

SECTION 23 00 10 - MECHANICAL GENERAL

PART 1 - GENERAL

1.01. CONTRACT DOCUMENTS

- A. Drawings are diagrammatic, due to scale, and indicate the general arrangements and geometric relationships of equipment, systems, and services. They are not intended to show or indicate every offset, sequence, device, option, fitting, valve, or accessory. Plan work around building details and other crafts. Do not scale drawings for exact sizes and locations.
- B. Contractor shall base all his measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Contractor shall verify all measurements at site and check correctness as related to the work.
- C. In case of interferences between trades, Engineer will decide which work is to take precedence regardless of work that might be installed.

1.02. CODES, ORDINANCES, INSPECTIONS AND PERMITS

- A. Work is to be executed and inspected in accordance with local and State codes, laws, ordinances, rules and regulations applicable to particular class of work, including the State Mechanical Code, State Plumbing Code, State Gas Code, and State Fire Code. Associated fees shall be paid by the Contractor.
- B. Should any part of drawings or specifications be found to be in conflict with applicable codes or ordinances, notify the Engineer, in writing, within 72 hours prior to bid deadline for review and/or correction of bid documents. After project bidding is closed, any discovery of code violations shall be promptly reported to the Engineer. Any work performed in violation of applicable codes or ordinances shall be corrected without additional expense to the Owner or his representatives.
- C. Pressure and heating vessels, including hot water storage containers, shall be constructed in compliance with the rules and regulations of the Boiler Inspection Division of the State. All installations of such equipment shall be made by a firm licensed and approved by the Boiler Inspection Division of the State.
- D. Facilities shall be installed in compliance with the requirements of the current version of the Americans with Disabilities Act (ADA). Installation of mechanical and plumbing systems including fixtures and control mounting heights, clear knee space, and access clearances shall comply with ADA required dimensions, and as shown on details or schedules when shown.
- E. Contractor shall arrange with County, City or State, if City has no ordinances covering work, for complete inspection, paying all charges required. Give proper

authority requisite notice relating the work; afford Engineer and authorized inspectors adequate access to the Work for inspection; and be responsible for all violations of law. Upon completion of work, have work inspected, if required, obtaining certificates of inspection and approval from inspecting agency and deliver certificates to Engineer and Owner.

1.03. REVIEW OF CONTRACT DOCUMENTS AND SITE

- A. With the submission of his bid, Contractor shall give written notice to the Engineer of any materials or apparatus believed inadequate or unsuitable, in violation of laws, ordinances, rules or regulations of Authorities having jurisdiction, and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that the Contractor has included the cost of all required items in his proposal for a complete project.
- B. Contractor shall acknowledge that he has examined the Plans, Specifications, and Site, and that from his own investigation he has satisfied himself as to the nature and location of the work; the general and local conditions, particularly those bearing upon transportation, disposal, handling and storage of materials; availability of labor, water, electric power, roads and uncertainties of weather; the confirmation and condition of the ground; the characters, quality and quantity of subsurface materials to be encountered; the character of equipment and facilities needed preliminary to and during the execution of the Work, especially the prohibited use of Owner's permanent equipment, ductwork, and controls; all federal, state, county, township and municipal laws, ordinances, and regulations particularly those relating to employment of labor, wage rates, and construction methods; and all other matters which can in any way affect the Work or the associated cost of the Work under this Contract. Any failure by the Contractor to acquaint himself with the available information concerning these conditions will not relieve him from the responsibility for estimating properly the difficulty or cost of successfully performing the work.
- C. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.

1.04. USE OF THE OWNER'S EXISTING AND NEW, PERMANENT HVAC SYSTEM DURING CONSTRUCTION

- A. Use of the Owner's existing and currently being installed, permanent HVAC system during Construction is prohibited. Provide temporary means for heating and cooling required by construction activities for curing or drying completed installations or for protecting installed construction from adverse effects of temperature and humidity. Provide temporary dehumidification systems when

required to reduce substrate moisture levels required to accommodate installation or application of finishes.

- B. Maintain a minimum ambient temperature of 50 DEG. F. in areas where construction is in progress, unless indicated otherwise in the specifications.
- C. Prevent dust, fumes, construction debris, and odors from entering existing and newly installed HVAC equipment, ductwork, and control system components. Prior to commencing work, isolate HVAC equipment. Where existing HVAC systems will be affected, isolate existing supply, return, and exhaust ducts by disconnecting ductwork at point where existing duct shall remain. Cover ends of existing ductwork securely with black plastic material.
- D. Newly installed ductwork shall be thoroughly cleaned before installation. Each section that is installed at the end of the day shall have open ends securely covered with black plastic material.
- E. Newly installed HVAC equipment shall be securely covered and protected with black plastic material or by other approved method. After installation of air moving equipment, duct connections shall be securely covered with black plastic material. Connections to duct systems shall not be made until final finishes have been installed, areas served are clean, and building is ready for HVAC equipment start-up and use.
- F. Securely cover control system components to prevent damage from construction debris, dust, and dirt. Control systems shall not be energized for testing and adjusting until HVAC system start-up.
- G. HVAC Equipment, Ductwork, and Control Components contaminated by construction debris, dirt, and construction dust shall not be acceptable and shall be replaced at no additional cost to the Owner. HVAC Equipment, Ductwork, and Control components shall be kept clean throughout construction. Cleaning after an HVAC system has been contaminated shall not be an acceptable alternate to replacement.

1.05. SHOP DRAWINGS AND SUBMITTALS

- A. Submit manufacturer's catalog sheets and/or shop drawings covering all phases of work included in this Contract.
- B. Arrange submittals in sets and bind in PDF format. Loose sheets are not acceptable. Indicate for each item the location, system, or position where it is to be used, arrange by equipment type and tab sections.
 - 1. Individual submittal packages may be made for plumbing, HVAC, fire protection, test and balance, and controls. The Contractor may submit up to 5 different packages, but where practical provide all submittals in a single PDF.

2. Items which are required to be resubmitted shall come in a single PDF. Approved equipment is not required to be resubmitted.
 3. The Contractor is responsible for verification that all items are submitted.
- C. Submittals shall bear written certification to the effect that the Contractor has examined them and found them to include all items required to be submitted and to be in accordance with specifications.
- D. Submittals are required even though equipment being furnished is exactly as specified.
- E. Submittals shall include all data required in individual sections of these specifications.
- F. Contractor is responsible for making all submittals required by the specifications for approval. If equipment is delivered or installed without an approved submittal, Contractor may be required to remove and replace equipment with specified and approved equipment, as directed by the Engineer, without additional cost to the project.
- G. Exceptions for Submittals
1. Exceptions to the Specifications or Drawings shall be clearly defined in a separate section of each submittal package. The submittal shall contain the reason for the exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an “or equal” or “exception” to the Specifications shall be at the sole discretion of the Engineer.
 2. By noting the term “compliance”, it shall be understood that the Contractor is in full compliance with the item specified and will provide exactly the same with no deviations.
 3. By noting the term “deviation”, it shall be understood that the Contractor prefers to provide a different component in lieu of the one specified and in so doing, takes full responsibility for making the equipment work as specified and will provide any and all ancillary components to make the equipment work at no extra cost to the Owner.
 4. By noting the term “alternate”, it shall be understood that the manufacturer proposes to provide the same operating function but prefers to do it in a different manner and in so doing, takes full responsibility for making the equipment work as specified and will provide necessary ancillary components to make the equipment work at no extra cost to the Owner. The alternate method shall be fully described with schematic diagrams and one-line diagrams as applicable.

1.06. SUBSTITUTION OF MATERIALS

- A. Final decision as to whether or not a specific piece of equipment meets specifications shall rest with Engineer.
- B. Substitution requests will not be accepted prior to bid.
- C. Equipment and material manufacturers are referenced in the Plans and Specifications to establish the basis of design and required standards.
- D. With each Substitution Request, submit technical data that will fully establish the equality of the proposed substitute product with that listed. Submit completed Substitution Request Form.
- E. Substitution Process
 - 1. The naming of a manufacturer's product with the words "basis of design" or the naming of a single manufacturer's product on a drawing equipment schedule, on other drawings, or in the specifications, establishes that specific product as the basis for design. In the absence of any other named acceptable manufacturer's product, provide the "basis of design" product. No substitutions will be accepted.
 - 2. Where other manufacturer's names are listed on the drawings or in the specifications as acceptable in addition to the "basis of design" product, product acceptability for these manufacturers shall be verified via submittal review after the project has bid. No other substitutions will be accepted.
 - 3. Where the words "include but shall not be limited to" or "or equal" are used in addition to a manufacturer's name or a list of manufacturer's names, product acceptability for these manufacturers shall be verified via submittal review after the project has bid.
 - 4. It is the responsibility of the Contractor to provide all of the data necessary to establish acceptability of the product.
 - 5. The submittal for the substitution will be reviewed for conformance with the specifications and equality to the specified products. Full submittals will be required of all equipment. Substitution submittals will be reviewed and shall be rejected if the proposed equipment is found to be different than indicated on the Substitution Request Form, or is found deficient compared to scheduled performance/or specifications.
- F. Any proposed substitutions of equipment shall be accompanied by product submittal and shop drawings showing revised equipment layouts, piping diagrams, ductwork drawings and/or wiring diagrams. Where substituted equipment furnished requires use of larger, more, or differently arranged

connections, such connections shall be installed to the complete satisfaction of Engineer without additional cost to Owner.

- G. The Contractor is responsible for full coordination of all changes required by substituted equipment, including dimensional clearance.
- H. The Contractor is responsible for all additional costs of equipment installation, coordination and engineering which results from his substitution. This includes all aspects of the work including architectural, structural, civil, electrical, and mechanical. This also includes costs for the redesign time of Architects and Engineers.
- I. Costs associated with dimensional, performance, or other deviations from the “basis of design” equipment, including engineering costs to evaluate such deviations, shall be paid by the Contractor. If a product other than the “basis of design” product is submitted and subsequently rejected during the submittal process, Contractor shall provide the “basis of design” product.
- J. Should a substitution be accepted and subsequently proven unsatisfactory for the service intended within the warranty period, the Contractor shall provide the basis of design, or make corrections as directed by Engineer.

1.07. GUARANTY-WARRANTY

- A. Guarantee shall include capacity and integrated performance of component parts of various systems in strict accord with the intent and purpose of these specifications. Conduct such tests as herein specified or as may be required by the Engineer to demonstrate capacity and performance ability of various systems to maintain specified conditions.
- B. Compile and assemble the warranties specified in the mechanical division, tabulated and indexed for easy reference.
- C. Provide complete warranty information for each item to include product or equipment; date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, telephone numbers, and procedures for filing a claim and obtaining warranty services.
- D. All materials and equipment shall carry a full year's warranty from time Owner accepts building or the date of substantial completion, whichever is earlier, regardless of start-up date of equipment, unless a longer warranty period is specified under other sections. Longer warranty periods for specific items shall be listed in other sections of these specifications.

PART 2 MATERIAL

2.01. MATERIAL AND EQUIPMENT

- A. Equipment shall be new, undamaged, and of the same manufacturer except where indicated otherwise.
- B. Deliver products to project properly identified with names, model numbers, types, grades, compliance labels, and similar information needed for distinct identifications; adequately packaged and protected to prevent damage during shipment, storage, and handling.
- C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.
- D. Protect work and equipment at all times from damage, weather, and entrance of dirt and water. Close pipe and duct openings with caps or plugs during installation.

2.02. ELECTRICAL

- A. Contractor shall carefully coordinate voltage and amperage requirements of equipment to be provided. Coordinate with Electrical Contractor prior to equipment order. Any change to electrical systems required by Contractor's substitutions or uncoordinated equipment needs shall be made without cost to the project.
- B. Provide all electrical interlock, control, and other wiring, not covered specifically under the electrical drawings and specifications, for proper operation and control of all equipment specified under this Division of the specifications.
- C. Supervise and coordinate all electrical work in connection with mechanical systems.
- D. Furnish all motor controllers and contactors, not furnished as part of a motor control center, or by Electrical Division for proper operation of all motors. Submit motor data with submittals.

2.03. ROOF AND FLASHINGS

- A. A. Special care shall be taken on roofs to prevent damage. Promptly repair any damage at no additional expense to the Owner. Comply with bonding requirements of new and existing roofs.
- B. B. Flashings are not covered by this section. Refer to Architectural Division.

2.04. ACCESS PANELS

- A. Provide access panels in all floors, walls, and plaster and non-lay-in type ceilings as required or as indicated to service devices in piping requiring access, controls, devices in ductwork requiring access, and other system components requiring access for service or regular maintenance. Closely coordinate requirements for

access doors before bidding.

- B. Access doors shall be "Milcor" type appropriate for the construction involved.
- C. Size and type shall be as required for proper service and/or as may be directed by the Engineer. Minimum size to be 24" x 24".

2.05. ASBESTOS AND OTHER HAZARDOUS OR TOXIC MATERIALS

- A. No Asbestos containing materials shall be used on this project.
- B. Contractor is responsible for his own means and methods of safety where Hazardous or Toxic materials are use for the installation of his work. All work shall comply with state and federal regulations.
- C. Contractor shall protect the Owner's facility and employees from conditions generated by his work.
- D. In the event that a potentially hazardous material is discovered during the course of the work, Contractor shall stop work immediately, and provide for the safety of his employees and other occupants. He shall make proper notifications as required by his contract and by law.

2.06. CONCRETE

- A. Concrete materials and installations indicated on the drawings for curbs, pads, and supports for mechanical equipment shall be provided as part of the contract.
- B. Comply with other architectural and structural portions of the specifications for materials and methods.
- C. Concrete.
 - 1. Concrete shall be commercial grade containing Portland cement, aggregates, clean water, and mix ratios suitable for the loads, and site conditions.
 - 2. Concrete shall be 3,000 psi class indoors and 3,500 psi class outdoors unless noted otherwise.
 - 3. Comply with ACI standards for cold and hot weather applications.
- D. Installation
 - 1. Use rigid and smooth forms to prevent visible defects and deflections in the work. Use form compound to prevent concrete bonding to the forms.
 - 2. Provide chamfered corners on the tops of curbs.

3. Reinforce pads and curbs with steel reinforcing bars minimum size number 3, welded wire fabric, or as indicated on the drawings. Set the reinforcing depth within the concrete for optimum strength for the application.
4. Provide equipment pads of sizes indicated and at least large enough to extend past the mechanical equipment 6" on all sides. Minimum height 6" unless otherwise noted.
5. Pour pads integral with the floor slab, isolate from the floor slab, or dowel the pads, as indicated on the drawings.
6. Grout all voids with high strength grout mixture.
7. Installation of the pads shall be coordinated so that the concrete has set and the strength is suitable for installation of the equipment.
8. Set anchor bolts where indicated by either equipment manufacturer or Structural Engineer.
9. Brush-finish equipment pads.

2.07. LOCAL SITE CONDITIONS

- A. Before bidding, make complete investigation at site in order to be informed as to location of utilities and as to conditions under which work is to be performed. Utility locations shown were obtained from surveys and/or local utility companies and are offered as a general guide only and are not to be assured accurate.
- B. Make determination of soil conditions before bidding. These specifications and accompanying drawings in no way imply condition of soil to be encountered.

2.08. EXCAVATION, TRENCHING AND BACKFILLING

- A. Excavation, trenching, and backfilling in connection with the mechanical system, to a point 5'-0" outside the building, is included as part of this Division, unless indicated otherwise.
- B. Excavation required shall be done as part of the contract price regardless of any implied conditions on the drawings or in these specifications.
- C. Excavation to have 12" minimum and 24" maximum clearance on all sides. Do not carry excavation below required level unless indicated otherwise on the drawings. Excess excavation below required level shall be backfilled at no expense to Owner with earth, sand, gravel, or concrete, as directed by Engineer and thoroughly compacted. Remove any unstable soil and replace with gravel, crushed stone, or clean sand and thoroughly compact. Engineer will determine the depth of removal of any unstable soil encountered. Grade ground adjacent to

excavation to prevent water from running into excavation. Remove accumulated water in the excavation.

