Rating: 20 amperes for all types of ballast and tungsten lighting, resistive heating, and motor loads.

F. Contacts: Totally enclosed, double-break silver-cadmium-oxide power contacts. Contact inspection and replacement shall be possible without disturbing line or load wiring. All contacts shall have clearly visible N.O. and N.C. contact status indicators.

G. Wiring: Straight-through with all terminals clearly marked.

H. Enclosure: ANSI/NEMA ICS 6, Type 1 or 3R, as required to meet conditions of installation.

I. Accessories

1. Selector Switch: HAND-OFF-AUTOMATIC.
2. Auxiliary Contacts: Two, normally open and normally closed, field convertible, field convertible.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

END OF SECTION 16485

SECTION 16500

LIGHTING FIXTURES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, material, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of the lighting as indicated.

B. Fixtures shall be complete with lamps, ballasts and related auxiliary equipment and accessories necessary to the intended operation, including mounting devices required for each type of installation.

C. Specific responsibilities of the Contractor shall include: Receipt, handling, installation, lamping, focusing, and final cleaning.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

PART 2 - PRODUCTS

2.1 LIGHTING FIXTURES

A. Provide lighting fixtures in accordance with the designations and descriptions in the "Lighting Fixture Schedule" located on the Drawings. Where a single manufacturer and associated catalog number is scheduled, it has been done in order to establish a desired type and standard of quality rather than to discriminate against an equal product made by another manufacturer. Where multiple manufacturers are listed, none other than those manufacturers will be accepted.

B. Provide a lighting fixture complete with lamps, ballasts, and other required appurtenances for each lighting outlet shown. Each unit shall be furnished with all mounting and trim accessories to suit the specific services applied. Finishes shall be factory-standard except where scheduled otherwise.

C. All lighting fixtures shall bear the UL label.

D. Submit shop drawings following procedures described in Division 1.

E. Where lighting fixtures are scheduled with plastic lenses, provide virgin acrylic lenses having a thickness of 0.125 inches.

F. Exit lighting fixtures shall comply with NFPA 101 and shall have "chevron" type arrows external to the lettering.

2.2 LAMPS

A. Each lighting fixture shall be furnished with a full set of new lamps of the types indicated on the Drawings and specified herein. Lamps shall be manufactured by General Electric, Philips, or Osram-Sylvania, except where scheduled otherwise.

B. Incandescent Lamps: In general, they shall be inside frosted, energy-saving style designed for 130-volt operation with a rated life of 2500 hours (extended service). Where reflector style lamps are scheduled, furnish beam pattern indicated. Special purpose incandescent and incandescent quartz lamps shall be of style, color, wattage, and configuration as scheduled as recommended by the luminaire manufacturer.

C. Fluorescent Lamps: In general, they shall be 3500K color, 48-inch length, T-8, rapid start, energy-saving lamps with an initial nominal output of 2,850 lumens at 32 watts, and an average rated life of 20,000 hours. For special purpose fluorescent lamps, color types, lamp length, socket configuration, and illumination output shall be as scheduled, and specified herein.

D. High Intensity Discharge (HID) Lamps: Shall be of the type and wattages scheduled. Where metal halide lamps are indicated, self extinguishing lamps shall be furnished where available in that wattage range.

E. Special lamps shall be as indicated or required for the lighting fixtures scheduled.

2.3 BALLASTS

A. Fluorescent Ballasts:

1. Indoor Applications: Fluorescent ballast for indoor applications (minimum starting temperature of 50 degrees F) shall be equal to Motorola Lighting Inc. (MLI) rapid start high performance electronic type and meet the following requirements:

   a. Operate lamps at a frequency of 25 Khz or higher with less than 2% lamp flicker.
   b. Operate at an input voltage of 120V line at an input frequency of 60 Hz. Light output shall remain constant for line voltage fluctuation of +5%.
   c. Comply with EMI and RFI limits set by the FCC (CFR 47 Part 18) for non-residential applications and not interfere with normal electrical equipment.
   d. Withstand transients as specified by ANSI C.62.41 for location category A3 in the normal mode and location category A1 in the common mode.
   e. Meet applicable ANSI standards.
   f. Nominal power factor of 0.99.
   g. No potting or PCB's.
   h. Less than 10% Total Harmonic Distortion.
   i. Less than 6% Third Harmonic Distortion.
   j. Height compatible with fixture ballast compartment.
   k. Include a poke-in wiretrap connector.
   l. Meet sound rating "A".
   m. Underwriters Laboratories (UL) listed Class P, Type 1 Outdoor.
   n. Provide normal rated lamp life as stated by lamp manufacturers.
   o. Series wired and maintain full cathode heat during operation.
   p. Less than 1.5 lamp current crest factor (LCCF).
   q. Ballast factor standard of 0.875 +0.025 on all normal light output ballasts.

2. Outdoor Applications: Fluorescent ballast for outdoor applications (minimum starting temperature of 0 degrees F) shall be equal to Motorola Lighting Inc. (MLI) instant start high performance electronic type and meet the following requirements:

    a. Operate lamps at a frequency of 25 Khz or higher with less than 2% lamp flicker.
    b. Operate at an input voltage of 120V line at an input frequency of 60 Hz. Light output shall remain constant for line voltage fluctuation of +5%.
    c. Comply with EMI and RFI limits set by the FCC (CFR 47 part 18) for non-residential applications and not interfere with normal electrical equipment.
    d. Withstand transients as specified by ANSI C.62.41 for location category A3 in the normal mode and location category A1 in the common mode.
    e. Meet applicable ANSI standards.
    f. Nominal power factor of 0.99.
    g. No plotting or PCB's.
    h. Less than 10% Total Harmonic Distortion.
    i. Less than 6% Third Harmonic Distortion.
    j. Height compatible with fixture ballast compartment.
    k. Include a poke-in wiretrap connector.
    l. Meet sound rating "A".
    m. Underwriters Laboratories (UL) listed Class P, Type 1 Outdoor.
    n. Provide normal rated lamp life as stated by lamp manufacturers.
    o. Series wired and maintain full cathode heat during operation.
    p. Less than 1.7 lamp current crest factor (LCCF).
    q. Ballast factor standard of 0.875 +0.025 on all normal light output ballasts.

B. High Intensity Discharge (HID) Ballasts: In general, shall be regulator type designed to start and operate the specified lamp combination with a maximum wattage variation of +/-5% with a variation input voltage of +/-10%. Unit shall be designed for reliable start and operation to an ambient temperature of 20 degrees F. At rated line voltage, the power factor shall be not less than 95%. Ballast primary current during starting shall not exceed current during lamp operation. Voltage and lamp characteristics shall be as indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures shall be installed in symmetrical patterns with ceiling grids, partitions, air conditioning outlets, smoke detectors, sound system speakers and similar devices. The locations are of a general nature, and shall not be scaled for locations. Refer to architectural reflected ceiling plans, where these are provided, for specific locations of lighting fixtures. The reflected ceiling plans shall be the governing documents for fixture locations.

B. Stem-mounted fixtures shall have stems installed straight and perpendicular to the mounting surfaces.

C. Each luminaire shall be supported at no fewer than two (2) points on each side for fixtures up to 48 inches in length.

D. The weight of each fixture shall rest only on the fixture support system and attached to ceiling channels. Provide hangers, cables, supports, channels, frames and brackets of each kind required to erect this equipment safely in place.

E. The mounting brackets shall be installed to overlap the ceiling support channels in order to prevent the channels from shifting from underneath the fixtures.

F. The mounting brackets shall lock in position so that the bottom of each fixture is flush with the underside of the ceiling, without additional leveling adjustments.

G. The lighting fixture installations shall not interfere with the installation or removal of adjacent ceiling panels.

H. Wire lay-in type fixtures in ceilings using concealed outlet boxes accessible through ceiling panels; install conductors, including a grounding conductor, in flexible metallic conduit from box to fixture.

3.2 CLEANING

A. At the completion of the work leave all fixtures free of all dirt, duct, grease, spots and debris, with all glass and plastic clean and unbroken.

END OF SECTION 16500

SECTION 16692

DISTRIBUTION PANELBOARD POWER CONDITIONING DEVICES

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, material, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of a high-energy service entrance power conditioning device incorporating transient voltage surge suppression (TVSS) and high-frequency electrical line noise filtering. The device shall provide effective high energy transient voltage suppression, surge current diversion, high-frequency attenuation, and line stabilization in ANSI/IEEE C62.41-1991 environments connected downstream from the facility's main overcurrent protective device. The device shall be connected in parallel with the facility's wiring system.

1.3 SUBMITTALS

A. Submit product data and shop drawings for products specified under PART 2 - PRODUCTS.

B. Manufacturers' Product Data: Submit material specifications and installation data for products specified under PART 2 - PRODUCTS.

C. Shop Drawings: Submit shop drawings to indicate information not fully described by the product data to indicate compliance with the contract documents.

1. Include electrical characteristics and ratings for the specified equipment.
2. Include wiring diagrams indicating the internal connections of the specified equipment within its enclosure.
3. Drawings shall be provided indicating device dimensions, weights, mounting provisions, connection details and wiring diagrams.
4. Documentation of the specified device UL 1449 rating shall be included. All submittals without this documentation will be rejected.
5. The manufacturer shall make available upon request certified documentation of applicable Location Category Testing in full compliance with ANSI/IEEE C62.41-1991 and ANSI/IEEE C62.45-1987 Guidelines.

D. Record Drawings

1. A complete set of manufacturers' product data and shop drawings indicating all post bid revisions and field changes.

1.4 QUALITY ASSURANCE

A. Industry Reference Standards and Publications: The device shall be designed, manufactured, tested and installed in compliance with the latest editions of:

1. American National Standards Institute (ANSI) and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.41-1991 and C62.45-1987)
2. Federal Information Processing Standards Publication 94 (FIPS PUB 94)
3. National Electrical Manufacturers Association (NEMA)
4. National Fire Protection Association (NFPA 70, National Electrical Code (NEC), 75 and 78)
5. Underwriters Laboratories UL 1449 Standard for Transient Voltage Surge Suppressors and UL 1283 Standard for Electromagnetic Interference Filters.

B. The device shall be UL listed under UL 1449 and UL 1283.

C. The device shall be warranted against defects in material and/or workmanship for a minimum of five (5) years from the date of shipment.

D. The device shall be thoroughly factory-tested before shipment. Testing of the device shall include but not be limited to quality control checks, maximum continuous operating voltage (MCOV) check, and clamping voltage verification tests. The MCOV check shall consist of a minimum of one (1) hour burn-in at the applicable MCOV.

E. Based on life expectancy testing, the device shall be capable of protecting against and surviving at least 3,000 ANSI/IEEE C62.41-1991 and C62.45-1987 Category C3 surges without failing or degrading the UL 1449 surge suppression rating by more than 10%.

1.5 SYSTEM DESCRIPTION

A. Environmental Requirements

1. Storage Temperature: Storage temperature range shall be -40º to +85º C (-40º to +185º F).
2. Operating Temperature: Operating temperature range shall be -40º to +60º C (-40º to 140º F).
3. Relative Humidity: Operation shall be reliable in an environment with 5% to 95% non-condensing relative humidity.
4. Operating Altitude: The device shall be capable of operation in an altitude of 0 - 12,000 feet above sea level.
5. Audible Noise: The device shall not generate any audible noise.
6. Magnetic Fields: No appreciable magnetic fields shall be generated. The device shall be capable of use directly in computer rooms in any location without danger to data storage systems or devices.

B. Electrical Requirements

1. Device Operating Voltage: The nominal operating voltage and configuration shall be 208Y/120, plus ground. Refer to drawings for proper application voltage.
2. Maximum Continuous Operating Voltage (MCOV): The allowable maximum continuous operating voltage of all suppression components utilized in the unit shall not be less than 115% of the nominal operating voltage.
3. Operating Frequency: The operating frequency range of the device shall be 47 to 63 Hertz.
4. Protection Modes: The devices primary mode of protection shall be line-to-neutral. The secondary modes of protection shall be line-to-ground and neutral-to-ground.
5. Single Pulse Surge Current Capacity: The tested single pulse surge current capacity of

the device based on the standard 8 X 20 microsecond current waveform per ANSI/IEEE C62.41-1991 shall be no less than 250,000A per phase, 125,000A L-N, 125,000A L-G and 125,000A N-G.

6. Performance Rating: The device performance ratings shall be based on the UL 1449 listed suppression ratings. The UL 1449 voltage suppression rating for the required mode of protection at 208Y/120 volts shall be 1000 volts with fused disconnect switch as an integral part of the device.

1.6 DOCUMENTATION

A. Equipment Manual. The manufacturer shall furnish an equipment manual with installation, operation, and maintenance instructions for the system.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

1. Current Technology
2. Liebert
3. United Power
4. LEA Dynatech
5. EFI Electronics

2.2 TRANSIENT VOLTAGE SURGE SUPPRESSION COMPONENTS

A. The device shall include a solid-state suppression system which includes arrays of fused non-linear voltage dependent metal oxide varistors (MOV's) with similar operating characteristics. The suppression system shall not utilize gas tubes, spark gaps, silicon avalance diodes or other components which might short or crowbar the line, thus leading to interruption of normal power flow to or system upset of connected loads. The suppression system shall not incorporate any other components which may degrade performance or reliability of the suppression system.

2.3 HIGH-FREQUENCY FILTER

A. The device shall include a UL 1283 high frequency extended range tracking filter. The filter shall reduce fast rise-time, high-frequency, error-producing transients and electrical line noise eliminating disturbances which may lead to system upset. The filter shall provide minimum insertion loss at the indicated attenuation frequency utilizing the MIL-STD-E220A 50 ohm insertion loss methodology as follows:

1. 100 KHZ: Insertion loss (ratio) - 50 to 1; insertion loss (dB) - 34.
2. 1 MHZ: Insertion loss (ratio) - 350 to 1; insertion loss (dB) - 51.
3. 10 MHZ: Insertion loss (ratio) - 500 to 1; insertion loss (dB) - 54.
4. 100 MHZ: Insertion loss (ratio) - 250 to 1; insertion loss (dB) - 48.