- D. Banks of trenches shall be vertical or as shown on the drawings. Width of trench shall be 5" minimum, 8" maximum on each side of pipe bell. Excavate bell holes accurately to size by hand. In rock, excavations shall be carried 8" below bottom of pipe. Use loose earth or gravel for backfill and tamp thoroughly.
- E. Bracing, sheathing, and shoring shall be performed as necessary to complete and protect excavations indicated on the drawings, as required for safety, as directed by Engineer, and to conform to governing laws and state and federal regulations. Comply with OSHA Regulations.
- F. After piping installation, inspection, testing, and approval by governing agency; backfill trenches with clean, stable soil free from stones. Place backfill in 4" layers, tamped under and around pipe and conduit to height of at least 2' above pipe. Tamping shall be done in such manner as not to disturb underlying work. Remainder of trenches and excavations shall be backfilled with clean, stable earth, deposited in 8" layers and brought up to rough grade, with each layer compacted to density of surrounding soil. Remove sheathing and shoring as backfill is placed and fill space with dry sand. Compaction tests may be required by the Engineer, with the costs paid by the Contractor.
- G. Underground piping shall be marked with metallic marking tape inserted in the trench a minimum of 12" below grade and a minimum of 12" above mains.
- H. Replace existing appurtenances removed or damaged in connection with work, and restore to original conditions, unless directed otherwise.

2.09. MECHANICAL INSTALLATIONS:

- A. Coordinate mechanical equipment and material installation with other building components and other trades. Investigate each space in the structure through which mechanical equipment furnished under these specifications must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. Verify all dimensions by field measurements. By ordering equipment, Contractor assumes responsibility for the installation and orientation of equipment in the available space.
- C. Arrange for chases, slots, and openings in other building components to allow for mechanical installations.
- D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
- E. Sequence, coordinate, and integrate installations of mechanical materials and

equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing-in the building.

- F. Fit equipment, pipe, and duct into the available spaces in the building and introduce into the building, at a time, and in a manner, as not to damage the structure. Install ductwork and piping to provide the maximum possible clear height underneath.
- G. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
- H. Where mounting heights are not detailed or dimensioned, install mechanical services and overhead equipment to provide the maximum headroom possible.
- I. Install mechanical equipment to facilitate maintenance and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations.
- J. Coordinate the installation of mechanical materials and equipment above ceilings with suspension systems, light fixtures, and other installations.
- K. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
- L. Do not support material or equipment of other trades from piping or ductwork.
- M. Do not use equipment, piping, or ductwork as scaffolding, scaffolding support, or as other means to access the work. Damaged systems and components shall be repaired or replaced in accordance with the full satisfaction of the Owner and Engineer.
- N. Core drill piping penetrations of concrete walls, floors, and other concrete structures.
- O. Equipment locations shown on the drawings are approximate. Final locations shall be established and determined in the field to best utilize available space.
- P. Replace architectural features removed or damaged during the course of the work.
- Q. Maintain fire assembly ratings as dictated by authorities having jurisdiction. Seal around penetrations through UL rated assemblies, fire, and smoke walls.
- R. Fully seal around duct or pipe routed through exterior walls.

2.10. EQUIPMENT CONNECTIONS

- A. Each equipment item with drain connections shall be provided with a properly-sized drain run to the nearest floor drain or as directed.
- B. Rough-in and make final required connections to equipment, furnished under other Divisions of the Specifications or by the Owner.
 - 1. Provide necessary labor and materials for a complete installation. Trap and vent drainage connections as required.
 - 2. If equipment or fixtures furnished by others are not delivered prior to final acceptance, services shall be capped or plugged at walls or floor as directed, ready for future connection.
- C. No equipment or fixture shall be "roughed-in" until proper rough-in drawings are provided to the installer.
- D. Extend grease fittings to accessible locations.

2.11. CUTTING AND PATCHING

- A. Provide cutting and patching required to perform the mechanical work, when alteration, repair, renovation, or addition, to existing construction is specified or required for new work.
- B. Cutting of structural members will not be permitted except through explicit instructions from the Engineer. Reinforcing will be required where members are cut.
- C. Do not endanger or damage installed work through procedures and processes of cutting and patching.
- D. Arrange for repairs required to restore other work, because of damage caused as a result of mechanical installations.
- E. No additional compensation will be authorized for cutting and patching work that is necessitated by ill-timed, defective, or non-conforming installations.
- F. Perform cutting, fitting, and patching required to:
 - 1. Uncover Work to provide for installation of ill-timed Work.
 - 2. Remove and replace defective Work.
 - 3. Remove and replace Work not confirming to requirements of the Contract Documents.
 - 4. Remove samples of installed Work as specified for testing.
 - 5. Upon written instructions from Engineer, uncover and restore Work to

provide for Engineer observation of concealed Work.

2.12. GROUTING

- A. Mix and install grout for mechanical equipment base bearing surfaces, base plates, and anchors.
- B. Clean surfaces that will come into contact with grout.
- C. Provide forms as required for placement of grout.
- D. Avoid air entrapment during placement of grout.
- E. Place grout, completely filling equipment bases.
- F. Place grout on concrete bases and provide smooth bearing surface for equipment.
- G. Place grout around anchors.
- H. Cure placed grout.
- I. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
 - 1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
 - 2. Design Mix: 5,000-psi (34.5-MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

2.13. SEISMIC

- A. Mechanical systems shall be installed in conformance with the requirements of the state and federal codes and regulations for Seismic considerations, as specified and noted on the drawings.
- B. All seismic restraining and snubbing devices shall be manufactured specifically for this duty. Devices constructed by the Contractor will not be accepted.
- C. Contractor shall be responsible for the design and installation of the restraining and snubbing systems based on the criteria included on the drawings and in the specifications, and the actual equipment, and locations of installation.

2.14. START UP, TESTING, AND ADJUSTING

- A. Contractor shall include adequate time in construction schedule for HVAC system start-up; testing, adjusting, and balancing; and control system installation,

programming, testing, and commissioning.

- B. Each and every phase of the plumbing, air conditioning, heating and ventilating systems shall be operated separately, or in conjunction, one with the other, for a sufficient period of time to demonstrate to the entire satisfaction of the Engineer the ability of the systems to meet the capacity and the performance requirements while maintaining design conditions, in accordance with the intent of these specifications.
- C. Previous to any performance tests, the Contractor shall have set and adjusted valves, dampers, motors, controllers, thermostats, and other items as are necessary to properly balance phases of the mechanical systems and shall have the systems operating and maintaining design temperatures, humidity, and air circulation throughout all areas of the building.
- D. See other sections of these specifications for other possible records and tests to be made.
- E. During the first-year warranty, the Contractor may be required to make some or all of the readings above to assure system is functioning properly through the various seasons. Contractor shall make additional adjustments as required.

2.15. PAINTING

- A. Provide mechanical equipment with factory painted finish. Where factory finish is damaged during handling and installation, use touch-up paint of same type and color as original paint. Where extensive refinishing of factory applied finishes are required, equipment shall be repainted by the factory.
- B. All uninsulated, ferrous equipment, tanks, pipes, fittings, pipe hangers, supports, miscellaneous steel, and ironwork without factory finish shall be primed and painted. Do not paint galvanized hanger rods or galvanized duct straps.
 - 1. Where exposed to view, except in mechanical spaces, color shall be as selected by the Architect.
 - 2. Where located in mechanical spaces or in areas not exposed to view, color shall be as directed by Owner's representative to match Owner's existing color schedule. In the absence of an Owner's color schedule, color shall be black.
- C. All insulated mechanical equipment, tanks, and piping not provided with a factory finish shall be painted.
 - 1. Where exposed to view, except in mechanical spaces, color shall be as selected by the Architect.
 - 2. Where located in mechanical spaces or in areas not exposed to view, color shall be as directed by Owner's representative to match Owner's existing color schedule. In the absence of an Owner's color schedule, color shall

be black.

- D. For uninsulated material to be painted, prime with one coat of alkyd primer and paint with two coats of alkyd enamel gloss. Paint shall be suitable for the environmental and temperature conditions where material is installed.
 - E. Paint insulated material with two coats of alkyd enamel gloss. Paint shall be suitable for the environmental and temperature conditions where material is installed.
 - F. Prepare surfaces for painting in accordance with the paint manufacturer's requirements. Remove or protect portions of the work which are not to be painted.
 - G. Apply primer coat(s) of paint as recommended by the paint manufacturer.
 - H. Apply final coat(s) of paint as recommended by the paint manufacturer. Apply paint by brush or roller as dictated by the surface to be painted. Paint should have a smooth appearance without cloudiness, spotting, marks, runs, or other surface imperfections.
 - I. Clean-up the area of materials, waste, and rubbish. Clean splattered surfaces.
 - J. Protect the work from damage. Touch-up and restore defaced painted surfaces at the end of the project.
- 2.16. NOISE: Contractor shall isolate pipes, ductwork, equipment, and other items to insure no additional noise is generated or transmitted to the building when systems are in operation.
- 2.17. ERECTION OF METAL SUPPORTS AND ANCHORAGES
- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment and elevation to support and anchor mechanical materials and equipment. See Paragraph 3.11 for painting.
 - B. Field Welding: Comply with AWS D1.1.
- 2.18. OPERATION INSTRUCTIONS
- A. Contractor shall provide bound manuals containing complete repair parts' lists, and operating service and maintenance instructions for equipment provided. The manual shall include:
 - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of all replaceable parts.
 - 2. Manufacturer's printed operating procedures to include start-up, break-in, routine and normal operating instructions; regulation, control, stopping, shut-down, and emergency instructions; and summer and winter operating instructions.
 - 3. Maintenance procedures for routine preventative maintenance and

troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

4. Servicing and instructions and lubrication charts and schedules.

- B. Contractor shall carefully instruct the Owner's operations personnel during the adjustment and testing period of the equipment for such length of time as may be necessary to thoroughly familiarize them with the proper care, operation, and maintenance of the equipment.
- C. Contractor shall turn special tools, maintenance items, keys, other devices and materials required to operate or maintain the systems over to the Owner.

2.19. CLEAN UP

- A. Do not allow waste material or rubbish to accumulate in or about jobsite. Clean work areas daily.
- B. At completion of work, remove rubbish, tools, scaffolding, and surplus materials from and about building, leaving work clean and ready for use without further cleaning required. Clean equipment, piping, valves, fixtures, and fittings of grease, metal cuttings, insulation cement, dust, dirt, paper labels, and other materials that are not part of the final finish.
- C. Any discoloration or other damage to parts of building, its finish or furnishings due to failure to properly clean or keep mechanical systems clean shall be repaired without cost to Owner.

2.20. NAMEPLATE DATA:

- A. Provide permanent operational data nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data.
- B. Locate nameplates in an accessible location. Where manufacturer's name plate is not stamped or engraved, provide additional heavy gauge aluminum or brass, stamped or engraved nameplate.
- C. Do not remove manufacturer's nameplates. When manufacturer's nameplates are to be covered by insulation or other material, provide a separate nameplate for mounting on the exterior of the covering.

2.21. RECORD DOCUMENTS

- A. At completion of this project, the Contractor shall provide Engineer with one set of "red lined" design drawings and specification showing all Work installed by him.
- B. These documents shall incorporate all changes made in the course of the project

so as to enable the Owner to properly maintain, operate, and repair both exposed and concealed work. The redlines shall indicate changes:

1. Made by Contractor.
 2. Addendum Items.
 3. Change Orders.
 4. Substitutions.
- C. Drawings and specifications shall be updated during the progress of the work and kept at the job site.
- D. Record Prints: Maintain one set of blue-line or black-line prints of the Contract Drawings, Submittals, and Shop Drawings.
1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally.
 - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
 - b. Accurately record information in an understandable drawing technique.
 - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
- 2.22. FINAL PROJECT OBSERVATION: The final project observation shall not be made until the following items have been assembled and approved as indicated in other sections of the specifications.
- A. Certificate of acceptance from local inspecting authorities.
 - B. Letter of compliance from the Controls Systems Provider indicating that the system is complete, fully operational, and installed as specified by manufacturer's certified or licensed individuals.
 - C. Test and Balance report.
 - D. Owner's Operations and Maintenance manual.
 - E. Copies of bonds, insurance certificates, waivers, affidavits, warranties and guarantees, and other documents required in the specifications signed and ready for appropriate action.
 - F. Written notification from the Contractor that the work is complete and ready for final observation and the above documents are completed and available

- G. Other documentation which may be required by the Engineer.

2.23. PROJECT CLOSEOUT

- A. The final mechanical systems closeout shall not be completed until the Contractor has completed his work and submitted the documents required by Division 1 portions of the specifications. In addition the following work items and specific mechanical documents described in other portions of this specification section shall also be submitted and approved:
 - 1. Record drawings.
 - 2. Record specifications.
 - 3. Guarantee and Warranties.
 - 4. Operating and Maintenance Manuals (O&M). O&M Manuals shall also be provided to the Owner in duplicate. Manuals shall contain approved shop drawings, operations and maintenance instructions, parts manuals for HVAC equipment, an accurate set of design plans showing all construction revisions to the design set, and a copy of the test and balance report.
 - 5. Final clean up.
 - 6. Final Test and Balance Reports with startup logs.
 - 7. Pipe and Equipment Identification.
 - 8. Pipe test certifications.
 - 9. Water treatment analysis and application.
 - 10. Bonds, Insurance Certificates, Waivers, Affidavits, and other documents required in the specifications signed and ready for appropriate action.
 - 11. Other items which may be required by the Engineer.
- B. Confirm in writing that specified training specified has been completed with the Owner.
- C. Confirm in writing that specified demonstrations have been completed with the Owner.
- D. Confirm that test and balance is complete.

END OF SECTION

SECTION 23 0015 - FIRESTOPPING AND SMOKE STOPPING

PART 1 - GENERAL

1.01. SUMMARY

- A. Section includes:
 - 1. Through-penetration firestopping in fire rated construction.
- B. Scope:
 - 1. The scope of the work shall include the mechanical systems, HVAC piping and ductwork, plumbing piping, fire protection piping, and other systems installed by the contractor.

1.02. 1.02 REFERENCES

- A. Underwriters Laboratories
 - 1. U.L. Fire Resistant Directory
 - a. Through-penetration firestop devices (XHCR)
 - b. Fire resistance ratings (BXUV)
 - c. Through-penetration firestop systems (XHEZ)
 - d. Fill, void, or cavity material (XHHW)
- B. American Society for Testing and Materials Standards:
 - 1. ASTM E 814-88: Standard Test Method for Fire Tests of Through-Penetration Firestops.

1.03. 1.03 DEFINITIONS

- A. Assembly: Particular arrangement of materials specific to given type of construction described or detailed in referenced documents.
- B. Barriers: Time rated fire walls, time rated ceiling/floor assemblies, and structural floors.
- C. Firestopping: Methods and materials applied in penetrations and unprotected openings to limit spread of heat, fire, gasses and smoke.
- D. Penetration: Opening or foreign material passing through or into barrier or structural floor such that full thickness of rated materials is not obtained.
- E. System: Specific products and applications, classified and numbered by Underwriters Laboratories, Inc. to close specific barrier penetrations.
- F. Sleeve: Metal fabrication or pipe section extending through thickness off barrier and used to permanently guard penetration. Sleeves are described as part of

penetrating system in other sections and may or may not be required.

1.04. SYSTEM DESCRIPTION

A. Design Requirements

1. Fire-rated construction: Maintain barrier and structural floor fire resistance ratings including resistance to cold smoke at all penetrations, connections with other surfaces or types of construction, at separations required to permit building movement and sound or vibration absorption, and at other construction gaps.
2. Smoke barrier construction: Maintain barrier and structural floor resistance to cold smoke at all penetrations, connections with other surfaces and types of construction and at all separations required to permit building movement and sound or vibration absorption, and at other construction gaps.

1.05. SUBMITTALS

- A. Submit in accordance with general conditions unless otherwise indicated.
- B. Product data: Manufacturer's specifications and technical data including the following:
 1. Detailed specification of construction and fabrication
 2. Manufacturer's installation instructions.
- C. Shop drawings: Indicate dimensions, description of materials and finishes, general construction, specific modifications, component connections, anchorage methods, hardware, and installation procedures, plus the following specific requirements.
 1. Details of each proposed assembly identifying intended products and applicable UL System number, or UL classified devices.
 2. Manufacturer or manufacturers' representative shall provide qualified engineering judgements and drawings relating to non-standard applications as needed.
- D. Quality control submittals:
 1. Statement of qualifications.
- E. Applicators' qualifications statement:
 1. List past projects indicating required experience.

1.06. QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing the work of this section with

minimum three years documented experience and approved by manufacturer.

1.07. REGULATORY REQUIREMENTS

- A. Conform to applicable code for fire resistance ratings and surface burning characteristics.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of combustibility.

1.08. ENVIRONMENTAL REQUIREMENTS

- A. Do not apply materials when temperature of substrate material and ambient air is below 60 degrees F.
- B. Maintain this minimum temperature before, during, and for 3 days after installation of materials.
- C. Provide ventilation in areas to receive solvent cured materials.
- D. Furnish forced air ventilation during installation if required by manufacturer.
- E. Keep flammable materials away from sparks or flame.
- F. Provide masking and drop cloths to prevent contamination of adjacent surfaces by firestopping materials.
- G. Comply with manufacturing recommendations for temperature and humidity conditions before, during and after installation of firestopping.