2.4 INTERNAL CONNECTIONS

A. All internal wiring associated with the suppression/filter device and subject to surge currents shall utilize low-impedance copper bus bar and/or #4 AWG copper conductor or larger. All internal connections associated with the suppression/filter device and subject to surge currents shall be made with compression solderless-type lugs and shall be bolted to the bus bars in order to reduce overall system impedance.

2.5 FIELD CONNECTIONS

A. The device shall include mechanical lugs for each phase, neutral and ground, as applicable. The lugs shall accommodate up to #4 AWG copper conductor.

2.6 INTEGRAL DISCONNECT SWITCH

A. The device shall include an integral fused and safety interlocked disconnect switch located in the device enclosure with an externally mounted manual operator. The switch shall disconnect all ungrounded circuit conductors from the distribution system to enable testing and/or maintenance without interruption of power to the facility's distribution system. The switch shall be rated for 600 volts AC. Each current-carrying ungrounded circuit conductor connected to the facility's wiring system shall be individually fused with 200,000 AIC rated fuses in order to provide maximum fault current protection. The device shall be UL 1449 listed with the integral fused disconnect switch.

2.7 ENCLOSURE

A. The device shall be provided in a surface mounted NEMA 1 type hinged enclosure of minimum 14 gauge steel, painted inside and out. Enclosure width shall not be greater than 24 inches.

2.8 STATUS INDICATORS

A. The device shall include solid-state, long-life externally mounted LED visual status indicators that indicate the on-line status of each phase of the unit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. The installation and testing of the system shall be in full accordance with the manufacturer's installation, operation and maintenance instructions, and all national and local codes.

B. The device shall be installed as close as practical to the facility's wiring system in accordance with applicable national/local electrical codes and the manufacturer's recommended installation instructions. Connection shall be with #4 AWG copper conductor and not be any longer than necessary, avoiding unnecessary bends. In no case shall conductors be longer than 10 feet in length.

3.2 TESTING

A. The system shall be field tested in the presence of the Owner. At the same time operational procedures shall be reviewed with the Owner.

END OF SECTION 16692

SECTION 16721

FIRE ALARM SYSTEM

PART 1 – GENERAL

1.1 SUMMARY

A. This Section covers fire alarm systems, including initiating devices, notification appliances, controls, and supervisory devices.

B. Work covered by this section includes the furnishing of labor, equipment, and materials for installation of the fire alarm system as indicated on the drawings and specifications.

C. The Fire Alarm System shall consist of all necessary hardware equipment and software programming to perform the following functions:

1. Fire alarm system detection and notification operations.
2. Control and monitoring of HVAC duct detectors and other equipment as indicated in the drawings and specifications.

1.2 SCOPE OF WORK

A. General: This project installs an addressable fire alarm system in the new five-story hotel in . The new fire alarm system shall comply with the local authorities having jurisdiction. The building is fully sprinkler protected.

B. Multiple station type smoke sensors shall be provided in each sleeping area, in every room in the path of the means of egress from the sleeping area to the door of the sleeping unit, and at each story within the sleeping units as indicated on the drawings. Any multiple station smoke sensor in alarm shall operate only the sounder base for the detector in alarm, the sounder bases for the other multiple station smoke sensors within the sleeping unit, and transmit a supervisory signal to the FACP. No other fire alarm notification appliances, suppression systems, or smoke control systems shall be activated by the multiple station smoke sensors.

C. Upon general alarm, all sounder bases installed on the multiple station type smoke sensors shall operate.

D. In accessible sleeping units and where indicated on the drawings, provide addressable visible notification appliances which operate upon activation of the multiple station type smoke sensors in that sleeping unit or activation of any building alarm initiating device. Multiple station smoke alarms with integral strobes are not required in the accessible sleeping units with addressable notification appliances provided as specified.

E. Synchronize any strobe notification appliances in the building when three or more strobe notification appliances can be viewed from any viewing angle.

1.3 ACCEPTABLE EQUIPMENT AND SERVICE PROVIDERS

A. Manufacturers: The equipment and service described in this specification are those

supplied and supported by SimplexGrinnell and represent the base bid for the equipment.

1. Subject to compliance with the requirements of this specification, provide alternate products by one of the following:
   a) Simplex
   b) Autocall

B. Alternate products must be submitted to the Engineer two weeks prior to bid for approval. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.

1.4 RELATED DOCUMENTS

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

B. The work covered by this section is to be coordinated with related work as specified elsewhere in the specifications. Requirements of the following sections apply:

1. Division 16: "Basic Electrical Materials and Methods."
2. Division 16: "Wiring Methods."
3. Division 15: "Fire Protection".
4. Division 15: "HVAC Systems".

C. The system and all associated operations shall be in accordance with the following:

1. IBC-2003 edition: International Building Code
2. IFC-2003 edition: International Fire Code
3. IMC-2003 edition: International Mechanical Code
4. NFPA 70-2005 edition, National Electrical Code
5. NFPA 72-2002 edition, National Fire Alarm Code
6. Other applicable NFPA standards
7. Adopted Codes and Standards
8. Oklahoma Accessibility Standards and ADA Accessibility Guidelines

1.5 SYSTEM DESCRIPTION

A. General: Provide a complete, non-coded addressable, microprocessor-based fire alarm system with initiating devices, notification appliances, and monitoring and control devices as indicated on the drawings and as specified herein.

B. Software: The fire alarm system shall allow for loading and editing instructions and operating sequences as necessary. The system shall be capable of on-site programming to accommodate system expansion and facilitate changes in operation. All software operations shall be stored in a non-volatile programmable memory within the fire alarm control unit. Loss of primary and secondary power shall not erase the instructions stored in memory. System shall be capable of storing dual configuration programs with one active and one in reserve. Panel shall be capable of full system operation during a new configuration download.

C. History Logs: The system shall provide a means to recall alarms and trouble conditions in chronological order for the purpose of recreating an event history. A separate alarm and trouble log shall be provided.

D. Recording of Events: Record all alarm, supervisory, and trouble events by means of system printer. The printout shall include the type of signal (alarm, supervisory, or trouble) the device identification, date and time of the occurrence. The printout differentiates alarm signals from all other printed indications.

E. Wiring/Signal Transmission:

1. Transmission shall be hard-wired, using separate individual circuits for each zone of alarm operation as required or addressable signal transmission, dedicated to fire alarm service only.
2. System connections for signaling line circuits including addressable notification appliance circuits shall be Class B, Style 4 and conventional notification appliance circuits shall be Class B, Style Y.
3. Circuit Supervision: Circuit faults shall be indicated by a trouble signal at the FACP. Provide a distinctive indicating audible tone and alphanumeric annunciation.

F. Required Functions: The following are required system functions and operating features:

1. Priority of Signals: Fire alarm events have highest priority. Subsequent alarm events are queued in the order received and do not affect existing alarm conditions. Priority Two, Supervisory and Trouble events have second-, third-, and fourth-level priority, respectively. Signals of a higher-level priority take precedence over signals of lower priority even though the lower-priority condition occurred first. Annunciate all events regardless of priority or order received.
2. Noninterfering: The activation of an addressable device does not prevent the receipt of signals from subsequent activations.
3. Transmission to the remote supervising station.
4. Annunciation: Operation of alarm and supervisory initiating devices shall be annunciated at the FACP indicating the type of device, the operational state of the device (i.e. alarm, trouble or supervisory) and shall display the custom label associated with the device.
5. General Alarm: A system general alarm shall include:
    a) Indication of alarm condition at the FACP.
    b) Identification of the device/zone that is the source of the alarm at the FACP.
    c) Operation of audible and visible notification appliances until silenced at FACP.
    d) Audible Alarm Notification shall operate as a Temporal Code pattern.
    e) Unlocking designated doors.
    f) Shutting down supply and return fans serving zone where alarm is initiated.
    g) Closing smoke dampers on system serving zone where alarm is initiated.
    h) Transmission of signal to the remote supervising station.
    i) Initiation of elevator Phase I functions (recall, shunt trip, illumination of indicator in cab, etc.) in accordance with ASME/ANSI A17.1, when

elevator lobby, elevator machine room, or elevator shaftway sensors are activated.

6. Supervisory Operations: Upon activation of a supervisory device, the system shall operate as follows:
   a) Activate the system supervisory service audible signal and illuminate the LED at the FACP.
   b) Pressing the Supervisory Acknowledge key will silence the supervisory audible signal while maintaining the Supervisory LED "on" indicating off-normal condition.
   c) Record the event in the FACP historical log.
   d) Transmission of supervisory signal to the remote supervising station.
7. Alarm Silencing: If the "Alarm Silence" button is pressed, all audible and visible alarm signals shall cease operation.
8. System Reset
   a) The "System Reset" button shall be used to return the system to its normal state. Display messages shall provide operator assurance of the sequential steps ("IN PROGRESS", "RESET COMPLETED") as they occur. The system shall verify all circuits or devices are restored prior to resetting the system to avoid the potential for re-alarming the system. The display message shall indicate "ALARM PRESENT, SYSTEM RESET ABORTED."
   b) Should an alarm condition continue, the system will remain in an alarmed state.
9. Drill: A manual evacuation (drill) switch shall be provided to initiate an alarm on the FACP.
10. Manual Control: Manual controls shall be supervised so that an "off normal" position of any switch shall cause an "off normal" system trouble. The "off normal" status shall be clearly identified in plain-language on the FACP alphanumeric display.
    a) Manual Bypass Control: The ability to perform a manual bypass of selected automatic functions shall be provided.
    b) Circuit Enable/Disable Control: The system shall have provisions for disabling and enabling each circuit individually for maintenance or testing purposes.

G. Audible Alarm Notification: By horns in areas as indicated on drawings.

H. Power Requirements

1. The control panel shall receive AC power via a dedicated fused disconnect circuit.
2. The system shall be provided with sufficient battery capacity to operate the entire system upon loss of normal AC power in a normal supervisory mode for a period of 24 hours with 5 minutes of alarm operation at the end of this period. The system shall automatically transfer to battery standby upon power failure. All battery charging and recharging operations shall be automatic.
3. All circuits requiring system-operating power shall be 24 VDC and shall be individually fused at the control panel.
4. The incoming power to the system shall be supervised so that any power failure will be indicated at the control panel. A green "power on" LED shall be displayed

continuously while incoming power is present.

5. The system batteries shall be supervised so that a low battery condition or disconnection of the battery shall be indicated at the control panel.
6. The system shall support 100% of addressable devices in alarm operated at the same time, under both primary (AC) and secondary (battery) power conditions.
7. Loss of primary power shall sound a trouble signal at the FACP. FACP shall indicate when the system is operating on an alternate power supply.

1.6 SUBMITTALS

A. General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.

1. Product data sheets for system components highlighted to indicate the specific products, features, or functions required to meet this specification. Alternate or as-equal products submitted under this contract must provide a detailed line-by-line comparison of how the submitted product meets, exceeds, or does not comply with this specification.
2. Wiring diagrams from manufacturer.
3. Shop drawings showing system details including location of FACP, all devices, and circuit details.
4. System power and voltage drop calculations to assure that the system will operate in accordance with the prescribed backup time periods and under all voltage conditions in accordance with UL and NFPA standards.
5. Operation and maintenance data for inclusion in Operating and Maintenance Manual. Include data for each type product, including all features and operating sequences, both automatic and manual. Provide the names, addresses, and telephone numbers of service organizations.

B. Submission to Authority Having Jurisdiction: In addition to routine submission of the above material, make an identical submission to the authority having jurisdiction. Include copies of shop drawings as required to depict component locations to facilitate review. Upon receipt of comments from the Authority, make resubmissions, if required, to make clarifications or revisions to obtain approval.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: A factory authorized installer is to perform the work of this section.

B. Each and every item of the Fire Alarm System shall be listed under the appropriate category by Underwriters Laboratories, Inc. (UL), and shall bear the "UL" label.

1.8 MAINTENANCE SERVICE

A. Maintenance Service Contract: Provide maintenance of fire alarm systems and equipment for a period of 12 months, using factory-authorized service representatives.

B. Basic Services: Systematic, routine maintenance visits on a quarterly basis at times scheduled with the Owner. In addition, respond to service calls within 24 hours of notification of system trouble. Adjust and replace defective parts and components with original manufacturer's replacement parts, components, and supplies.

PART 2 – PRODUCTS

2.1 FIRE ALARM CONTROL PANEL (FACP): Simplex Model No. 4100U

A. General: Comply with UL 864, "Control Units and Accessories for Fire Alarm Systems".

B. The following FACP hardware shall be provided:

1. Power Limited base panel with beige cabinet and door, 120 VAC input power.
2. 2,000 point capacity where (1) point equals (1) monitor (input) or (1) control (output).
3. 2,000 points of Network Annunciation at FACP Display when applied as a Network Node.
4. 2000 points of annunciation where one (1) point of annunciation equals:
   a) 1 LED driver output on a graphic driver or 1 switch input on a graphic switch input module.
   b) 1 LED on panel or 1 switch on panel.
5. From all battery charging circuits in the system provide battery voltage and ammeter readouts on the FACP LCD Display.
6. One Auxiliary electronically resettable fused 2A @24VDC Output, with programmable disconnect operation for 4-wire detector reset.
7. One Auxiliary Relay, SPDT 2A @32VDC, programmable as a trouble relay, either as normally energized or de-energized, or as an auxiliary control.
8. Where required provide Intelligent Remote Battery Charger for charging up to 110Ah batteries.
9. Power Supplies with integral intelligent Notification Appliance Circuit Class B for system expansion.
10. Four (4) form "C" Auxiliary Relay Circuits (Form C contacts rated 2A @ 24VDC, resistive), operation is programmable for trouble, alarm, supervisory of other fire response functions. Relays shall be capable of switching up to ½ A @ 120VAC, inductive.
11. The FACP shall support (6) RS-232-C ports and one service port.
12. Remote Unit Interface: supervised serial communication channel for control and monitoring of remotely located annunciators and I/O panels.
13. Programmable DACT for either Common Event Reporting or per Point Reporting.
14. Service Port Modem for dial in passcode access to all fire control panel information.

C. Cabinet: Lockable steel enclosure. Arrange unit so all operations required for testing or for normal care and maintenance of the system are performed from the front of the enclosure. If more than a single unit is required to form a complete control unit, provide exactly matching modular unit enclosures.

D. Alphanumeric Display and System Controls: Panel shall include an 80 character LCD display to indicate alarm, supervisory, and component status messages and shall include a keypad for use in entering and executing control commands.