1.09. SEQUENCING

- A. Sequence work to permit firestopping materials to be installed after adjacent and surrounding work is complete.

1.10. QUALITY ASSURANCE

- A. Installer's qualifications: Firm experienced in installation or application of systems similar in complexity to those required for this project, plus the following:
 - 1. Acceptable to or licensed by manufacturer, State or local authority where applicable.
 - 2. At least 2 years experience with systems.
 - 3. Successfully completed at least 5 comparable scale projects using this system.
- B. Local and State regulatory requirements: Submit forms or acceptance for proposed assemblies not conforming to specific UL Firestop System numbers, or UL classified devices.
- C. Materials shall have been tested to provide fire rating at least equal to that of the construction.

1.11. DELIVERY, STORAGE, AND HANDLING

- A. Packing and shipping:
 - 1. Deliver products in original unopened packaging with legible manufacturer's identification.
 - 2. Coordinate delivery with scheduled installation date, allow minimum storage at site.
- B. Storage and protection: Store materials in a clean, dry, ventilated location. Protect from soiling, abuse, moisture and freezing when required. Follow manufacturer's instruction.

1.12. PROJECT CONDITIONS

- A. Existing conditions:
 - 1. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.
 - 2. Proceed with installation only after penetrations of the substrate and supporting brackets have been installed.

1.13. GUARANTEE

- A. Submit copies of written guarantee agreeing to repair or replace joint sealers which fail in joint adhesion, co-adhesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The guarantee period shall be one year from date of substantial completion.

PART 2 PRODUCTS

2.01. THROUGH-PENETRATION FIRESTOPPING OF FIRE-RATED CONSTRUCTION

- A. Systems or devices listed in the U.L. Fire Resistance Directory under categories XHCR and XHEZ may be used, providing that it conforms to the construction type, penetrant type, annular space requirements and fire rating involved in each separate instance, and that the system be symmetrical for wall applications. Systems or devices must be asbestos-free.
 - 1. Additional requirements: Withstand the passage of cold smoke either as an inherent property of the system, or by the use of a separate product included as a part of the U.L. system or device, and designed to perform this function.
 - 2. Acceptable manufacturers and products: Those listed in the U.L. Fire Resistance directory for the U.L. System involved and as further defined in Part 3.06 of this section.

3. All firestopping products must be from a single manufacturer. All trades shall use products from the same manufacturer.
4. Products shall be 3M firestopping products and systems or equal.

2.02. SMOKE-STOPPING AT SMOKE PARTITIONS

- A. Through-Penetration Smoke-Stopping: Any system complying with the requirements for through-penetration firestopping in fire-rated construction, as specified in this section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.
- B. Construction-Gap Smoke-Stopping: Any system complying with the requirements for construction-gap firestopping in fire-rated construction, as specified in this section, is acceptable, provided that the system includes the specified smoke seal or will provide a smoke seal. The length of time of the fire resistance may be disregarded.

2.03. MATERIALS

- A. Firestopping Material: Single or multiple component silicone elastomeric rubber type foam compound mixed with incombustible non-asbestos ceramic fibers.
- B. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces.

2.04. 2.04 ACCESSORIE

- A. Fill, void or cavity materials: As classified under category XHHW in the U.L. Fire Resistance Directory.
- B. Forming materials: As classified under Category XHKU in the U.L. Fire Resistance Directory.

PART 3 EXECUTION

3.01. EXAMINATION

- A. Verification of conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.
 1. Verify barrier penetrations are properly sized and in suitable condition for application of materials.
 2. Do not proceed until unsatisfactory conditions have been corrected.

3.02. SURFACE PREPARATION

- A. Clean surfaces to be in contact with penetration seal materials, of dirt, grease, oil, loose materials, rust, or other substances that may affect proper fitting, adhesion,

or the required fire resistance.

3.03. INSTALLATION

- A. Apply primer and materials in accordance with manufacturer's instructions.
- B. Install penetration seal materials in accordance with printed instruction of the U.L. Fire Resistance Directory and in accordance with manufacturer's instruction.
- C. Seal holes or voids made by penetrations to ensure an effective smoke barrier.
- D. Where floor openings without penetrating items are more than four inches in width and subject to traffic or loading, install firestopping materials capable of supporting same loading as floor.
- E. Apply firestopping material in sufficient thickness to achieve rating and to a uniform density and texture.
- F. Protect materials from damage on surfaces subject to traffic.
- G. Install material at walls or partition openings which contain penetrating sleeves, piping, ductwork, conduit and other items requiring firestopping.
- H. Place firestopping in annular space around fire dampers before installation of damper's anchoring flanges - installed in accordance with fire damper manufacturer's recommendations.
- I. Where large openings are created in walls or floors to permit installation of pipes, ducts, cable tray, bus duct or other items, close unused portions of opening with firestopping material tested for the application. See U.L. Fire Resistance Directory.
- J. Install smoke stopping as specified for firestopping.
- K. Where rated walls are constructed with horizontally continuous air space, double width masonry, or double stud frame construction, provide vertical 12 inch wide fiber dams for full thickness and height of air cavity at maximum 15 foot intervals.
- L. Dam material to remain.

3.04. FIELD QUALITY CONTROL

- A. Examine penetration sealed areas to ensure proper installation before concealing or enclosing areas.
- B. Keep areas of work accessible until inspection by applicable code authorities.
- C. Perform under this section patching and repairing of firestopping caused by cutting or penetration by other trades.

3.05. ADJUSTING AND CLEANING

- A. Clean adjacent surfaces of firestopping materials.
- B. Clean up spills of liquid components.
- C. Neatly cut and trim materials as required.
- D. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

3.06. PROTECTION OF FINISHED WORK

- A. Protect adjacent surfaces from damage by material installation.

3.07. SYSTEMS AND APPLICATION

- A. The installation shall be as required by manufacturer for type of construction, Type of U.L. systems, type of penetration, and type of fire stopping system.

END OF SECTION

SECTION 23020

MECHANICAL DEMOLITION

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK

- A. This Section describes the demolition, removal, relocation, rerouting and reconnection of existing mechanical facilities, as required, shown and specified herein, to accomplish alteration, restoration and to accommodate the HVAC system(s) upgrades..
- B. The work shall include but not be limited to, draining, disconnecting, relocating, removing and dismantling, in a neat and workmanlike manner, the items and their accessories as indicated or Shown on the Contract Drawings.

1.02 REFERENCES

- A. ANSI A10.6 – Safety Requirements for Demolition
- B. National Association of Demolition Contractors (NADC) – Demolition Safety Manual
- C. NFPA 51B – Cutting and Welding Processes
- D. NFPA 70 – National Electrical Code
- E. NFPA 241 – Safeguarding Building Construction and Demolition Operations
- F. OSHA 29 CRF 1910 – Occupational Safety and Health Standards
- G. US EPA – Clean Air Act Amendment of 1990.

1.03 SUBMITTALS

- A. Demolition Schedule
- B. Fire Watch Procedures (If Required)
- C. Inspection Report of Underground Piping Systems
- D. Welding/Burning Permit – Obtain a welding/burning permit from the Campus Fire Official prior to the start of any welding or burning in accordance with the local Fire Code and as required by the Owner.

1.04 QUALITY ASSURANCE

- A. Cutting, patching and removal shall be performed by workers skilled in the specific trades involved.
- B. Job Conditions: Prior to start of work, make an inspection accompanied by the Engineer to determine and document physical condition of adjacent construction that is to remain.

1.05 SPECIAL PRECAUTIONS

- A. Torch cutting of ductwork will not be permitted.

- B. Torch cutting of other mechanical equipment will be permitted only as indicated by the Engineer.
- C. Any cutting method, which may create sparks, must include "Fire Watch" as required by the Fire Code and/or Owner's Fire Insurance Carrier. Submit fire watch procedures for approval.
- D. Draining operations must be monitored and not damage building components.

PART 2 - PRODUCTS

2.01 Adequately sized rubbish containers for the proper and safe disposal of all debris.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Construct temporary partitions prior to any demolition work enclosing respective work. Erect temporary fencing and signage around demolished materials. Use water sprinkling and other suitable methods to limit dust and dirt arising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.
- B. Protect existing materials and equipment which are not to be demolished.
- C. Prevent movement of structure; provide required bracing and shoring.
- D. Do not begin the work until the time schedules and manner of operations have been approved by the Engineer and Owner. All interruptions of existing services shall be included in the schedules as approved by the Engineer and Owner.

3.02 GENERAL

- A. Provide alteration and demolition of mechanical facilities as required by the contract drawings, specifications and phasing plan.. The drawings are diagrammatic and do not show the exact location of all existing mechanical work. Where existing equipment shall remain in service during construction, provide rerouting and reconnection of mechanical services as required to maintain continuous service.
- B. Review all equipment with the Engineer and Owner prior to disposal. Existing ductwork, piping, conduit and similar items to be abandoned that are not embedded in walls or floor slabs shall be completely removed unless otherwise shown on the drawings. Cap open ends at all walls and floors.
- C. Remove, store and protect all equipment or materials to be reused by or delivered to the Owner as shown on the drawings. Coordinate exact location of storage with the Owner. Items indicated to be removed, and not designated for Owner's salvage or for reuse, may be salvaged by Contractor. Transport salvaged items that are not to be reused from site as they are removed. Storage or sale of removed items on site will not be permitted.
- D. Temporarily cap ends of ductwork to avoid entry of dirt, debris, or discharge of foul odors and gases.
- E. Where existing louvers or ductwork penetrations are to remain, blank-off the louver on

the inside with galvanized sheet metal on both sides of 2-inch thick, 6 pcf density rigid fiberglass board insulation. Paint side attached to the louver with flat black paint.

- F. Do not close or obstruct egress width to exits. Conduct demolition operations and removal of debris to ensure minimum interference with roads, streets, walkways, occupied areas, and other adjacent occupied or used facilities. Ensure safe passage of persons around or through area of demolition operations to prevent injury to adjacent buildings, structures, other facilities, and persons.
- G. Do not disable or disrupt building fire or life safety systems without five (5) days' prior written notice to the Engineer and Owner.
- H. Conform to procedures applicable when discovering hazardous or contaminated materials.
- I. Conduct demolition to minimize interference with adjacent building structures or Owner's operations.
- J. Cease operations immediately if structure appears to be in danger or hazardous materials are encountered. Notify Architect/Engineer. Do not resume operations until directed.
- K. Demolish in an orderly and careful manner. Do not cut or remove more than is necessary to accommodate the new construction or alteration.
- L. Remove demolished materials from site daily. Do not burn or bury materials on site. Dispose of all material at an approved disposal facility.
- M. Cover and protect floors, furniture, equipment and fixtures to avoid soiling or damage when demolition work is performed in rooms or areas from which such items have not been removed. Protect finished surfaces at all times and repair or replace, if damaged, to match existing construction to the satisfaction of the Engineer.
- N. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
- O. Protect new and existing roofs from damage.
- P. Do not interrupt existing utilities serving occupied portions of the facility, except when authorized in writing by Owner's representative. Provide temporary services during interruptions to existing utilities, as acceptable to the Owner. Contractor shall disconnect and seal only utilities to be demolished serving areas being demolished, prior to start of demolition work. If Contractor is required to disconnect utility services or other services to an occupied area, the Contractor shall provide temporary or alternative service to that area, as acceptable to the Owner.

3.03 PIPING REMOVAL

- A. Cut off all welded piping square at the locations indicated on the drawings. No cutting will be required where the demolition ends at a flanged valve or equipment. Close off all openings of any remaining valves, piping or fittings with weld caps or blind flanges to prevent debris from entering the existing system.
- B. Disconnect all threaded piping at the location indicated on the drawings. Close off all

openings of remaining valves, piping, fittings and equipment with pipe plugs or pipe caps as required to prevent debris from entering the existing systems.

- C. Remove all pipe hangers, supports, miscellaneous steel and anchors with the piping.

3.04 PROTECTION FROM FREEZING

- A. It is intended that the building remain protected from damage due to freezing temperatures. To that end, existing equipment and systems used for heating shall remain in place and in operation until scheduling permits shutdown.
- B. Where the removal of equipment and/or existing systems will leave an area unprotected from freezing, notify the Owner and Engineer at least 72 hours in advance prior to removal so appropriate steps can be taken by the Owner to protect the area. Provide temporary heating equipment sufficient to prevent freezing.
- C. It is the Contractor's responsibility to ensure that piping systems that are being worked on are completely drained from water prior to the start of demolition. If water is not drained and the piping freezes it is the Contractor's responsibility to replace piping at his own expense.

3.05 DISCONNECTION AND INTERRUPTION OF MECHANICAL SERVICES

- A. When portions of an existing piping system or ductwork system are removed, and this removal causes loss of operation to another piece of equipment due to open (disconnected) piping or ductwork, then cap piping or ductwork or provide temporary piping or ductwork system to retain operation of various systems.

3.06 MECHANICAL EQUIPMENT REMOVAL

- A. Remove all mechanical equipment as shown on the Contract Drawings. Remove all electrical work, including wiring between equipment, and wiring to power source or point of origin.
- B. Where equipment is supported by steel and/or structural supports, remove these supports.

3.07 REFRIGERANT REMOVAL

- A. Recover and dispose of all existing refrigerant charges in accordance with EPA regulations. Release of chlorofluorocarbon refrigerants to atmosphere is prohibited per the Clean Air Act Amendments of 1990.

3.08 DUCTWORK REMOVAL

- A. Disconnect all ductwork, which must be removed, at the closest joint and resupport the remaining ductwork.
- B. Prepare all remaining ductwork joints at the point of disconnection to receive new ducts or blank-off panels.
- C. Remove all ductwork supports and miscellaneous steel with ductwork to be demolished.

3.09 INSULATION REMOVAL

- A. Remove insulation, together with all piping, fittings, valves and equipment designated for demolition.

3.10 CONTROL WIRING REMOVAL

- A. Disconnect and remove all control wiring and tubing, including conduit, for the Automatic Temperature Control (ATC) System associated with equipment to be removed.

END OF SECTION

SECTION 23 00 30 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

- A. This section specifies the basic requirements for electrical components which are to be provided for operation of mechanical equipment. These components include, but are not limited to, motors, starters, and disconnect switches when indicated, furnished as an integral part of packaged mechanical equipment, or furnished separately for mechanical equipment.
- B. Furnish all motor controllers and contactors, not furnished as part of a motor control center, for proper operation of all motors.
- C. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specification sections and scheduled on the drawings.

1.02 REFERENCES:

- A. NEMA Standards MG 1: Motors and Generators.
- B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
- C. NEMA Standard 250: Enclosures for Electrical Equipment.
- D. NEMA Standard KS 1: Enclosed Switches.
- E. National Electric Code (NFPA 70).

1.03 SUBMITTALS:

- A. Separate submittal is not required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.04 QUALITY ASSURANCE:

- A. Electrical components and materials shall be UL labeled.
- B. The electrical work shall comply with the National Electric Code.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Equipment shall be by same manufacturer, except those items furnished by an equipment manufacturer as an integral part of his equipment. Where possible the equipment shall be by the same manufacturer specified in Division 16.

2.02 MOTORS: The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are specified in the individual equipment specifications.

- A. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
- B. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
- C. 2-speed motors shall have 2 separate windings on poly-phase motors.
- D. Temperature Rating: Rated for 40 degrees C. environment with maximum 90 degree C rise for continuous duty at full load (Class B insulation).
- E. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly spaced starts per hour for manually controlled motors.
- F. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
- G. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
 - 1. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
 - 2. Bearings:
 - a. Ball or roller bearings with inner and outer shaft seals.
 - b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
 - c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
 - d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.

3. Enclosure Type:
 - a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
 - b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
 - c. Weather protected Type I for outdoor use, Type II where not housed.
4. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
5. Noise Rating: "Quiet".
6. Efficiency:
 - a. Motor shall comply with the efficiency requirements of the Energy Independence and Security Act of 2007.
 - b. Motors smaller than 1 HP shall have minimum full load efficiencies levels per NEMA Standards.
 - c. Motors 1 HP and larger shall be premium efficiency.
7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.03 STARTERS, ELECTRICAL DEVICES, AND WIRING:

- A. Motor Starter Characteristics:
 1. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R or NEMA 12 with conduit hubs installed by contractor, or units in hazardous locations which shall have NEC proper class and division.
 2. Type and size of starter shall conform to adopted standards and recommended practices of the National Electric Code and Underwriters' Laboratories.
- B. Manual Switches: Manual switches shall have:
 1. Pilot lights and extra positions for multi-speed motors.