2.2 EMERGENCY POWER SUPPLY

A. General: Components include battery, charger, and an automatic transfer switch.

B. Battery: Sealed lead-acid type. Provide sufficient capacity to operate the complete alarm system in normal or supervisory (non-alarm) mode for a period of 24 hours. Following this period of operation on battery power, the battery shall have sufficient capacity to operate all components of the system, including all notification appliances in alarm or supervisory mode for a period of 5 minutes.

2.3 ADDRESSABLE MANUAL PULL STATIONS

A. Description: Addressable double-action type, red LEXAN, with molded, raised-letter operating instructions of contrasting color. Station will mechanically latch upon operation and remain so until manually reset by opening with a key common with the control units.

2.4 SMOKE SENSORS

A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
4. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
5. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
6. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
7. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
8. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
9. Removal of the sensor head for cleaning shall not require the setting of addresses.

B. Type: Smoke sensors shall be of the photoelectric type.

C. Duct Smoke Sensor: Photoelectric type, with sampling tube of design and dimensions as recommended by the manufacturer for the specific duct size and installation conditions where applied. Sensor includes relay as required for fan shutdown.

1. Environmental compensation, programmable sensitivity settings, status testing, and monitoring of sensor dirt accumulation for the duct smoke sensor shall be provided by the FACP.
2. The Duct Housing shall provide a supervised relay driver circuit for driving up to 15 relays with a single "Form C" contact rated at 7A@ 28VDC or 10A@ 120VAC. This auxiliary relay output shall be fully programmable. Relay shall be mounted within 3 feet of HVAC control circuit.

3. Duct Housing shall provide a relay control trouble indicator Yellow LED.
4. Duct Housing shall have a transparent cover to monitor for the presence of smoke. Cover shall secure to housing by means of four (4) captive fastening screws.
5. Duct Housing shall provide two (2) Test Ports for measuring airflow and for testing. These ports will allow aerosol injection in order to test the activation of the duct smoke sensor.
6. Duct Housing shall provide a magnetic test area and Red sensor status LED.
7. Each duct smoke sensor shall have a Remote Test Station with an alarm LED and test switch.

2.5 SMOKE SENSORS-MULTIPLE STATION TYPE

A. General: Comply with UL 268, "Smoke Detectors for Fire Protective Signaling Systems." Multiple station type smoke sensors shall be provided in each sleeping area, in every room in the path of the means of egress from the sleeping area to the door of the sleeping unit, and at each story within the sleeping units as indicated on the drawings. Any multiple station smoke sensor in alarm shall operate only the sounder base for the detector in alarm, the sounder bases for the other multiple station smoke sensors within the sleeping unit, and transmit a supervisory signal to the FACP. No other fire alarm notification appliances, suppression systems, or smoke control systems shall be activated by the multiple station smoke sensors. Multiple station type smoke sensors shall include the following features:

1. Factory Nameplate: Serial number and type identification.
2. Operating Voltage: 24 VDC, nominal powered from the FACP.
3. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore normal operation.
4. Each sensor base shall contain an LED that will flash each time it is scanned by the Control Unit (once every 4 seconds). In alarm condition, the sensor base LED shall be on steady.
5. Each sensor base shall contain a magnetically actuated test switch to provide for easy alarm testing at the sensor location.
6. Each sensor shall be scanned by the Control Unit for its type identification to prevent inadvertent substitution of another sensor type. Upon detection of a "wrong device", the control unit shall operate with the installed device at the default alarm settings for that sensor; 2.5% obscuration for photoelectric sensor, 135-deg F and 15-deg F rate-of-rise for the heat sensor, but shall indicate a "Wrong Device" trouble condition.
7. The sensor's electronics shall be immune from nuisance alarms caused by EMI and RFI.
8. Sensors include a communication transmitter and receiver in the mounting base having a unique identification and capability for status reporting to the FACP. Sensor address shall be located in base to eliminate false addressing when replacing sensors.
9. Removal of the sensor head for cleaning shall not require the setting of addresses.

B. Type: Smoke sensors shall be of the photoelectric type.

1. Bases: Sounder bases transmitting a temporal 3 code shall be provided.

2.6 HEAT SENSORS

A. Thermal Sensor: Combination fixed-temperature and rate-of-rise unit with plug-in base and alarm indication lamp; 135-deg F fixed-temperature setting except as indicated.

B. Thermal sensor shall be of the epoxy encapsulated electronic design. It shall be thermistor-based, rate-compensated, self-restoring and shall not be affected by thermal lag.

C. Sensor fixed temperature sensing shall be independent of rate-of-rise sensing and] programmable to operate at 135-deg F or 155-deg F. Sensor rate-of-rise temperature detection shall be selectable at the FACP for either 15-deg F or 20-deg F per minute.

D. Sensor shall have the capability to be programmed as a utility monitoring device to monitor for temperature extremes in the range from 32-deg F to 155-deg F.

2.7 ADDRESSABLE CIRCUIT INTERFACE MODULES

A. Addressable Circuit Interface Modules: Arrange to monitor or control one or more system components that are not otherwise equipped for addressable communication. Modules shall be used for monitoring of non-addressable devices and for control of AHU systems.

B. Addressable Circuit Interface Modules will be capable of mounting in a standard electric outlet box. Modules will include cover plates to allow surface or flush mounting. Modules will receive their operating power from the signaling line circuit or a separate two wire pair running from an appropriate power supply, as required.

C. All Circuit Interface Modules shall be supervised and uniquely identified by the control unit. Module identification shall be transmitted to the control unit for processing according to the program instructions. Modules shall have an on-board LED to provide an indication that the module is powered and communicating with the FACP. The LEDs shall provide a troubleshooting aid since the LED blinks on poll whenever the peripheral is powered and communicating.

2.8 MAGNETIC DOOR HOLDERS

A. Description: Units shall be listed to UL 228. Units are equipped for wall or floor mounting as indicated and are complete with matching door plate. Unit shall operate from a 120VAC, a 24VAC or a 24VDC source, and develop a minimum of 25 lbs. holding force.

B. Material and Finish: Match door hardware.

2.9 ADDRESSABLE ALARM NOTIFICATION APPLIANCES

A. Addressable Notification Appliances: The Contractor shall furnish and install Addressable Notification Appliances and accessories to operate on compatible signaling line circuits (SLC).

1. Addressable Notification appliance operation shall provide power, supervision and separate control of horns and strobes over a single pair of wires. The controlling channel (SLC) digitally communicates with each appliance and receives a response to verify the appliance's presence on the channel. The channel provides a digital command to control appliance operation. SLC channel wiring shall be unshielded twisted pair (UTP), with a capacitance rating of less than 60pf/ft and a minimum 3 twists (turns) per foot.

2. Each Addressable notification appliance shall contain an electronic module and a selectable address setting to allow it to occupy a unique location on the channel. This on-board module shall also allow the channel to perform appliance diagnostics that assist with installation and subsequent test operations. A visible LED on each appliance shall provide verification of communications and shall flash with the appliances address setting when locally requested using a magnetic test tool.