2. Overload protection: Melting alloy type thermal overload relays.
3. Manual starters / switches are to be used on fractional horsepower motors only.

C. Magnetic Starters:

1. Momentary contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
2. Trip-free thermal overload relays, each phase.
3. Interlocks, witches and similar devices as required for coordination with control requirements of controls sections.
4. Built-in 120 volt control circuit transformer, with 2 primary and one secondary fuse, where service exceeds 240 volts. Fuses sized to carry holding coil circuit and other connected devices.
5. Externally operated manual reset.
6. Under-voltage release or protection (3-wire control).
7. Branch circuit protection shall meet type 2 coordination protection.
8. A hand-off-auto selector switch shall be provided in addition to start-stop buttons for all devices being controlled automatically.
9. Phase loss relay.
 - a. Provide protective relays with DPDT 600V rated contacts, locking potentiometer undervoltage adjustment, and LED indicating light at each starter for motors greater than 5 HP. Equal to Square D Class 8430, Type MPD, mounted in suitable enclosure.

D. Motor Connections:

1. Flexible conduit, except where plug-in electrical cords are specifically indicated.

E. Heater Contactors:

1. Contactors for resistance heat shall be by same manufacturer as starters unless furnished with heaters. Contactors shall be of the magnetic type and mounted in NEMA Type 1 general purpose enclosure. Contactors shall carry a UL listing and shall be rated for 100,000 cycles.

F. Disconnect Switches:

1. Fusible Switches: Fused, each phase; heavy duty; horsepower rated; non-teasible, quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "open" position; arc quenchers; capacity and characteristics as indicated.
2. Non-fusible Switches: For equipment less than 1 horsepower, switches shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment 1 horsepower and larger, switches shall be the same as fusible type.

2.04 CAPACITORS:

A. Features:

1. Individual unit cells, all welded steel housing, each capacitor internally fused, non-flammable synthetic liquid impregnant, craft tissue insulation, and aluminum foil electrodes.
2. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.
- B. Deliver starters and wiring devices which have not been factory-installed on equipment unit to electrical installer for installation.
- C. Install starters and wiring devices at locations indicated, securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate for proper operation access, including visibility, and for safety. Do not cover equipment data or informational tags when device is to be mounted on equipment.

- D. Install control connections for motors to comply with NEC and applicable provisions of Electrical. Install equipment grounding except where non-grounded isolation of motor is indicated.
- E. Connect protective relays to line side lugs of the motor starter and wire control contacts into motor starter circuit.
- F. Label starters with engraved plastic nameplate describing the equipment served, e.g., "A.C. Unit No. 1". Nameplates shall be U.V. stabilized for use indoor / outdoor. Attach nameplates with clear silicone sealant.

END OF SECTION

SECTION 23 0060

BASIC PIPING

PART 1 - GENERAL

1.01. THERMAL EXPANSION:

- A. Swing joints, turns, expansion loops, and long offsets shall be provided where necessary to allow for expansion and contraction. Pipe, fittings, or equipment damaged during the warranty period due to thermal expansion shall be replaced at no additional cost to the Owner.

1.02. NOISE CONTROL:

- A. Piping shall be free of any objectionable self-generated noise. Isolate piping from building where required to prevent transmission of noise.

1.03. CROSS CONNECTIONS:

- A. No piping shall be installed that will provide a cross-connection between potable water system and a polluted supply.

1.04. SUBMITTALS

- A. Product Data: Submit catalog cut sheets and specifications for each type of pipe, tube, and fitting. Submit pipe schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

1.05. DELIVERY, STORAGE, AND HANDLING

- A. Except for hub and spigot, clay, and similar piping, provide factory applied end caps on all pipe and tubing to prevent damage, and dirt and moisture entry. Maintain end caps through shipping, storage, and handling.
- B. Where possible, store pipe, tube, flanges, and fittings inside and protected from the weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

1.06. QUALITY ASSURANCE

- A. Qualify and certify welding and brazing procedures, equipment, and operators in accordance with ASME codes and standards for shop and job site work.
- B. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

- C. Welding procedures and testing shall comply with ANSI Standard B31.1.
- D. Soldering and brazing procedures and testing shall comply with ANSI Standard B31.9. Comply with ANSI Standard B31.5 for refrigerant piping.

PART 2 - PRODUCTS

2.01. MATERIALS:

- A. Refer to specific piping specification sections for materials to be used on the various piping systems.
- B. Materials shall be manufactured by firms whose products of types and sizes required for this project have been in satisfactory use in similar service for 5 years.
- C. All materials shall be new and undamaged.
- D. For corrosive environments all bare copper piping shall be provided with special Heresite coating even if located within outdoor equipment.

2.02. CONDENSATE, CONDENSING FURNACE, EXHAUST, AND INTAKE PIPE: Sch 40 PVC

- A. Condensate exhaust pipe should be sloped back to furnace.

2.03. REFRIGERANT PIPE, INCLUDING LIQUID AND HOT GAS LINES: hard drawn copper, Type "L" (degreased).

- A. Soft copper will be permitted when sleeving below grade or installing in wall to eliminate fittings. Soft copper may also be installed on units less than 1 1/2 tons.
- B. Do not run refrigerant lines thru return air plenum unless approved by engineer.
- C. Do not run refrigerant piping underground.

2.04. JOINING MATERIALS:

- A. Refer to specific piping specification sections for special joining materials not list below.
- B. Pipe Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8 inch maximum thickness, unless other thickness or specific material is indicated.
 - 2. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

3. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 4. AWWA C110, rubber, flat face, 1/8 inch thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32.
1. Alloy Sn95 or Alloy Sn94: approximately 95 percent tin and 5 percent silver, with 0.1 percent lead content.
 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.1 percent maximum lead content.
 3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.1 percent maximum lead content.
 4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.1 percent maximum lead content.
 5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.2 percent maximum lead content.
- E. Brazing Filler Metals:
1. BcuP Series: Copper-phosphorus alloys.
 2. Bag1: Silver Alloy.
- F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements: Manufacturer's standard solvent cements for the following:
1. ABS Piping: ASTM D 2235.
 2. CPVC Piping: ASTM F 493.
 3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
 4. PVC to ABS Piping Transition: ASTM D 3138.
- H. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.
- I. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.

J. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.

1. Sleeve: ASTM A 126, Class B, gray iron.
2. Followers: ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 536 ductile iron.
3. Gaskets: Rubber.
4. Bolts and Nuts: AWWA C111.
5. Finish: Enamel Paint.

K. Dielectric Fittings

1. 1. Provide dielectric connection at all connections between pipe materials of differing types whether indicated on plans or not.
2. 2. Insulating Material: Suitable for system fluid, pressure, and temperature.
3. 3. Dielectric Unions: Factory fabricated, union assembly, for 250-psig minimum working pressure at 180 °F.
4. 4. Dielectric flanges: Factory fabricated, companion-flange assembly, for 150- or 300-psig minimum working pressure as required to suit system pressures.
5. 5. Dielectric-Flange Insulation Kits: Field assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig minimum working pressure as required to suit system pressures.
6. 6. Dielectric couplings: Galvanized steel coupling with inert and non-corrosive, thermoplastic lining; threaded ends, and 300-psig minimum working pressure at 225°F,
7. 7. Dielectric Nipples: Electroplated steel nipple with inert and non-corrosive, thermoplastic lining; threaded ends, and 300-psig minimum working pressure at 225°F.

2.05. PIPE ESCUTCHEONS:

- A. Inside diameter shall closely fit pipe outside diameter, or outside of pipe insulation where pipe is insulated. Select outside diameter of escutcheon to

completely cover pipe penetration hole in floor, walls, or ceilings; and pipe sleeve extension, if any. Furnish solid pipe escutcheons with nickel or chrome finish for occupied areas. Prime paint finish for unoccupied areas. Split hinge type is not acceptable in occupied areas, except on existing piping.

- B. For waterproof floors and areas where water and condensation can be expected to accumulate, provide cast brass or sheet brass escutcheons.

2.06. PIPE SLEEVES:

- A. Sheet-Metal: Fabricate from galvanized sheet metal; round tube closed with snaplock joint, welded spiral seams, or welded longitudinal joint. Fabricate from the following gauges: 3" diameter and smaller, 20 gauge; 4" to 6" diameter, 16 gauge; over 6" diameter, 14 gauge.
- B. Steel-Pipe: Fabricate from ASTM A 53, Grade A, Schedule 40 galvanized steel pipe.
- C. Iron-Pipe: Fabricate from cast-iron or ductile iron pipe; cast-iron sleeve to be same wall thickness as equivalent ductile iron pipe.

2.07. SLEEVE SEALS:

- A. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing water tight seal and electrical insulation. Thunderline, "Link Seal" or equal.
- B. Fire Protection Mechanical Sleeve Seals: Three (3) hour rated modular mechanical type, consisting of interlocking fire resistant silicone rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing water tight seal and fire resistant seal. Thunderline, "Link Seal" or equal.
- C. Fire Protection Sealant
 - 1. Firestop System installation must meet requirements of ASTM E 814, UL 1479 or UL 2079 tested assemblies and provide a fire rating equal to that of construction being penetrated.
 - 2. All firestop materials and methods shall conform to applicable governing codes having local jurisdiction, whether approved by submittal or not.
 - 3. For those firestop applications that exist for which no UL tested system is available through any manufacturer, a manufacturer's engineering judgment derived from similar independently tested system designs will

be submitted to local authorities having jurisdiction for their review and approval prior to installation.

- D. Elastomeric Joint Sealant: Type S, Grade NS, Class 25, Use O, neutral-curing, silicone sealant unless otherwise indicated.
- E. Grout: Nonshrink, nonmetallic, hydraulic cement grout, ASTM C 1107, Grade B. Post hardening, volume adjusting, dry, nonstaining, noncorrosive, and nongaseous recommended for interior and exterior applications. 5000 psig, 28 day strength.

PART 3 - EXECUTION

3.01. GENERAL:

- A. Install piping as described below, unless indicated otherwise in the individual piping sections. See the individual piping sections for unique piping installation requirements.
- B. Exposed lines are to be run parallel with, or perpendicular to, building lines and wherever possible shall be grouped together for easy service and identification. Lines requiring a definite grade for drainage shall have precedence in routing over all other lines. Wherever possible, horizontal and vertical lines shall be held as close as possible to walls, ceilings, struts, and structural members to occupy minimum space consistent with the proper requirements for insulation, expansion, removal of pipe, and access to valves. Except in mechanical spaces, piping shall not be run exposed in finished area of buildings unless otherwise noted.
- C. General Locations and Arrangements: Drawings including plans, schematics, and diagrams indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.
- D. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- E. Install fittings for changes in direction and branch connections.
- F. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, and below grade or floors, unless indicated otherwise.
- G. Install piping at indicated slopes and as prescribed by Code.
- H. Install components with pressure rating equal to or greater than system operating pressure.
- I. Install piping free of sags and bends.

- J. Install piping with sufficient space above removable ceiling panels to allow for panel removal.
- K. Install drains at low points in mains, risers, and branch lines consisting of a branch fitting, 3/4" ball valve, and short 3/4" threaded nipple and cap.
- L. Piping shall be worked into place without springing and/or forcing. Arrange piping so that it does not interfere with removal of other equipment or devices, nor to block access to doors, windows, manholes, or other access openings.
- M. All piping shall be installed so as to avoid liquid or air pockets throughout the work. Piping shall be erected and pitched to insure proper draining. Provide air vents and drain traps where indicated and as required.
- N. All exposed plumbing fixture supplies and stops shall be chrome-plated.
- O. Do not run piping through electrical or electronic equipment spaces and enclosures unless unavoidable. If piping must be run through electrical spaces, comply with NFPA 70 for access clearance requirements for electrical equipment. Install drip pan under piping which must be run through electrical spaces. Pan drain shall be run at exterior or sanitary, as permitted by Code.
- P. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.
- Q. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained.

3.02. ASSEMBLY:

- A. All pipes shall be cut square and shall have burr and cutting slag removed by reaming or other cleaning methods.
- B. Remove scale, slag, dirt, and debris from both inside and outside of piping and fittings before assembly.
- C. Unions or flanges shall be used at all equipment connections to facilitate dismantling.
- D. All joints and changes of direction shall be made with standard fittings. Reducers shall be used at pipe size changes.
- E. Where required to prevent electrolysis and corrosion, dielectric fittings and couplings, or brass or bronze fittings or valves, shall be used between copper and steel piping. Provide insulating coupling on all underground metallic utility lines where they connect to building.

- F. Nipples shall be of same material and composition as pipe on which they are installed, and shall be extra heavy when unthreaded shoulder is less than 1-1/2". No running thread nipples will be permitted. Minimum exposed shoulder of any nipple shall not be less than 3/4".
- G. Joints between steel or copper pipe and cast iron shall be made with caulking ferrules.
- H. Cast iron soil pipe and fittings shall be assembled with approved molded push-on type gaskets. Approved no-hub pipe may be used where applicable.
- I. Galvanized steel pipe shall be assembled with galvanized screwed fittings.
- J. Black steel pipe shall be assembled with screwed or welded fittings.
- K. Copper pipe shall be assembled with wrought copper fittings. Use Alloy Sn95 (95/5) solder as a minimum. See specific piping sections for other requirements.
- L. For steel piping, use new forged tees for branch connections to main in new piping systems. Forged tees or forged weld-o-lets shall be used for branch connections to existing mains.
- M. Soldered Joints: Construct joints according to AWS's "Soldering Manual"; or CDA's "Copper Tube Handbook".
- N. Brazed Joints: Construct joints according to AWS's "Brazing Handbook".
- O. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Use appropriate tape or thread compound as required unless dry threading is specified.
- P. Welded Joints: Construct joints according to AWS D10.12 using qualified processes and welding operators.
- Q. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
- R. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: ASTM D 2235 and ASTM D 2661.
3. CPVC Piping: ASTM D 2846 and ASTM F 493.
4. PVC Pressure Piping: ASTM D 2672.
5. PVC Nonpressure Piping: ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.

3.03. FITTINGS AND ACCESSORIES:

- A. Install strainers on the supply side of each control valve, pressure reducing or regulating valve, solenoid valve, and elsewhere as indicated.
- B. Install unions adjacent to each valve at the final connection to each piece of equipment and plumbing fixture having 2" and smaller connections, and elsewhere as indicated.
- C. Install flanges in piping 2-1/2" and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.
- D. Pipe Escutcheons: Install pipe escutcheons on each pipe penetration through walls, partitions, and ceilings where penetration is exposed to view; and on the exterior of the building.

3.04. SUPPORTS:

- A. Provide an adequate pipe suspension system in accordance with recognized engineering practices, using, where possible, standard, commercially accepted pipe hangers and accessories. No piping shall be supported by, or from, hangers supporting electrical conduit.

3.05. SLEEVES

- A. Install pipe sleeves of types indicated where piping passes through walls, floors, slabs, ceilings, and roofs. Do not install sleeves through structural members of work, except as detailed on drawings, or as directed by the Structural Engineer.
- B. Install sleeves accurately centered on pipe runs. Size sleeves so that piping and insulation (if any) will have free movement in sleeve, including allowance for thermal expansion; but not less than two (2) pipe sizes larger than piping run. Where insulation includes vapor barrier jacket, provide sleeve with sufficient clearance for insulation.

- C. Install length of sleeve equal to the thickness of construction penetrated, and finished flush to surface; except extend floor sleeves 1 inch above level floor finish.
- D. Sleeves are not required for core-drilled holes.
- E. Permanent sleeves are not required for holes formed by removable plastic sleeves.
- F. Provide temporary support of sleeves during placement of concrete and other work around sleeves. Provide temporary closure to prevent concrete and other materials from entering sleeves.
- G. Install sheet-metal sleeves at interior partitions and ceilings other than suspended ceilings for pipe diameter including insulation (if any) of 6 inches and larger.
- H. Install iron-pipe sleeves at exterior penetrations, both above and below grade and for slab on grade penetrations.
- I. Install steel-pipe sleeves at interior partitions for pipe diameter including insulation (if any) of less than 6 inches.
- J. Seal voids between outside of sleeve and construction with nonshrink, nonmetallic grout.
- K. Sleeves Seals:
 - 1. Provide sleeve seals for core drilled holes and holes made using removable plastic sleeves.
 - 2. Provide mechanical sleeve seals for exterior wall, floor, and slab on grade applications. Install in accordance with manufacturer's recommendations for a water tight seal. Except for slab on grade and below grade wall penetrations, elastomeric joint sealants may be used in lieu of mechanical sleeve seals.
 - 3. Provide fire mechanical sleeves seals for penetrations of rated walls, slabs, floors, and ceilings. Fire protection sealants complying with all authorities having jurisdiction may be used in lieu of mechanical type seals.
 - 4. Sleeve seals are not required in non-rated interior partitions and ceilings.

3.06. CLEANING, FLUSHING, INSPECTION:

- A. Clean exterior surfaces of installed piping systems and prepare for application of coating and painting (if any). Flush out piping systems with clean water before proceeding with required tests. Inspect each length for completion, supports, and accessories.

3.07. TESTING:

- A. Test all piping systems as hereinafter specified and advise the Engineer, Contractor and owner 5 days in advance for witnessing the testing. Furnish to the Engineer copies of the test reports signed by the Contractor.
- B. Piping located underground shall be tested and inspected by the governing agency before backfilling.
- C. Equipment and personnel required for tests shall be furnished without additional cost. Testing equipment shall be as required for particular test, with all equipment and gauges accurate and in good working order.
- D. Equipment subject to damage at given test pressure shall be removed from line before pressure is applied. Use proper plugs or caps.
- E. Repair piping system sections which fail the required test, by disassembly and re-installation, using new materials. Do not use chemicals, stop-leak, mastics, or other temporary repair methods. Retest the system.
- F. Drain test water after testing and repair work has been completed.
- G. See specific piping system sections for test pressure, duration and medium.
- H. Comply with ANSI Standard B31.1.

END OF SECTION 23 0060

SECTION 230075

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

- A. This Section includes the following mechanical identification applications:
 - 1. Equipment identification.
 - 2. Pipe identification.
 - 3. Valve tags.
 - 4. Valve schedule.
 - 5. Duct identification.

1.02 SUBMITTALS

- A. Product Data: For each type of product proposed.
- B. Product Schedule: Provide schedule indicating each type of identification material to be used for equipment, piping, and ductwork. Indicate colors to be used.
- C. Valve and Steam Trap Schedule: Submit a valve and steam trap schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Provide three (3) copies. Mark valves which are intended for emergency shut-off, normally open, normally closed, and similar special uses by special flag in the margin of the schedule. Include the following for each valve:
 - 1. Valve identification number.
 - 2. System.
 - 3. Purpose.
 - 4. Location.
 - 5. Type.
 - 6. Size.
 - 7. Manufacturer.

1.03 QUALITY ASSURANCE

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems", for letter size, length of color field, for colors not included in the schedule herein, and for viewing angles of identification devices for piping.

1.04 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting

of surfaces where devices are to be applied.

- B. Coordinate installation of identifying devices with location of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.01 EQUIPMENT IDENTIFICATION

- A. Engraved Plastic Laminate Identification Signs
 - 1. General: Provide engraving stock melamine plastic laminate in the sizes and thicknesses indicated, with engraver's standard letter style, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where using adhesive mounting.
 - 2. Thickness: 1/16" for units up to 20 inches square or 8" length; 1/8" for larger units.
 - 3. Fasteners: Self tapping stainless steel screws except use contact-type, permanent adhesive where screws cannot or should not penetrate the substrate. Where sign cannot be attached directly to device or equipment, attach with brass chain.
 - 4. Letter sizes: Minimum 1/4 inch for names of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionally larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

2.02 PIPE IDENTIFICATION

- A. All above grade piping shall be identified with pipe markers with colors as indicated. Identification shall have proper legend and meet OSHA specifications. Comply with ASME A13.1, unless otherwise noted.
- B. For piping where diameter including insulation is less than 8", pipe markers shall be plastic, pre-tensioned, semi-rigid type that encircles entire pipe without the use of adhesives. Tape and sticker types are unacceptable.
- C. For piping where diameter including insulation is 8" or greater, pipe markers shall be plastic, full-band, semi-rigid type strapped to pipe using manufacturer's standard stainless steel bands.
- D. Underground line markers: Manufacturer's standard permanent, bright colored, continuous printed, plastic tape intended for direct burial service, not less than 6" wide and 4 mils thick. Provide tape with printing which most accurately indicates the type of buried pipe.
- E. Manufacturer: Pipe markers as manufactured by Seton, Brady, Brimar, or EMED are acceptable.
- F. Identification Schedule:

- | | <u>Piping System</u> | <u>Legend</u> | <u>Band/Text Color</u> |
|----|--|------------------------|------------------------|
| 1. | <u>Chilled Water System</u> | | |
| | Chilled Water Supply | Chilled Water Supply | Green/White |
| | Chilled Water Return | Chilled Water Return | Green/White |
| | Condensate Drain | Drain | Green/White |
| | System Make-up Water | Make-Up Water | Green/White |
| 2. | <u>Hot Water System</u> | | |
| | Hot Water Supply | Hot Water Supply | Green/White |
| | Hot Water Return | Hot Water Return | Green/White |
| | System Make-up Water | Make-Up Water | Green/White |
| 3. | <u>Cooling Tower System</u> | | |
| | Condenser Water Supply | Condenser Water Supply | Green/White |
| | Condenser Water Return | Condenser Water Return | Green/White |
| | Cooling Tower Feedwater | Make-Up Water | Green/White |
| | Cooling Tower Drain | Drain | Green/White |
| 4. | <u>Steam Piping System</u> | | |
| | Low Pressure Steam | Low Pressure Steam | Green/White |
| | High Pressure Steam | High Pressure Steam | Green/White |
| | Condensate Return | Condensate Return | Green /White |
| | Pumped Condensate | Cond. Pump Discharge | Green /White |
| 5. | Arrows and lettering shall be black. Arrows shall point in the direction of flow. Locate downstream of pipe legend. | | |
| 6. | Arrows shall be of same color as bands and shall point in direction of flow. Locate downstream of pipe legend. | | |
| 7. | Valve Identification: Provide brass tags for all valves and steam traps with legend describing function of each valve and trap. Tag shall also indicate normally open or normally closed, where position is noted on the drawings. | | |
| G. | Valve Tags: Brass tags shall be a minimum of 2" diameter or 3-1/2" oval, to accommodate 1" high numbers. Tag shall be equipped with a 3/16" X 6" long brass chain. | | |

2.03 DUCT IDENTIFICATION

- A. Engraved Plastic Laminate Identification Signs
- General: Provide engraving stock melamine plastic laminate in the sizes and thicknesses indicated, with engraver's standard letter style, colored black background with white letters except as otherwise indicated.
 - Thickness: 1/16" for units up to 20 inches square or 8" length; 1/8" for larger units.
 - Fasteners: Contact-type, permanent adhesive.
 - Letter sizes: Minimum 1/4 inch for names of units if viewing distance is less than

24 inches, ½ inch for viewing distances up to 72 inches, and proportionally larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

- B. Stencils: As specified and indicated herein.

2.04 STENCILS:

- A. Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4" for ducts; and minimum letter height of ¾" for equipment and access door signs.
- B. Use alkyd paint.
- C. Use stencils only as directed herein.

PART 3 - EXECUTION

3.01 EQUIPMENT IDENTIFICATION

- A. Provide permanent, factory, operational data, nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Where manufacturer's nameplate is not stamped or engraved, provide additional heavy gauge, aluminum or brass, stamped or engraved nameplate. Do not remove manufacturer's nameplates. When manufacturer's nameplates are to be covered by insulation or other material, provide a separate nameplate for mounting on the exterior of the covering.
- B. In addition to factory nameplate, provide an engraved plastic laminate (stenciled) identification sign for each major item of mechanical equipment and each operational device. Provide identification signs for the following general categories of equipment.
 - 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets or steam relief valves.
 - 2. Chillers, cooling towers, condensing units, compressors, pumps, and similar motor-driven units.
 - 3. Heat exchangers, coils, and similar equipment.
 - 4. Fans and blowers.
 - 5. Packaged and central-station type air units.
 - 6. Tanks and pressure vessels.
 - 7. Strainers, filters, humidifiers, water treatment systems, and similar equipment.
 - 8. Control panels.
 - 9. Fuel burning units, such as boilers, furnaces, and heaters.
 - 10. Fire department hose valves and hose stations.

- C. Provide engraved sign at each access door, indicating equipment or device to be accessed.
- D. Coordinate names, abbreviations, and other designations used in equipment identification with corresponding designations shown, specified, scheduled, or as designated by the Owner's representative. Provide numbers, lettering, and wording as indicated or as directed by the Owner's representative. Owner shall set priority for lettering and graphics. Where multiple systems of the same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, AHU-1H, Standpipe G14).

3.02 PIPE IDENTIFICATION

- A. Provide 1" thick molded fiberglass insulation with jacket under each plastic pipe marker to be installed on uninsulated pipes where fluid temperatures will be 125°F or greater. Insulation shall extend 4" beyond edges of marker.
- B. Valve tags and steam traps shall be numbered as indicated on the valve listing provided to the Owner.
- C. As a minimum, identification shall be applied to piping at the following locations:
 - 1. Adjacent to each valve.
 - 2. At each branch and riser take-off.
 - 3. At each pipe passage through wall, floor, and ceiling construction.
 - 4. At each pipe passage to underground.
 - 5. At not more than forty feet spacing on straight pipe runs.
- D. Place identification so it can be easily read. Arrows shall be applied to indicate direction of flow.
- E. Underground Piping: During back-filling of each exterior underground piping system, install plastic line marker, located directly over buried line no deeper than 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install a single line marker.

3.03 DUCTWORK IDENTIFICATION

- A. Identify ductwork using stenciled signs. Letter color for stenciled signs shall be either white or black. Provide the color that produces the most contrast with the covering being stenciled. Indicate direction of flow, air handling unit or fan, air terminal box, and duct service (such as supply, return, and exhaust).

END OF SECTION

SECTION 23 0086

PIPING INSULATION

PART 1 - GENERAL

1.01. SUMMARY

- A. Perform all Work required to provide and install piping insulation, jackets, and accessories indicated by the Contract Documents with supplementary items necessary for proper installation.
- B. Insulation of Underground Piping is specified elsewhere and not work of this Section.

1.02. REFERENCE STANDARDS

- C. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- D. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- E. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:
 - 1. ASTM B209 - Aluminum and Aluminum-Alloy Sheet and Plate.
 - 2. ASTM C168 - Terminology Relating to Thermal Insulation Materials.
 - 3. ASTM C177 - Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded- Hot-Plate Apparatus.
 - 4. ASTM C195 - Mineral Fiber Thermal Insulating Cement.
 - 5. ASTM C335 - Steady-State Heat Transfer Properties of Horizontal Pipe Insulation.
 - 6. ASTM C449 - Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
 - 7. ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
 - 8. ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
 - 9. ASTM C547 - Mineral Fiber Pipe Insulation.
 - 10. ASTM C552 - Cellular Glass Thermal Insulation.

11. ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
13. ASTM C591 - Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C450 - Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
15. ASTM C610 - Molded Expanded Perlite Block and Pipe Thermal Insulation.
16. ASTM C921 - Jackets for Thermal Insulation.
17. ASTM C1126 - Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
18. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
19. ASTM D1667 - Flexible Cellular Materials – Poly (Vinyl Chloride) Foam (Closed-Cell).
20. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
21. ASTM C795 - Insulation For Use Over Austenitic Steel.
22. ASTM E84 - Surface Burning Characteristics of Building Materials.
23. ASTM E96 - Water Vapor Transmission of Materials.
24. NFPA 255 - Surface Burning Characteristics of Building Materials.
25. UL 723 - Surface Burning Characteristics of Building Materials.
26. ASTM D5590 - Standard Test Method for Determining the Resistance of Paint Films and Related Coatings to Fungal Defacement by Accelerated Four-Week Agar Plate Assay

1.03. DEFINITIONS

- F. Concealed: Areas that cannot be seen by the building occupants.
- G. Interior Exposed: Areas that are exposed to view by the building occupants, including underneath countertops, inside cabinets and closets, and all equipment rooms.
- H. Interior: Areas inside the building exterior envelope that are not exposed to the outdoors.
- I. Exterior: Areas outside the building exterior envelope that are exposed to the outdoors, including building crawl spaces and loading dock areas.

- J. Unconditioned Space: Interior space that is not temperature-controlled by cooling and/or heating system. Includes attics, chases, unconditioned living spaces and non-conditioned equipment rooms.

1.04. QUALITY ASSURANCE

- K. All piping requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.
- L. All insulation, jacket, adhesives, mastics, sealers, and accessories utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement.
 - 1. Certificates to this effect shall be submitted along with submittal data.
 - 2. No material shall be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.
- M. Application Company Qualifications: Company performing the Work of this Section shall have minimum three (3) years experience specializing in the trade.
- N. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.
- O. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, damaged or water-soaked Work will not be acceptable.
- P. Stainless Steel: Insulation applied on stainless steel shall meet requirements of ASTM C795 and NRC 1.36. These requirements are for prevention of external stress Corrosion Cracking (ESCC) for austenitic stainless steel.

1.05. SUBMITTALS

- Q. Prepare a schedule of piping insulation showing systems insulated. For each system, show insulation type, thickness, temperature rating, and special conditions where applicable.
- R. Submit product data for each piping system. Product data shall include but not be limited to the following:
 - 1. Manufacturer's name
 - 2. Insulation material and thickness

3. Jacket
 4. Adhesives
 5. Fastening methods
 6. Fitting materials
 7. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
 8. Insulation installation details (manufacturer's installation instructions/details, Contractor's installation details, MICA plates where applicable)
 9. Other appropriate data
- S. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.
- T. Operation and Maintenance Data: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.06. DELIVERY, STORAGE AND HANDLING

- U. Deliver materials to the Project Site in original factory packaging, labeled with manufacturer's identification including product thermal ratings and thickness.
- V. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.
- W. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

PART 2 - PRODUCTS

2.01. GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02. MANUFACTURERS

- B. Insulation:
1. Owens-Corning
 2. Certainteed Corporation

3. Johns Manville Corporation
4. Knauf Corporation
5. Armstrong/Armacell (Armaflex)
6. RBX Industries/Rubatex
7. FOAMGLAS (Cellular Glass) by Pittsburgh Corning

C. Jackets:

1. Childers Products Company
2. PABCO
3. RPR Products, Inc.
4. John Mansfield Speedline
5. Foamglas

D. Coatings, Sealants, and Adhesives:

1. Foster
2. Childers

2.03. INSULATION MATERIALS

- E. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- F. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- G. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- H. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- I. Piping Insulation Type P1: Glass-Fiber, Preformed Pipe Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A with factory applied ASJ-SSL vapor barrier jacket with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I. Provide one of the following:
 1. Owens Corning; Evolution Fiberglas Pipe Insulation.

2. Johns Manville; Micro-Lok Pipe Insulation.
 3. Knauf; Earthwool 1000 degree Pipe Insulation.
- J. Piping Insulation Type P2: Flexible Elastomeric Pipe Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials. Provide one of the following:
1. Armacell LLC; AP Armaflex
 2. Aeroflex USA Inc; Aerocel
 3. K-Flex USA; Insul-Lock, Insul-Tube, and K-FLEX LS.
- K. Piping Insulation Type P3: Handicap Lavatory and Sink Piping Insulation Kit:
1. Handicap lavatory and sink drain piping, P-trap, cold and hot water assemblies and valves shall be insulated with fully molded insulation kit specifically designed for handicap lavatories and sinks. ADA conforming.
 2. Material shall be 3/16" thick molded closed cell vinyl with nylon fasteners, white finish and be self-extinguishing per ASTM D635, with K value of 1.17 BTU/in./hr./sq. ft./deg. F.
- L. Piping Insulation Type P4: Preformed Cellular Glass: Comply with ASTM C 585, ASTM C 450. Provide one of the following:
1. Pittsburgh Corning; Foamglas

2.04. FIELD-APPLIED FABRIC-REINFORCING MESH

- M. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe. Provide one of the following:
1. Foster Brand, Specialty Construction Brands, Inc; Mast-A-Fab.
 2. Vimasco Corporation; Elastafab 894.

2.05. FIELD-APPLIED JACKETS

- N. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- O. Piping Jacket Type J1: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; 40 mil thickness, roll stock ready for shop or field cutting and forming. Provide factory-fabricated fitting covers to match jacket. Provide one of the following
1. Johns Manville; Zeston.

2. Proto Corporation; LoSmoke
- P. Piping Jacket Type J2: Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14. Provide factory-fabricated fitting covers or field fabricate covers only if factory-fabricated fitting covers are not available. Provide one of the following:
1. Provide Childers Brand Metal Jacketing Systems.
 2. Provide shop fabricated smooth aluminum jacket 0.016".

2.06. TAPES

- Q. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- R. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.