B. Addressable Controller: Addressable Controller shall supervise Channel (SLC) wiring, communicate with and control addressable notification appliances. It shall be possible to program the High/Lo setting of the audible (horn) appliances by channel from the addressable controller.

C. Horn: Addressable horn shall be listed to UL 464. Horn appliances shall have a High/Lo Setting, programmable by channel from the addressable controller or by appliance from the host FACP. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The horn shall mount directly to a standard single gang, double gang or 4" square electrical box, without the use of special adapter or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot.

D. Visible/Only: Addressable strobe shall be listed to UL 1971. The V/O shall consist of a xenon flash tube and associated lens/reflector system. The V/O enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. V/O appliances shall be provided with different minimum flash intensities of 15cd, 75cd and 110cd. Provide a label inside the strobe lens to indicate the listed candela rating of the specific Visible/Only appliance.

1. Audible/Visible: Addressable combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1971 and UL 464. Exterior rated (weatherproof) combination Audible/Visible (A/V) Notification Appliances shall be listed to UL 1638, UL 1971, and UL 464. The strobe light shall consist of a xenon flash tube and associated lens/reflector system. Provide a label inside the strobe lens to indicate the listed candela rating of the specific strobe. The horn shall have a minimum sound pressure level of 83 or 89 dBA @ 24VDC. The audible/visible enclosure shall mount directly to standard single gang, double gang or 4" square electrical box, without the use of special adapters or trim rings. Appliances shall be wired with UTP conductors, having a minimum of 3 twists per foot. The appliance shall be of two-wire synchronization with synchronized strobe and temporal code pattern on horn.

E. Accessories: The contractor shall furnish the necessary accessories.

F. Weatherproof (exterior rated) alarm notification appliances shall be provided where indicated on the drawings and where temperatures of 32-120°F are not maintained.

2.10 TrueAlert Addressable Appliances NAC Power Extender

A. The TrueAlert Addressable Controller shall be a stand-alone panel capable of powering a minimum of 3 TrueAlert Signaling line circuits. Each channel shall be rated for 2.5 amps and support up to 63 TrueAlert addressable notification appliances. Power and communication for the notification appliances shall be provided on the same pair of wires.

B. Addressable SLC notification appliance circuits shall be Class B Style 4.

C. The internal power supply & battery charger shall be capable of charging up 12.7 Ah batteries internally mounted or 18Ah batteries mounted in an external cabinet.

D. The NAC extender panel may be mounted close to the host control panel or can be remotely located.

PART 3 – EXECUTION

3.1 INSTALLATION, GENERAL

A. Install system components and all associated devices in accordance with applicable NFPA Standards and manufacturer's recommendations.

B. Installation personnel shall be supervised by persons who are qualified and experienced in the installation, inspection, and testing of fire alarm systems. Examples of qualified personnel shall include, but not be limited to, the following:

1. Factory trained and certified personnel.
2. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.
3. Personnel licensed or certified by state or local authority.

3.2 EQUIPMENT INSTALLATION

A. Furnish and install a complete Fire Alarm System as described herein and as shown on the plans. Include sufficient control unit(s), manual stations, automatic fire detectors, smoke detectors, audible and visible notification appliances, wiring, terminations, electrical boxes, and all other necessary material for a complete operating system.

B. Device Location-Indicating Lights: Locate in the public space immediately adjacent to the device they monitor.

C. Install manual station with operating handle 48 inches (1.22 m) above floor. Install wall mounted audible and visual notification appliances not less than 80 inches (2.03 m) above floor to bottom of lens and not greater than 96 inches (2.44 m) above floor to bottom of lens.

D. Mount outlet box for electric door holder to withstand 80 pounds pulling force.

E. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, fire suppression system control panels, and duct smoke detectors.

F. Automatic Detector Installation: Conform to NFPA 72.

3.3 PREPARATION

A. Coordinate work of this Section with other affected work and construction schedule.

3.4 WIRING INSTALLATION

A. System Wiring: Wire and cable shall be a type listed for its intended use by an approval agency acceptable to the Authority Having Jurisdiction (and shall be installed in accordance with the appropriate articles from the referenced edition of NFPA 70-National Electric Code (NEC).

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Provide services of a factory-authorized service representative to supervise the field assembly and connection of components and the pretesting, testing, and adjustment of the system.

B. Service personnel shall be qualified and experienced in the inspection, testing, and maintenance of fire alarm systems. Examples of qualified personnel shall be permitted to include, but shall not be limited to, individuals with the following qualifications:

1. Factory trained and certified.
2. National Institute for Certification in Engineering Technologies (NICET) fire alarm certified.
3. International Municipal Signal Association (IMSA) fire alarm certified.
4. Certified by a state or local authority.
5. Trained and qualified personnel employed by an organization listed by a national testing laboratory for the servicing of fire alarm systems.

C. Pretesting: Determine, through pretesting, the conformance of the system to the requirements of the Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new and retest until satisfactory performance and conditions are achieved.

D. Inspection:

1. Inspect equipment installation, interconnection with system devices, mounting locations, and mounting methods.
2. Verify that units and controls are properly installed, connected, and labeled and that interconnecting wires and terminals are identified.

E. Acceptance Operational Tests:

1. Perform operational system tests to verify conformance with specifications:

F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.6 TRAINING

A. Provide the services of a factory-authorized service representative to demonstrate the system and train Owner's maintenance personnel as specified below.

1. Train Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing, and preventive maintaining of the system. Provide a minimum of four hours' training.
2. Schedule training with the Owner at least seven days in advance.

END OF SECTION 16721

SECTION 16741

TELEPHONE AND DATA COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of a telephone and data communications empty conduit system, including all related systems and accessories.

1.3 SUBMITTALS

A. Submit product data and shop drawings in accordance with Division 1 for products specified under PART 2 - PRODUCTS.

PART 2 - PRODUCTS

2.1 GENERAL

A. Conduit, conduit sleeves, outlet boxes, cover plates and pullwire as indicated.

B. Fireproofing material for telephone and data communication conduit and conduit sleeves through fire rated walls and floors.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install telephone and data communication raceways as indicated.

B. Install individual raceways from telephone and data communications outlets to above accessible ceiling. In areas without a ceiling, raceways shall be routed to the nearest ceiling space. In building without a ceiling, raceways shall be extended back to the main telephone/ data communication board or to a location indicated on the Drawings.

1. Minimum size conduit: 3/4 inch.
2. Raceway installation shall be in accordance with Section 16110.

3. Coordinate raceway installations in millwork and other fabricated architectural items with the other portions of the Work.
4. Provide pullwire in each raceway tagged on each end.
5. Raceways shall be terminated with an insulating bushing or a suitable connector with an insulated throat.

C. Provide telephone and data communications outlet boxes.

1. Provide a one-gang outlet unless noted otherwise.
2. Install outlet box and device ring at each location.
3. Install telephone and data communications outlets at same height specified for convenience outlets unless noted otherwise. Group telephone and data communications outlets with related receptacle outlets unless noted otherwise.
4. Install a blank cover plate on all unused communications outlet boxes.

END OF SECTION 16741

SECTION 16900

EQUIPMENT CONNECTIONS AND CONTROL WIRING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

C. The furnishing and installation of control power wiring required for equipment furnished under Division 15 and not shown on the electrical drawings shall be furnished under Division 15. Control power wiring is defined as the line voltage (120V) power wiring for equipment control cabinets, temperature control, energy management, or building automation system panels and line voltage smoke/fire dampers.