2.07. INSULATION INSERTS

- S. Provide insert between support shield and piping on piping 1 1/2" diameter or larger. Inserts shall be factory fabricated of heavy density insulating material suitable for temperature. Insulation inserts shall not be less than the following lengths:
1. 1 1/2" to 2 1/2" pipe size 10" long

2. 3" to 6" pipe size 12" long
3. 8" to 10" pipe size 16" long
4. 12" and over 22" long

2.08. PIPE INSULATION ACCESSORIES

- T. Vapor Retarder Lap Adhesive: Compatible with insulation.
- U. Covering Adhesive Mastic: Compatible with insulation.
- V. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12-inch centers.
- W. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- X. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- Y. Adhesives: Compatible with insulation.
- Z. Banding:
 1. Aluminum bands, 3/4" x 0.02 inches
 2. Stainless Steel, 304, 3/4" by 0.02 inches

PART 3 - EXECUTION

3.01. PREPARATION

- A. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping shall be completely dry at the time of application. Insulating piping where condensate is occurring is unacceptable. Wet insulation is unacceptable and shall be removed and replaced before acceptance by the Owner.
- B. Coordinate insulation installation with trade installing heat trace. Comply with requirements for heat tracing that apply to insulation.
- C. Verify that piping has been tested for leakage before applying insulation.

3.02. GENERAL INSTALLATION REQUIREMENTS

- D. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards, and shall conform to codes and ordinances of authorities having jurisdiction.

- E. Installation of insulation and jacket materials shall be in accordance with manufacturer's published instructions.
- F. Handle and install materials in accordance with manufacturer's instructions in the absence of specific instructions herein.
- G. On exposed piping, locate insulation cover seams with the ridge of the lap joint is directed down.
- H. Provide dams in insulation at intervals not to exceed 20 feet on cold piping systems to prevent migration of condensation or fluid leaks. Indicate visually where the dams are located for maintenance personnel to identify and also provide dams at butt joints of insulation at fittings, flanges, valves, and hangers.
- I. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- J. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- K. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- L. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- M. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- N. Keep insulation materials dry during application and finishing.
- O. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- P. Install insulation with least number of joints practical.
- Q. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- R. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- S. Install insulation with factory-applied jackets as follows:
1. Draw jacket tight and smooth.
 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- T. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- U. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- V. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere and seal patches similar to butt joints.
- W. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.

5. Handholes.
6. Cleanouts.

3.03. PENETRATIONS

- X. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- Y. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- Z. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- AA. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- BB. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions. Comply with requirements in Section 15050 for firestopping and fire-resistive joint sealers.
- CC. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 15050."

3.04. GENERAL PIPE INSULATION INSTALLATION

DD. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

EE. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket where concealed unions, check valve or piping specialties are insulated. Provide descriptive label at device under the insulation. For example at each union stencil with the word "union." Match size and color of pipe labels.
- FF. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- GG. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.05. INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

HH. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

II. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

JJ. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

KK. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.06. INSTALLATION OF GLASS-FIBER PREFORMED PIPE INSULATION

LL. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on below-ambient surfaces, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

MM. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

NN. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with bands.

OO. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.07. FIELD-APPLIED JACKET INSTALLATION

- PP. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- QQ. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.08. FINISHES

- RR. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- SS. Do not field paint aluminum jackets.

3.09. PIPING SYSTEMS INSULATION SCHEDULE

PIPING SYSTEMS INSULATION SCHEDULE					
Service	Insulation Type	Location	Jacket Type	Pipe Size	Insulation Thickness by Pipe Size
COLD PIPING					
Chilled Water	P1	Interior Concealed	--	3.0" and smaller	1.0"
				4.0" and larger	1.5"
Cooling Tower Condenser Water	P1	Interior Exposed	J1	3.0" and smaller	1.0"
		Exposed		4.0" and larger	1.5"
		Unconditioned Space	--	3.0" and smaller	1.0"
				4.0" and larger	1.5"
		Unconditioned Space	--	3.0" and smaller	1.5"
				4.0" and larger	2.0"
		Exterior	J2	3.0" and smaller	1.5"

				4.0" and larger	2.0"
		Equipment Rooms	J1	3.0" and smaller	1.5"
		below 7.0" above floor		4.0" and larger	2.0"
Make-Up Water		Interior	J1	0.5" and smaller	0.5"
		Exposed		1.0" through 2.0"	1.0"
				2.5" and larger	1.5"
		Unconditioned Space	--	0.5" and smaller	0.5"
				1.0" through 2.0"	1.0"
				2.5" and larger	1.5"
		Unconditioned Space	--	0.5" and smaller	0.5"
				1.0" through 2.0"	1.0"
				2.5" and larger	1.5"
		Exterior	J2	0.5" and smaller	1.0"
				1.0" through 2.0"	1.5"
				2.5" and larger	2.0"
		Equipment Rooms below 7.0" above floor	J1	0.5" and smaller	0.5"
				1.0" through 2.0"	1.0"
				2.5" and larger	1.5"
Refrigerant Suction	P2	Interior Concealed	--	3.0" and smaller	0.75"
				4.0" and larger	1.0"
		Interior Exposed	J1	3.0" and smaller	0.75"

				4.0" and larger	1.0"
		Unconditioned Space	--	3.0" and smaller	0.75"
				4.0" and larger	1.0"
		Exterior	J2	3.0" and smaller	0.75"
				4.0" and larger	1.0"
		Equipment Rooms: below 7.0" above floor	J1	3.0" and smaller	0.75"
				4.0" and larger	1.0"
Cooling Coil Condensate Drain Branch Lines	P2	Interior Concealed	--	3.0" and smaller	0.5"
				4.0" and larger	0.75"
Cooling Coil Condensate Drain Main Lines		Interior Exposed	J1	3.0" and smaller	0.5"
				4.0" and larger	0.75"
Sewer/Storm Drain Lines Carrying Cooling Coil Condensate		Unconditioned Space	--	3.0" and smaller	0.5"
				4.0" and larger	0.75"
		Exterior	J2	3.0" and smaller	0.5"
HOT PIPING					
Heating Water	P1	Interior Concealed	--	3.0" and smaller	1.0"
				4.0" and larger	1.5"
		Interior Exposed	J1	3.0" and smaller	1.5"
				4.0" and larger	2.0"
		Unconditioned Space	--	3.0" and smaller	1.5"
				4.0" and larger	2.0"
		Exterior	J2	3.0" and smaller	1.5"
				4.0" and larger	2.0"

		Equipment Rooms below 7.0" above floor	J1	3.0" and smaller	1.5"
				4.0" and larger	2.0"
Refrigerant Hot Gas	P2	Interior Concealed	--	3.0" and smaller	0.75"
				4.0" and larger	1.0"
		Interior Exposed		3.0" and smaller	0.75"
				4.0" and larger	1.0"
		Unconditioned Space	--	3.0" and smaller	0.75"
				4.0" and larger	1.0"
		Exterior	J2	3.0" and smaller	0.75"
				4.0" and larger	1.0"
		Equipment Rooms below 7.0" above floor		3.0" and smaller	0.75"
				4.0" and larger	1.0"

END OF SECTION 23 0086

SECTION 23 0090 - SUPPORTS, HANGERS AND ANCHORS

PART 1 GENERAL

1.01. WORK INCLUDED

- A. Inserts, Anchors, and Upper Attachments
- B. Pipe Hangers, Rods, Supports, and Accessories
- C. Fabricated Steel Support

1.02. QUALITY ASSURANCE

- A. Design of pipe supporting elements shall be in accordance with ANSI B31.1
- B. Fabrication and installation of pipe hangers and supports shall be in accordance with the following Manufacturers Standardization Society (MSS) Standards:
 - 1. SP-58 Pipe Hangers and Supports: Materials, Design and Manufacture.
 - 2. SP-69 Pipe Hangers and Supports: Selection and Application.
 - 3. SP-89 Pipe Hangers and Supports: Fabrication and Installation Practices.
- C. Steel angles, channels and plate shall be in accordance with ASTM A36, red primed or hot dipped galvanized for interior applications and hot galvanized for exterior applications.
- D. Bolts, including nuts and washers, used for fabricating steel members shall be in accordance with ASTM A325 and shall be stainless steel or plated for corrosion protection. Plain steel components are unacceptable.
- E. Welding of steel members shall be in accordance with AWS D1.1.
- F. Steel supports for ducts, pipe anchors, pipe guides, and piping supported from below shall be fabricated in accordance with AISC Specification for the Design, Fabrication and Erection of Structural Steel for buildings. If required, the Contractor shall include the cost of the services of a structural engineer to design or review the system.

1.03. APPLICABLE PUBLICATIONS

- A. Applicable sections of the publications listed below form a part of this Section. The publications are referenced by the basic designation only.
 - 1. American Institute of Steel Construction (AISC)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society for Testing and Materials (ASTM)
 - 4. American Welding Society (AWS)
 - 5. The Manufacturer's Standardization Society of the Valve and Fittings Industry

(MSS)

6. National Fire Protection Agency (NFPA)

7. Sheet Metal and Air Conditioning Contractor's National Association, Inc.
(SMACNA)

1.04. SUBMITTALS

- A. Submit schedule indicating type of hanger to be used by system and pipe size. Include rod size for each hanger size.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Provide shop drawings for fabricated steel supports.

PART 2 PRODUCTS

2.01. ACCEPTABLE MANUFACTURERS

- A. Inserts, Anchors, and Upper Attachments:
 - 1. Anvil International, Inc.
 - 2. Carpenter Paterson, Inc.
 - 3. Cooper B-Line, Inc.
 - 4. Elcen Metal Products
 - 5. Hilti
 - 6. Unistrut
 - 7. ITW Red Head
- B. Pipe Hangers, Rods, Supports and Accessories:
 - 1. Anvil International, Inc.
 - 2. Carpenter Paterson, Inc.
 - 3. Cooper B-Line, Inc.
 - 4. Elcen Metal Products
 - 5. Hilti
 - 6. Unistrut
- C. Fabricated Steel Support: As indicated on Drawings.

2.02. DESIGN REQUIREMENTS

- A. Supports capable of supporting the pipe for all service and testing conditions. Provide 4-to-1 safety factor.

- B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.
- C. Design supports and hangers to allow for proper pitch of pipes.
- D. For chemical and waste piping, design, materials of construction, and installation of pipe hangers, supports, guides, restraints, and anchors:
 - 1. ASME B31.3.
 - 2. MSS SP-58 and MSS SP-69.
 - 3. Except where modified by this Specification.
- E. For steam and hot and cold water piping, design, materials of construction and installation pipe hangers, supports, guides, restraints and anchors:
 - 1. ASME B31.1
 - 2. MSS SP-58 and MSS SP-69.
- F. Check all physical clearances between piping, support system, and structure. Provide for vertical adjustment after erection.
- G. Support vertical pipe runs in pipe chases at base of riser. Support pipes for lateral movement with clamps or brackets.
- H. Place hangers on outside of pipe insulation. Use a pipe covering protection saddle for insulated pipe at support point.
- I. Fabricated Steel Supports: As detailed on the drawings.

2.03. INSERTS AND ANCHORS

- A. Inserts: MSS Type 18; malleable iron body and nut, galvanized finish, opening in top of insert for reinforcing rod, lateral adjustable.
- B. Anchors: Steel shell and expander plug, snap off end fastener

2.04. HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Select size of hangers and supports to exactly fit pipe size for bare piping, and around piping insulation with saddle or shield for insulated piping.
- B. For suspension of non-insulated or insulated stationary pipe lines: Adjustable steel clevises, MSS Type I.
- C. For suspension of non-insulated stationary pipe lines: Adjustable band hangers, MSS Type 7 or 9; or split pipe rings, MSS Type II.
- D. For support of piping where horizontal movement due to expansion and contraction may occur, and where a low coefficient of friction is desired: Pipe slides and slide plates, MSS Type 35, including guided plate mounted on a concrete pedestal or structural steel support.

- E. For support from floor stanchion, using floor flange to secure stanchion to floor: Adjustable pipe stanchion saddles, MSS Type 37 or 38, including steel pipe base support and cast-iron floor flange.
- F. For suspension of pipe from two (2) rods where longitudinal movement due to expansion and contraction may occur: Adjustable roller hangers, MSS Type 43.
- G. For suspension of pipe from a single rod where horizontal movement due to expansion and contraction may occur: Adjustable roller hangers, MSS Type 43.
- H. For support of pipe from a single rod where vertical adjustment is not necessary: Pipe roll stands, MSS Type 45.
- I. For support of pipe where small horizontal movement due to expansion and contraction may occur, but vertical adjustment is not necessary: Pipe rolls and plates, MSS Type 45.
- J. For support of pipe lines where vertical and lateral adjustment during installation may be required in addition to provision for expansion and contraction: Adjustment pipe rolls stands, MSS Type 46.

2.05. VERTICAL PIPING CLAMPS

- A. Select size of vertical piping clamps to exactly fit size of bare pipe.
- B. For support and steadying of pipe risers: Two-bolt riser clamps, MSS Type 8 or 42.

2.06. HANGER ROD ATTACHMENTS

- A. Select size of hanger rod attachments to suit hanger rods.
- B. For adjustment up to six (6) inches for heavy loads: Steel turnbuckles, MSS Type 13.
- C. For use on high temperature piping installations: Steel clevises, MSS Type 14.
- D. For use with split pipe rings, MSS Type II: Swivel turnbuckles, MSS Type 15.
- E. For attaching hanger rod to various types of building attachments: Malleable iron sockets, MSS Type 16 or 17.
- F. Rods:
 - 1. Size 3/8" and up: All thread steel rod electro galvanized. Sizing for pipe or equipment support as follows:

Copper Tube, Plastic		Steel, Cast Iron	
Pipe Size (Copper, Plastic)		Pipe Size (Steel, Cast Iron)	Rod Size
1/4" to 2"		1/4" to 2"	3/8"
2-1/2" to 4"		2-1/2" to 3"	1/2"
6"		4"	5/8"
8" to 12"		6"	3/4"
			Max. Equip. Load
			730 lbs.
			1,350 lbs.
			2,160 lbs.
			3,230 lbs.

14"	8" to 12"	7/8"	4,480 lbs.
16"	14" to 16"	1"	5,900 lbs.
18" to 20"	18" to 20"	1-1/4"	9,500 lbs.
22" to 42"	22" to 42"	1-1/2"	13,800 lbs.

2. Rods may be reduced one size for double rod hangers with 3/8" minimum diameter, or when other paragraphs require a minimum of 2 hangers per section, provided the minimum diameter of 3/8" is maintained.

- G. For upper attachment for suspending pipe hangers from concrete: Concrete inserts MSS Type 18.
- H. For attachment to top flange of structural shape: Top beam C-clamps, MSS Type 19.
- I. For attachment to bottom flange of structural shape: Side beam or channel clamps, MSS Type 20 or 27.
- J. For attachment to center of bottom flange of beams: Center beam clamps, MSS Type 21.
- K. For attachment to bottom of beams where heavy loads are encountered and hanger rod sizes are large: Welded attachments, MSS Type 22.
- L. For attachment to structural shapes: C-clamps, MSS Type 23.
- M. For attachment to top of beams when hanger rod is required tangent to edge of flange: Top I-beams clamps, MSS Type 25.
- N. For attachment to bottom of steel I-beams for heavy loads: Steel I-beam/WF-beam clamps with eye nut, MSS Type 28 or 29.
- O. Steel brackets, for indicated loading:
 1. Light duty, 750 pounds, MSS Type 31.
 2. Medium duty, 1,500 pounds, MSS Type 32.
 3. Heavy duty, 3,000 pounds, MSS Type 33.
- P. For use on sides of steel beams: Side beam brackets, MSS Type 34.

2.07. SPRING HANGERS AND SUPPORTS

- A. Select spring hangers and supports to suit pipe size and loading.
- B. For control of piping movement: Restraint control devices, MSS Type 47.
- C. For light loads where vertical movement does not exceed 1-1/4 inch: Springs cushion hangers, MSS Type 48.
- D. For equipping Type 41 roll hanger with springs: Spring cushion roll hangers, MSS Type 49.

- E. For retardation of sway or thermal expansion in piping systems: Spring way braces, MSS Type 50.
- F. For absorbing expansion and contraction of piping system from hanger: Variable spring hangers, MSS Type 51; preset to indicated load and limit variability factor to 25%.
- G. For absorbing expansion and contraction of piping system from base support: Variable spring base supports, MSS Type 52; preset to indicated load and limit variability factor to 25%; include flange.
- H. For absorbing expansion and contraction of piping system from trapeze support: Variable spring trapeze hangers, MSS Type 53; preset to indicated load and limit variability factor to 25%.
- I. Constant supports: Provide one of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.
 - 1. Horizontal Type: MSS Type 54.
 - 2. Vertical Type: MSS Type 55.
 - 3. Trapeze Type: MSS Type 56.

2.08. SUPPLEMENTARY SUPPORTS

- A. Where support spacing is more frequent than distance between structural members, provide steel angles, channels or beams sized to provide a deflection of less than $1/240$ of span when fully loaded, to transfer pipe support loads to structural members.
- B. Where deflection of center of trapeze support exceeds $1/240$ of distance between hanger rods, provide additional hanger rods.
- C. Where multiple risers are supported within shafts, provide steel angles, channels or beams, sized to provide a deflection of less than $1/240$ of span when fully loaded, to transfer loads to the concrete floor slab. Anchor supplemental supports to the slab, and provide resilient element where required by other Sections of this Division.

2.09. ACCESSORIES

- A. Protective Shields, MSS Type 40: Carbon steel, galvanized minimum of 12" length sized for required insulation.
- B. Protective Saddles, MSS Type 39: Carbon steel plate, minimum of 12" length, sized for required insulation.
- C. Steel Turnbuckle, MSS Type 13: Forges steel, galvanized finish with locknuts. Rated at a minimum of 730 lbs. at $3/8$ " size.
- D. Steel Clevis, MSS Type 14: Forged steel, galvanized finish with steel pin and cotter pin. Rated for a minimum of 730 lbs. at $3/8$ " size.
- E. Weldless Eye Nut, MSS Type 17: Forges steel, galvanized finish. Rated for a minimum

of 730 lbs. at 3/8" size.

2.10. PIPE INSULATION HANGER SHIELDS

- A. Where hangers are placed outside the jackets of pipe insulation, provide shields equal to "Thermal Hanger Shields" as manufactured by Pipe Shields, Inc. or equivalent by Elcen Metal Products Company.
- B. Shields shall consist of a 360-degree insert of high-density, 100 psi, waterproof calcium silicate, encased in a 360-degree galvanized sheet steel shield. Insert shall be same thickness as adjoining pipe insulation, and shall extend 1 inch beyond sheet metal shield in each direction on cold lines. Shield lengths and minimum sheet metal gauges shall be as directed below:

PIPE SIZE	SHIELD LENGTH	MINIMUM GAUGE
1/2" to 1-1/2"	4"	26
2" to 6"	6"	20
8" to 10"	9"	16
12" to 18"	12"	16
20" & Larger	18"	16

- C. Shields shall be Model CS-CW, except for pipe roller applications: then provide Model CSX-CW.
- D. At the Contractor's option, shop-fabricated galvanized metal shields may be provided based on approved shop drawings. Length and gauge of sheet metal shall be as specified above.
- E. For all insulated piping 4" and larger, provide insulation insert at a minimum of 12" long. Insert shall extend a minimum of one inch beyond shield. Insulation inserts shall be minimum 12" long section of foam glass insulation.

2.11. METAL FRAMING: Provide products compliant with NEMA ML-1.

2.12. STEEL PLATES, SHAPES AND BARS: Provide products compliant with ANSI/ASTM A-36.

2.13. PIPE GUIDES: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base, with a two-section guiding spider bolted tight to pipe or as shown on Drawings. Size guides and spiders to clear pipe, cylinder and insulation, if any. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 EXECUTION

3.01. GENERAL REQUIREMENTS

- A. Where applicable, install in accordance with the manufacturer's written installation

instructions.

- B. Where supports are in contact with copper pipe, provide copper plated support.
- C. Where supports are in contact with glass, aluminum or brass pipe, provide plastic coating on supports.
- D. Interior hangers, supports, including attachments, that are plain steel shall be primed and painted.
- E. Hangers and supports, including attachments, exposed to weather or located in utility tunnels or accessible utility trenches or subject to spillage shall be hot dip galvanized after fabrication.
- F. Fabricated steel supports exposed to weather or located in utility tunnels and accessible utility trenches or subject to spillage shall be primed and painted. Cut, welded, drilled or otherwise damaged surfaces of coating shall be repaired.

3.02. PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including but not limited to proper placement of inserts, anchors and other building structural attachments.

3.03. INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure in compliance with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together in trapeze-type hangers where possible. Install supports with maximum spacing as specified in this Section. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for small diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire protection water piping independently of other piping
- D. The location of hangers and supports shall be coordinated with the structural work to ensure that the structural members will support the intended load.
- E. Provide hex head nut on rod at top and bottom of clevis hanger yoke, and at each rod connection to intermediate and upper attachment. Rod nuts shall be securely locked in place.
- F. Hanger rods shall be subject to tensile loading only. Where lateral or axial movement is anticipated, use suitable linkage in hanger rod to permit swing.
- G. Hangers shall be fabricated to permit adequate adjustment after erection while still

supporting the load. Turnbuckles shall be provided where required for vertical adjustment of the piping.

- H. Supports for vertical piping shall be located at each floor or at intervals of not more than 15 feet and at intervals of not more than 8 feet from end of risers. Where supports are provided on intermediate floors spaced 15 feet or less between floors, no additional supports are required other than those specified for end of risers.
- I. A hanger or support shall be provided adjacent to each piece of equipment to ensure that none of the pipe weight is supported from the equipment.
- J. Provide protective shields on all piping required to be insulated.
- K. Provide protective saddles sized to match insulation thickness on all hot piping required to be insulated. Fill void between saddle and pipe with insulation as specified.
- L. Provide turnbuckles on all hangers that require leveling or aligning.
- M. Provide steel clevis where detailed and/or required.
- N. Provide weldless eye nuts on hanger terminations where disassembly or swing may be required. Use in combination with steel clevis.
- O. Supports
 - 1. Provide additional supports at:
 - a. Changes in direction.
 - b. Branch piping and runouts over 5 feet.
 - c. Concentrated loads due to valves, strainers and similar items.
 - d. At valves 4 inches and larger in horizontal piping.
 - e. Support piping on each side of valve.
 - f. Brace hubless piping to prevent horizontal and vertical movement.
 - g. Where number of grooved couplings exceeds 3 between supports or provide continuous steel between supports.
 - 2. Sanitary waste and vent, roof drains per UPC Section 316: Vertical supports are not required within 2.5 feet of wall penetrations for pipes 8 inches in diameter and smaller, and not more than 3 feet for 10 inches and larger.
 - 3. Other piping support spacing shall be as scheduled on Drawing or as required by referenced standard.

3.04. HANGER SPACING

- A. The maximum spacing between pipe supports for straight runs shall be in accordance with the following chart. If any deviation from the table exists within the manufacturer's written installation instruction, whichever spacing reflecting the smaller centerline to centerline dimension shall be used.

MAXIMUM HORIZONTAL PIPE HANGER AND SUPPORT SPACING TABLE

1. Steel Pipe (Schedule 40 & 80):
Up to 1"7 ft. on center
1-1/4" and greater.....10 ft. on center
2. Copper Pipe (Types L, K and M):
Up to 1" size:.....5 ft. on center
1-1/4" to 2-1/2"7 ft. on center
3" and larger.....10 ft. on center
3. Ductile Iron and Cast Iron: Two hangers per section length.
4. Polyvinyl Chloride (PVC):
Up to 1-1/2"3 ft. on center
2" to 4"4 ft. on center
5" to 8"5 ft. on center
10" and larger.....6 ft. on center
5. Sprinkler and Standpipe: Pipe hangers to be as per NFPA-13 and NFPA-14 standards.

- B. Hanger centerline spacing shall be reduced by 50% in areas of concentrated valves and/or fittings, also no more than a maximum distance of 12 inches from valves, fittings and/or couplings, or 24 inches from a change in direction.

3.05. ATTACHMENT TO STRUCTURE

- A. For plain steel devices, prime and paint.
- B. Adjust attachment location for proper alignment and no more than 4 degrees offset from a perpendicular alignment.
- C. If proper alignment cannot be achieved from the existing building structure, provide a trapeze type support sized to handle the design load with a minimum safety factor of 5.

3.06. INSERTS

- A. Contractor shall have inserts at site and dimensional location drawings ready at the beginning of the involved concrete work.
- B. Install inserts by securing to concrete forms and inserting reinforcing rod through the opening provided in the insert in accordance with shop drawings.
- C. Provide necessary supervision while concrete is being poured to correct any misalignment caused by the concrete.

3.07. INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B-31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bards to piping and to

structure. Comply with ANSI B-31, with AWS standards, and with the Details shown on the drawings.

- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required, accommodating both expansion and contraction of piping.
- E. Size anchor shell length to assure a minimum of 1" solid concrete remaining from shell and to concrete face.

3.08. INSTALLATION OF TRAPEZES OR PIPE RACKS

- A. Light/Medium Duty: Assemble from standard manufactured metal framing systems, in accordance with manufacturer's recommendations.
- B. Heavy Duty: Fabricate from structural steel shapes selected for loads required. Weld steel in accordance with AWS standards.

3.09. AUXILIARY STEEL

- A. Furnish all miscellaneous structural members necessary to hang or support ductwork, piping, and mechanical equipment.
- B. Notify Engineer of any adjustment necessary in main structural system for proper support of major equipment.
- C. Fabricated Steel Supports: Steel for supports shall be saw cut, with sharp edges ground smooth. After fabrication, remove all foreign material, including welding slag and spatter, and leave ready for painting.

END OF SECTION

SECTION 23100 - VIBRATION ISOLATION AND SEISMIC RESTRAINT FOR MECHANICAL COMPONENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

The work under this section is subject to the requirements of the Contract Documents, including General and Supplementary Conditions and Division 01 General Requirements.

Specifications throughout all Divisions are directly applicable to this Section, and this Section is directly applicable to them. In the event that this section conflicts with the requirements of other Sections, the more stringent criteria shall apply.

1.2 DESCRIPTION

This section includes requirements for vibration isolation and seismic restraint of nonstructural components in Risk Category I, II, III, & IV structures, including, but not limited to:

1. Mechanical Components: heating, ventilating, and air-conditioning systems; hot/chilled water systems; boiler equipment and components; tanks and vessels, etc.

Work in this section includes the restraint design and/or equipment/product certifications to be submitted for review by the registered design professional.

1.3 DEFINITIONS

Active Equipment: Equipment with dynamic moving or rotating parts or parts that are energized.

Attachments / Anchorage: Means by which nonstructural components or supports for nonstructural components are secured or connected to the seismic-force resisting system of the structure. Such attachments may include anchor bolts, welded connections, mechanical fasteners or other approved attachment devices. Friction attachments do not constitute positive attachments.

Bracing: Struts, braces, cables, anchors or other structural elements providing restraint for nonstructural components to prevent excessive movement.

Certificate of Compliance: A certificate, supplied by the component manufacturer, stating that materials and products meet specified standards and project specific requirements.

Component Importance Factor (I_p): Factor applied to a component that defines the criticality of that component. This factor can be 1.0 or 1.5 in accordance with ASCE 7, Section 13.1.3.

Consequential Damage: Failure of an essential component caused by the failure of a separate essential or non-essential component due to the functional and physical interrelationship of the components, their supports, and their effect on each other.

Designated Seismic System: Those nonstructural components that require design in accordance with Chapter 13 of ASCE 7, for which the Component Importance Factor (I_p) is 1.5 in accordance with Section 13.1.3 of ASCE 7.

Special Seismic Certification: A certificate of compliance, supplied by the manufacturer of Active Designated Seismic Systems, which certifies that the equipment will remain operable during the design seismic event. Components with hazardous contents shall be certified as maintaining containment following the design seismic event.

Structure: The load-bearing building elements designed by the Structural Engineer of Record. Non-load bearing partition walls, unreinforced slabs or other building elements that do not provide direct load transfer to the load-bearing building elements shall not be defined as part of the Structure and cannot be used for attachment of seismic restraints.

Supports: Those members, assemblies of members, or manufactured elements, including braces, frames, legs, snubbers, curbs, rails, hangers, saddles or struts, and associated fasteners that transmit loads between non-structural components and their attachments to the structure.

1.4 REGULATORY REQUIREMENTS

Comply with the 2015 International Building Code (IBC) and applicable local adopted amendments, and the 2010 Edition on ASCE 7 (ASCE 7-10).

1.5 DESIGN PERFORMANCE CRITERIA

Provide seismic restraint of components to withstand seismic forces and displacements without displacing or overturning. Design of seismic restraint shall be performed in accordance with the 2015 International Building Code and ASCE 7-10, as follows.

1. Seismic forces shall be determined in accordance with Chapter 13 of ASCE 7-10. The seismic design parameters shall be as noted in the project Structural drawing. The assigned Component Importance Factors (I_p) for each component, shall be as noted on the project drawings and/or specifications.

2. For components installed on the exterior of the building, wind forces shall be determined in accordance with Chapter 29 of ASCE 7-10, except that the uplift forces per Equation 29.5-3 shall be considered regardless of the building height. Reference the Structural drawings for wind design criteria.
3. In addition to seismic and wind loads, consideration shall be given to other loads, including but not limited to dead, live, snow, etc., as applicable. All restraint design shall be based on the “worst case” combination of the applicable loads as prescribed by the referenced code and standards.
4. Consideration shall also be given to thermal stresses and expansion. Where thermal expansion applies, seismic restraint design shall be in accordance with the requirements of ASME B31.1 in addition to ASCE 7.

1.6 SUBMITTALS

Submit under the provisions of Division 1. Submittals shall include Product Data, Shop Drawings and the required Certificates of Compliance as described below.

Shop drawings shall be prepared and sealed by a professional engineer licensed in the state of the project, with a minimum of 5 years of experience in the design of vibration isolation and seismic restraint.

Vibration Isolation: submit the following, at a minimum, as applicable.

1. Detailed schedules of equipment requiring isolation, including clearly identified equipment identification or tag and equipment weight, and corresponding isolator type, manufacturer and model number.
2. Detailed drawings showing equipment, isolator bases and isolator spacing.
3. Descriptive data or cut sheets for each type of isolation mounting, including:
 - a. Dimensional data
 - b. Materials and finish
 - c. Rated loads
 - d. Rated deflection
 - e. Isolator free and operating heights
 - f. Detailed installations instructions

Seismic Restraint: submit the following, at a minimum, as applicable.

4. Catalog cut or data sheets on specific restraints detailing compliance with the project drawings and specifications.
5. Detailed schedules of components, showing seismic restraints by referencing numbered descriptive drawings.
6. Description, layout and location of items to be restrained with anchorage or brace points noted and dimensioned.
7. Details of anchorage or bracing at large scale with all members, parts brackets shown, together with all connections, fasteners, bolts, welds etc. clearly identified and specified.
8. Numerical value of design seismic restraint loads, or controlling loads if different than load combinations with seismic, with all supporting calculations.
9. Detailed installation instructions for seismic restraints.
10. Acceptable attachment methods of seismic restraints to structural members.
11. Fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
12. Details for housekeeping pads for base-mounted equipment, including reinforcing and doweling requirements to the building structure.
13. Documentation verifying seismic prequalification for anchors in concrete per ACI 318 Appendix D.
14. Additional information as required to substantiate adequate design and installation of seismic restraints.
15. Manufacturer's Seismic Certificate of Compliance: Each manufacturer of a Designated Seismic System (with a Component Importance Factor, $I_p = 1.5$) shall submit a ***Certificate of Compliance*** for review and acceptance by the design professional in responsible charge and the authority having jurisdiction, prior to installation.

PART 2 - PRODUCTS

2.1 GENERAL

All materials and devices shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

Refer to the “Selection Guide” table in Section 4 to correlate the specification references listed below with the appropriate components.

2.2 MANUFACTURERS

Isolators and seismic restraints shall be from the following manufacturers, or approved equals. Unless otherwise noted, the isolators and seismic restraint systems listed in the following sections are as manufactured by Gripple and California Dynamics.

1. Gripple
2. California Dynamics
3. The VMC Group
4. Mason Industries
5. Kinetics Noise Control
6. Cooper B-Line
7. CADDY
8. Hilti
9. Twin City Hose
10. Imperial Metals

2.3 EQUIPMENT BASES

Specification B-1 (Integral Structural Steel Base): Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Pump bases for split case pumps shall be large enough to support suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1". Bases shall be type XW as manufactured by California Dynamics Corporation or approved equal.

Specification B-2 (Wide Flange Structural Steel Base): Vibration isolation manufacturer shall furnish integral structural steel bases. Rectangular bases are preferred for all equipment. Pump bases for split case pumps shall be large enough to support suction and discharge elbows. All perimeter members shall be steel beams with a minimum depth equal to 1/10 of the longest dimension of the base. Height saving brackets shall be employed in all mounting locations to provide a base clearance of 1". Bases shall be type XW as manufactured by California Dynamics Corporation or approved equal.