D. The furnishing and installation of the temperature control wiring, energy management system or building automation wiring not shown on the electrical drawings shall be furnished under Division 15. Temperature control, energy management system and building automation system wiring is defined as the interlock or interconnecting wiring required between system control devices, appurtenances and control panels to allow the system to function automatically. This includes wiring between the fire alarm system, smoke exhaust systems, door entry systems and any other system requiring interface with the temperature control, energy management and building automation system.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of power wiring to each motor-driven and/or electrically-operated system or unit of equipment.

B. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the providing of the line voltage wiring serving power to a motor(s) or piece of electric powered equipment. The wiring shall allow the motor(s) or equipment to operate in a manual mode.

C. Provide labor, materials, equipment, tools and services and perform operations required for, and reasonably incidental to, the providing of control wiring for miscellaneous systems. The Contractor shall be responsible for reviewing the project specifications to ascertain the extent of the control wiring required for the miscellaneous systems and shall assume the responsibility for performing the work.

D. Provide labor, materials, equipment, tools and services, and perform operations required for and reasonably incidental to, the providing of a fully connected and operating smoke damper installation. Coordinate with the mechanical contractor th required work. The following is a description of the responsibilities for the specified system:

1. The mechanical contractor will provide the smoke dampers and actuators as indicated in the specifications and on the plans. In addition, if the smoke dampers have pneumatic

actuators, the mechanical contractor will provide all control air piping from a source to each smoke damper and the electro-pneumatic (EP) and/or pneumatic-electric (PE) switches as required for actuation of the smoke dampers.

2. The electrical contractor shall provide the power wiring for the smoke damper actuators.
3. The fire alarm contractor shall provide the signal and control wiring for the operation of the smoke dampers including all wiring of EP and/or PE switches.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials and equipment provided hereinafter shall comply with other Division 16 Sections and with Division 15 of these Specifications.

PART 3 - EXECUTION

3.1 MOTORS

A. Except for items that are furnished with factory-installed, integral motors, an electric motor of required size and electrical characteristics will be provided and installed as specified in Division 15 for each item of motor-driven equipment. As part of the work of this Section, complete the electrical installation of these motors in accordance with approved wiring diagrams and instructions.

B. Where disconnect switches or circuit breakers are not provided integral with control equipment for motors and other electrical appurtenances, provide and install all disconnect switches required by the National Electrical Code and/or as indicated on the Drawings.

3.2 SYSTEM, EQUIPMENT AND DEVICE WIRING

A. Connect complete for operation all items of heating, ventilation, air conditioning, plumbing, fire protection and all electrical systems, equipment and devices furnished by the Owner or specified in other Divisions of the Specifications. System, equipment and device outlets of various types have been indicated in the Specifications or on the drawings, but indication of exact location or scope of the work may not be indicated. Refer to the Owner and to the work specified in the other Divisions for the scope of connections to the equipment furnished by them and for the exact locations of all connections to the equipment furnished by them. Power wiring shall be provided under Division 16 as indicated. Control wiring not indicated to be provided under Division 16 shall be provided by the provider of the system, equipment, or device and installed and terminated under Division 16. Request all rough-in drawings required for proper installation of the electrical work in ample time to permit preparation of the installation drawings and thus avoid delays on the job.

END OF SECTION 16900

SECTION 16950

ELECTRICAL ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 RELATED REQUIREMENTS

A. The General Provisions, Supplemental General Provisions, Special Provisions and Division 1 Specification sections, apply to work covered by this Section.

B. Comply with Division 16 Sections, as applicable. Refer to other Divisions for coordination of work.

1.2 SCOPE OF WORK

A. Provide labor, materials, equipment, tools and services, and perform operations required for, and reasonably incidental to, the testing and inspecting of each item of equipment provided or installed under this Division of the Specifications.

B. Tests and inspections for each system and each item of equipment shall be in accordance with the manufacturer's instructions.

C. Tests shall prove that electrical equipment is operational within industry and manufacturer's tolerances, and that it is installed in accordance with the design Drawings and Specifications.

D. Tests and inspections shall verify that power supplies are suitable for connection to the designated equipment and systems, and shall determine suitability for continued reliable operation.

E. Upon completion of tests and inspections specified, a label shall be attached to each serviced device. Labels shall indicate date and by whom (name of company) serviced as well as whether or not the service device passed or failed, or passed with exceptions.

1.3 DIVISION OF RESPONSIBILITY

A. The Contractor shall perform routine insulation resistance, continuity, and rotation tests for distribution and utilization equipment prior to, and in addition to, the tests specified to be performed by the testing laboratory. The contractor's responsibility shall include the following:

1. Engage the services of an approved testing laboratory with more than five (5) years of experience for the purpose of performing the inspections and tests specified.
2. Supply a suitable and stable source of power to the testing laboratory at each test site. Notify the testing laboratory when equipment becomes available for acceptance tests.
3. Coordinate work to expedite project scheduling.

B. Prior to commencement of testing, the contractor shall supply a complete set of Electrical Drawings, Specifications, and pertinent change orders to the testing laboratory.

C. The testing laboratory shall perform tests and inspections as specified. The testing laboratory's responsibility shall include the following:

1. Notify the A/E as to when testing will commence.
2. Provide sufficient protective barriers and warning signs to conduct tests and inspections safely.
3. Report any material or workmanship found to be defective during tests and inspections to the A/E.
4. Implement final settings and adjustments on electrical equipment in accordance with the values indicated.

5. Maintain written records of tests. Upon completion of the project, furnish multiple copies of the test report to the A/E in accordance with Division 1 no later than 30 days after acceptance of the project for review prior to final acceptance. The test report shall be bound and its contents certified by the testing laboratory. The report shall include the following:

a. Summary of project.
b. Description of equipment tested.
c. Description of test.
d. List of the test equipment used in calibration, and calibration date.
e. Test results.
f. Conclusions and recommendations.
g. Appendix, including completed test forms.

1.4 TEST INSTRUMENT CALIBRATION

A. The testing laboratory shall maintain test instruments which have been calibrated within rated accuracy. Dated calibration labels shall be visible on the test equipment.

B. Instruments shall be calibrated in accordance with the following frequency schedule:

1. Field instruments - 6 months maximum.
2. Laboratory instruments - 12 months.
3. Leased specialty equipment - 12 months. (Where accuracy is guaranteed by lessor, i.e. Doble.)

1.5 SAFETY PRACTICES

A. Safety practices shall include, but are not limited to, the following requirements:

1. Occupational Safety and Health Act of 1970-OSHA.
2. Accident Prevention Manual for Industrial Operations as published by the National Safety Council.
3. Applicable safety operating procedures of the governing authorities.
4. Division 16 of these Specifications.

B. Perform tests with apparatus de-energized, except where otherwise specifically required.

C. Power circuits shall have conductors shorted to ground by a hot-line grounded device approved for that purpose.

1.6 REFERENCE STANDARDS

A. International Electrical Testing Association (NETA)

B. National Electrical Code (NEC)

C. National Electrical Safety Code

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL PROCEDURES

A. Perform each test and inspection until acceptable results are obtained in accordance with the manufacturer's recommendations, unless otherwise specified.

B. Perform tests and inspections for each system and item of equipment as applicable, unless otherwise specified. Inspect for physical damage and defective materials or installation work. Inspect for proper physical, electrical and mechanical conditions (materials and installation work).

C. Promptly report any discrepancies or unsatisfactory conditions determined by any test or inspection.

D. Perform insulation resistance tests for each applicable system and item of equipment. Do not perform this test on solid state devices or wiring connected to solid state devices. Be aware that in some cases terminated cables cannot be tested unless disconnected from end devices. Coordinate the test with the contractor in this instance.

1. Apply test voltages as follows:

INSULATION RESISTANCE TEST VOLTAGE

Voltage Rating	Test Voltage
150 - 600V	1000V

2. Investigate values of insulation resistance less than the manufacturer's recommended minimum, or less than a value equal to KV + 1 in megohms.

E. Overpotential tests shall not proceed until insulation resistance tests are satisfactorily performed. Perform overpotential tests for each system and item of equipment as specified.

3.2 SWITCHBOARDS

A. Inspect for proper alignment, anchorage and grounding.

B. Test electrical and mechanical interlock systems to ensure proper operation and sequencing.

1. Make closure attempt on locked-open devices. Make opening attempt on locked-closed devices.

2. Make key exchange with devices operated in off-normal positions.

C. Verify proper operation of indicating devices and exercise active components. Verify satisfactory performance of each control feature and protective device.

D. Perform insulation resistance test of each bus section, phase-to-phase and phase-to-ground for one (1) minute.

E. Perform overpotential test on each bus section and each phase-to-ground for five (5) minutes.

3.3 CABLES - 600 VOLTS AND LESS

A. Inspect for shield grounding, cable support and termination.

B. Check visible cable bends against ICEA and manufacturer's minimum allowable bending radius.

C. Inspect for proper fireproofing in common cable areas.

D. If cables are terminated through window type cable trays make an inspection to verify that neutrals and grounds are properly terminated for normal operation of protective devices.

E. Perform insulation resistance tests on each cable with respect to ground and adjacent cables.

F. Perform continuity tests to confirm proper cable connections.

3.4 SOLID STATE MOLDED CASE CIRCUIT BREAKERS - 600 VOLTS AND LESS

A. Measure contact resistance in micro-ohms. Investigate values which deviate from adjacent poles or similar breakers by more than 50%.

B. Perform insulation resistance tests from each pole-to-ground, from pole-to-pole, and across open contacts of each phase. Test values shall not be less than 50 megohms.

C. Utilize primary current injection method to determine the following:

1. Minimum pickup current of trip devices, where possible.
2. Long time delay, using 300% pickup current.
3. Short time pickup and short time delay.
4. Instantaneous pickup current.

D. Verify trip unit reset characteristics.

E. Activate auxiliary protective devices, such as ground fault and under voltage relays, to insure operation of shunt trip devices.

3.5 MOLDED CASE CIRCUIT BREAKERS - 600 VOLTS AND LESS (FEEDER CIRCUIT BREAKERS ONLY)

A. Check each circuit breaker for proper mounting, conductor size and feeder designation.

B. Operate circuit breaker to insure smooth operation.

C. Open unsealed breakers and check internal components for tightness, when applicable.

D. Measure contact resistance in micro-ohms. Investigate deviations greater than 50%, as compared to adjacent poles and similar breakers.

3.6 INSTRUMENT TRANSFORMERS

A. Verify proper operation of grounding and shorting devices.

B. Electrically confirm transformer polarity.

C. Verify connection at secondary current transformer leads by applying low current to leads and check for current contribution at applicable devices.

D. Confirm transformer ratio.

E. Verify connection of secondary power transformer and control transformer leads by applying low voltage to leads and check for voltage contribution at applicable devices.

F. Check power transformer secondary load with secondary voltage and current measurements to insure that load is less than the wattage of power transformer.

3.7 GROUND FAULT PROTECTION SYSTEMS

A. Inspect neutral main bonding connection to assure:

1. Zero sequence system is grounded upstream from sensor.
2. Ground strap systems are grounded through sensing device.
3. Ground connection is made ahead of neutral disconnect link.

B. Verify that control power transformer capacity is adequate for system.

C. Manually operate monitor panels to test sequences for:

1. Trip test.
2. No trip test.
3. Non-automatic reset.

D. Inspect zero sequence systems for symmetrical alignment of core. Balance transformers about current carrying conductors.

E. Verify ground fault device circuit nameplate identification by device operation.

F. Insure control circuit has disconnectable fuse device with current limit fuses.

G. Measure system neutral insulation resistance to insure no shunt ground paths exist. Remove neutral-ground disconnect link, and measure neutral insulation resistance, then replace link. System neutral insulation shall be one (1) megohm or greater.

H. Determine relay pickup current by primary injection at the sensor and operate the circuit interrupting device. Relay pickup current shall not exceed 1,200 amperes.

I. Test ground fault pickup and time delay.

3.8 GROUNDING SYSTEMS

A. Perform ground continuity tests between main ground system and equipment frames, and between main ground system and system neutral and/or derived neutral points. Make test by passing a minimum 10-amp DC current between the ground reference system and the ground point to be tested. Measure voltage drop and calculate resistance by voltage drop method.

B. The main ground electrode system resistance-to-ground shall be no greater than five (5) ohms.

C. Perform an insulation power factor test.

D. Perform ground continuity test to ground grid system.

3.9 THERMOGRAPHIC SURVEY

A. A thermographic survey shall be performed as follows on all electrical system equipment once the building load is connected to the system.

1. Visual and Mechanical Inspection

   a. Inspect for physical, electrical, and mechanical condition.
   b. Visually inspect for bus alignment.
   c. Remove all necessary covers prior to scanning.

2. Equipment to be scanned shall include switches, buses, cables, cable and bus connections and circuit breakers.
3. Provide a report indicating the following:

   a. Problem area (location of "hot spot").
   b. Indicate temperature rise between "hot spot" and normal or reference area.
   c. Indicate cause of heat use.
   d. Indicate phase unbalance, if present.
   e. Index of areas scanned.

4. Test Parameters

   a. Scanning distribution systems with ability to detect 1°C rise between subject area and reference at 30°C.
   b. Equipment shall detect emitted radiation and convert detected radiation to visual signal.
   c. Provide photographs (thermograms) of the deficient area as seen on imaging system.
   d. Infrared surveys should be performed during periods of maximum possible loading but not less than eighty percent (80%) of rated load of the electrical equipment being inspected.

5. Test Results

   a. Temperature gradients of 1°C to 3°C indicate possible deficiency and warrant investigation. Corrective measures may not be required. The testing laboratory shall review deficiency with the Owner and Architect/ Engineer and make recommendation.
   b. Temperature gradients of 4°C to 15°C indicate minor deficiency; repair is most

probably required. The testing laboratory shall review deficiency with the Owner and Architect/Engineer and make recommendation.

c. Temperature gradients of 16°C and above indicate major deficiency; secure power and repair as soon as possible.

d. Provide a report indicating the equipment and devices scanned. Provide photographs and/or thermograms any deficient area as seen on the imaging system.

END OF SECTION 16950