Specification B-3 (Concrete Inertia Base): Rectangular steel concrete pouring forms for floating concrete frames. Bases shall be a minimum of 1/12 of the longest dimension of the base but not less than 6". The base depth need not exceed 12" unless specifically recommended by the base manufacturer for mass or rigidity. Forms shall include minimum concrete reinforcing consisting of 1/2" bars welded in place on 12" centers running both ways in a layer 1 1/2" above the bottom. Height saving brackets shall be employed in all mounting locations to maintain a 1" clearance below the base. Base shall be type CW as manufactured by California Dynamics Corporation or approved equal

Specification B-4 (Non-Isolated Curbs): Non isolated seismically rated rooftop curb system that is flashed into roofing membrane. Air and watertight curb shall have a neoprene sponge seal at the top and be rigid enough to provide continuous perimeter support for rooftop unit. Curb must provide means to positively anchored to concrete deck, or bolted or welded directly to structural steel to withstand seismic loading. Curb shall provide a means by which contractor supplied insulation may be installed for thermal insulation and acoustic attenuation. Curbs shall accommodate roof pitch shown on drawings. **Curb shall use minimum 18 gage galvanized steel and shall be designed with crossbracing required to withstand the greater of calculated seismic forces and /or wind loading per local building code.** Design must be certified by registered professional engineer.

Specification B-5 (Isolated Curbs): Seismically rated rooftop isolation curb system that is flashed into roofing membrane. Standard unit curb will not be used. Air and watertight upper curb shall have a neoprene sponge seal at the top and be rigid enough to provide continuous perimeter support for rooftop unit. The upper curb shall be supported by Spec SV-1 isolators welded or bolted to concrete deck to the structure to withstand seismic loading. An EPDM nylon reinforced air tight weatherproof seal shall consolidate the upper and lower curbs. The lower curb shall be weatherproof and provide a base that the roofing system may be flashed to. Weatherproof access panel shall be provided at each isolator to allow isolator adjustment. Isolation curb shall provide a means by which contractor supplied insulation may be installed for thermal insulation and acoustic attenuation. Curbs shall accommodate roof pitch shown on drawings. **Isolation curb shall be designed to withstand the greater of calculated seismic forces and / or wind loading per local building code.** Design must be certified by registered professional engineer.

Specification B-6 (Non-Isolated Rails): Non isolated seismically rated rooftop rail system that provides equipment support in one roof flashed assembly with all features as described for Non-Isolated Curbs.

Specification B-7 (Isolated Rails): Vibration isolation manufacturer shall provide steel members welded to height saving brackets to cradle equipment having legs or bases that do not require a complete supplementary base. Members shall have sufficient rigidity to prevent misalignment of equipment. Structural steel rails shall be type, WW as manufactured by California Dynamics Corporation or approved equal.

2.4 VIBRATION ISOLATION

Specification V-1 (Pad Type Elastomer Isolator): A pad type mounting consisting of two layers of ribbed elastomeric pads with a 1" sandwich pad in between. Where the equipment foot is less than 80 percent of the surface of the pad a load distribution plate must be added to the top of the pad. Pads shall be VT as manufactured by California Dynamics Corporation or approved equal.

Specification V-2 (Neoprene Mounting): Elastomeric mounts single or double-deflection type, oil-resistant rubber or Neoprene isolator element with factory-drilled, bonded in place top plate for bolting to equipment and factory drilled base plate for bolting to structure. Color-coded or otherwise identify to indicate capacity range. Mount shall be type RM/RMD as manufactured by California Dynamics Corporation or approved equal.

Specification V-3 (Spring Isolator, Free Standing): Spring isolators shall be free standing and laterally stable without any housing and complete with a Neoprene acoustical pad between the base plate and the spring support. All mountings shall have load transfer bolts that must be rigidly bolted to the equipment. Installed and operating heights shall be equal. The ratio of the spring diameter divided by the compressed spring height shall be no less than 0.8. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Mountings shall be type SSL/K, as manufactured by California Dynamics Corporation or approved equal.

Specification V-4 (Elastomer Hanger Isolator): Hanger shall consist of a rigid steel frame and up to 1/2" deflection of a molded Neoprene element projecting thru the steel box so that no metal-to-metal contact occurs. Hanger shall be type RH/RHD as manufactured by California Dynamics Corporation or approved equal.

Specification V-5 (Spring Hanger Isolator): Hanger shall consist of a rigid steel frame containing a steel spring with a Neoprene sleeve to prevent steel to steel contact. Hanger shall be type CH as manufactured by California Dynamics Corporation or approved equal.

Specification V-6 (Combination Spring/Elastomer Hanger Isolator): Hangers shall consist of rigid steel frames containing double deflection Neoprene element at the top and a steel spring and a Neoprene sleeve on bottom to position spring and prevent steel to steel contact. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side. Hangers shall be type HH30 as manufactured by California Dynamics Corporation or approved equal.

2.5 VIBRATION ISOLATION WITH SEISMIC RESTRAINT

Specification SV-1 (Seismically Restrained Spring Isolator): Restrained spring isolators shall be free standing, laterally stable, springs with seismic restraints. A steel housing with cushioned lateral and vertical limit stops to restrict spring extension due to wind loads, or when weight is removed. The housing shall be Zinc plated. A clearance of 1/4" maximum shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Outside spring diameter not less than 80 percent of the compressed height of the spring at rated load. Minimum additional travel 50 percent of the required deflection at rated load. Isolator/Restraint shall be CQA as manufactured by California Dynamics Corporation or approved equal. This product is an OSHPD/ DSA approved product. Product tested for IBS.

Specification SV-2 (Seismically Restrained Spring Isolator): Restrained spring isolators shall be free standing, laterally stable, springs with seismic restraints. A welded housing with cushioned lateral and vertical limit stops to restrict spring extension due to wind loads, or when weight is removed. A clearance of 1/4" maximum shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Outside spring diameter not less than 80 percent of the compressed height of the spring at rated load. Minimum additional travel 50 percent of the required deflection at rated load. Isolator/Restraint shall be DLK as manufactured by California Dynamics Corporation or approved equal.

Specification SV-3 (Neoprene Mounting with Seismic Snubber) JQTQN Restrained Neoprene isolators shall be free standing, with a rated static deflection of .5". A steel housing with cushioned lateral and vertical limit stops to restrict extension due to wind loads, or when weight is removed. The housing shall be hot-dipped galvanized or zinc plated. Hot-Dipped zinc coating shall be not less than 2 ounces per square foot complying with ASTM A123. A clearance of 1/4 "maximum shall be maintained around restraining bolts and between the housing and the Neoprene so as not to interfere with the isolator action. Limit stops shall be out of contact during normal operation. Isolator/Restraint shall be JQTQN as manufactured by California Dynamics Corporation.

2.6 SEISMIC RESTRAINTS

Specification S-1 (Seismic Snubbers): All directional seismic restraints shall consist of interlocking steel members. Neoprene shall have a minimum thickness of 1/4". Incorporate a minimum air gap of 1/8", and a maximum air gap of 1/4" in the design, before contact is made between the rigid and resilient surfaces. Provide removable end plate to allow inspection of internal clearances. Restraints shall be type RL-A/ RL-C as manufactured by California Dynamics Corporation.

Specification S-2 (Seismic Cable Restraints): A restraint assembly for suspended equipment, piping or ductwork consisting of high strength galvanized steel aircraft cable. Cable Restraints shall be listed with any one of following evaluation agencies with certified break strength and shall be color-coded or include a tag for easy field verification.

1. IAPMO-UES
2. ICC-ES
3. OSHPD
4. Underwriters Laboratories (UL)

Secure cable to structure and braced component through bracket or stake eye specifically designed to meet or exceed cable restraint rated capacity. Cable must be manufactured to meet or exceed minimum materials and standard requirements per ASTM A1023 or EN-12385 or other approved equivalent. Cables shall be installed to prevent excessive seismic motion and so arranged that they do not engage during normal operation. Restraint shall be Gripple Inc. GS series.

Specification S-3 (Rigid Brace Restraints): A restraint assembly for suspended equipment, piping or ductwork consisting of steel angles or channels. Rigid braces and connecting elements shall be sized for the applied seismic loads. Connecting elements shall be steel assemblies that swivel to the final installation angle and utilize two anchor bolts to provide proper attachment. Restraint shall be CADDY Strut Seismic Hinge.

2.7 FLEXIBLE PIPE CONNECTIONS

Specification F-1 (Water Service Flexible Connection):

1. For flanged connections – A double sphere arch rubber expansion joint constructed of molded reinforced neoprene with integral steel floating flanges, and designed to be suitable for pressures up to 225 PSI (4 to 1 safety factor) and temperatures up to 225 degrees F. Connectors shall have minimum movement capabilities of 1.77” compression, 1.18” lateral and 1.18” extension. Connectors shall provide a minimum 35 degree angular movement up to 6”, minimum 30 degree up to 12” and minimum 20 degree up to 24”. Spring loaded control units shall be furnished to limit movement to within allowables. Flex connector shall be Twin City Hose Type MS2.
2. For threaded type – A double spherical rubber hose connector, minimum 8” long, constructed of molded neoprene, nylon cord reinforced, with female pipe unions each end. Connectors shall have a minimum movement capability of 7/8” compression, 7/8” lateral, 1/4” extension and 20 degree angular through 1-1/4”, 13 degree through 2”, and 9 degree through 3”. Connectors shall be suitable for a maximum working pressure (4 to 1 safety factor) of 150 psi and 225 degree F. Connectors shall have cable control units to limit extension to 1/4”. Flex connector shall be Twin City Hose Type MSFU.

Specification F-2 (Steam and Condensate Service):

3. For flanged connection – A metal hose connector constructed of stainless steel hose and braid with carbon steel plate flanges. Live lengths shall conform to hose minimum length to absorb thermal and dynamic movement. Hose axis must be perpendicular to pipe movement. Flex connector shall be Twin City Hose Type TCHS-FLG.
4. For threaded connections – A metal hose connector constructed of stainless steel hose and braid with carbon steel NPT threaded end fittings. Flex connector shall be Twin City Hose Type TCHS-MMT.

PART 3 - EXECUTION

3.1 EXAMINATION

All areas that will receive components requiring vibration isolation and seismic restraint shall be thoroughly examined for deficiencies that will affect the installation or performance of the installed devices. Such deficiencies shall be corrected prior to the installation.

3.2 INSTALLATION, GENERAL

Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.

All installation shall be in accordance with the requirements set forth in the project drawings and specifications, as well as the manufacturer's published instructions and all approved submittal data.

Do not anchor components to gypsum wallboard, plaster or other wall or ceiling finish that has not been engineered to resist imposed loads.

3.3 SEISMIC RELATIVE DISPLACEMENTS

Provide joints with sufficient flexibility capable of accommodating seismic relative displacements as follows.

1. Vertical ductwork, piping, etc. that pass between floors of the building,
2. Components that pass through a building seismic or expansion joint,
3. Rigidly supported components that connect to other components.

3.4 POST-INSTALLED ANCHORS:

Install all anchors in accordance with the manufacturer's written instructions for seismic applications.

Post-installed anchors in concrete shall be seismically prequalified for use in cracked concrete based on seismic testing in accordance with ACI 355.2 for mechanical anchors or ACI 355.4 for adhesive anchors.

3.5 HOUSEKEEPING PADS

Housekeeping pads shall be designed by the seismic restraint vendor with adequate reinforcing and doweling to the building structure, so as to withstand calculated seismic or wind forces. Frictional resistance due to the effects of gravity shall be neglected.

The size & thickness of the housekeeping pad shall be determined to ensure adequate edge distances & embedment depths in order to obtain the desired equipment anchor capacities.

1. If cast-in-place anchors are used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.
2. If post-installed anchors are used, the minimum edge distances, embedment depths and concrete/masonry member thicknesses specified by the anchor manufacturer shall be maintained.

3.6 MECHANICAL COMPONENTS

Floor and base-mounted components, vibration isolated equipment and associated system vibration and seismic controls for connections.

1. Design equipment anchorage to resist seismic design force in any direction.
2. Design vibration and seismic controls for equipment to include base and isolator requirements.
3. Provide flexible connections between equipment and interconnected piping to account for seismic relative displacements.
4. Where equipment is mounted on vibration isolators, use isolators designed for amplified code forces per ASCE 7 and with demonstrated ability to resist required forces including gravity, operational and seismic forces.
5. Provide supplemental steel or concrete base as required for mounting equipment on isolators. Where equipment is not designed to be point loaded, provide base capable of transferring gravity and seismic demands from equipment to isolator base plate anchorage.
6. Where concrete floor thickness is less than required for expansion anchor installation per ICC-ESR, install through bolt in lieu of expansion anchor. Where timber/wood floor or other substrate is inadequate for installation of lag bolts, screws or other mechanical fasteners, furnish and install supplemental framing or blocking to transfer loads to structural elements.
7. Housekeeping pads shall be coordinated with the seismic restraint vendor based on the equipment anchorage specified in the seismic design.

Suspended mechanical equipment

8. Design support and bracing to resist seismic design force in any direction.
9. Provide flexible connections between equipment and interconnected piping to account for seismic relative displacements.
10. Brace equipment hung from spring mounts using cable or other bracing that will not transmit vibration to the structure.

Wall-mounted mechanical equipment

11. Design attachments to resist seismic design force in any direction.
12. Install backing plates or blocking as required to deliver load to primary wall framing members. Do not anchor to gypsum wallboard, plaster or other wall finish that has not been engineered to resist imposed loads.

Piping

13. Provide supports, braces and anchors to resist gravity and seismic design forces.

14. Design piping and piping risers to accommodate interstory drift. Provide flexible connections wherever relative differential movements could damage pipe in an earthquake.
15. Brace every run (5' or more in length) with two transverse and one longitudinal bracing locations. For pipes and connections constructed of ductile materials (copper, ductile iron, steel or aluminum and brazed, welded or screwed connections) provide transverse bracing at not more than 40 feet on center and longitudinal bracing at spacing not more than 80 feet on center. For pipes and their connections constructed of nonductile materials (cast iron, no-hub pipe and plastic or non-UL listed grooved coupling pipe), provide transverse bracing at not more than 20 feet on center and longitudinal bracing at spacing not more than 40 feet on center.
16. Provide lateral restraint for risers at not more than 30 feet on center or as required for horizontal runs, whichever is less.
17. Where piping is explicitly exempt from seismic bracing requirements,
 - a. Install piping such that swinging of the pipes will not cause damaging impact with adjacent components. This will be considered satisfied if there is horizontal clear distance of at least $\frac{2}{3}$ the hanger length between subject components.
 - b. Provide flexible connections between piping and connected equipment, including in-line devices such as VAV boxes and reheat coils.

Ductwork

18. Provide supports, braces and anchors to resist gravity and seismic design forces.
19. Design ducts and duct risers to accommodate interstory drift. Provide flexible connections wherever relative differential movement could damage duct in an earthquake
20. Provide independent support and bracing for all in-line devices weighing more than 75 pounds.

3.7 QUALITY CONTROL

Do not install vibration isolators or seismic restraints until submittals have been reviewed and approved by the registered design professional in responsible charge.

Verify that multiple systems installed in the same vicinity can be installed without conflict.

Verify tolerances between installed items to confirm that unbraced components will not come into contact with restrained equipment or structural members during an earthquake. When contact is possible, provide seismic restraint or provide justification to the satisfaction of the registered design professional in responsible charge of the project that contact will not cause unacceptable damage to the components in contact, their supports, finishes or other elements that are contacted.

Coordinate with the Structural Engineer of Record for confirming that the structure is capable of supporting the loads imposed by nonstructural components.

No work shall be concealed by the Contractor prior to the required inspections being performed and all discrepancies resolved. The Contractor shall be responsible for all repairs required to uncover uninspected or unapproved work.

Where Special Inspections are required per Sections 1704 and 1705 of the 2015 International Building Code, the owner shall engage a qualified agency to perform the required inspections for components listed in the project-specific Statement of Special Inspections.

PART 4 - EQUIPMENT ISOLATION AND SEISMIC RESTRAINT SCHEDULE

MECHANICAL EQUIPMENT

EQUIPMENT TAG	Ip (Note 7)	ISOLATION SPEC.	ISOLATION DEFL.	SEISMIC REST. SPEC. (NOTE 1)
PACKAGED RTU > 5 TONS	1.0	SPEC B-5	2"	SPEC B-5
PACKAGED RTU ≤ 5 TONS	1.0	N/A	N/A	SPEC B-4
GAS PACKAGED RTU > 5 TONS	1.5	SPEC B-5	2"	SPEC B-5
GAS PACKAGED RTU ≤ 5 TONS	1.5	N/A	N/A	SPEC B-4
SUSPENDED GAS FURNACE	1.5	V-6	1.5"	SPEC S-2
AIR HANDLING UNITS (FLOOR)	1.0	INTERNAL BY MANUF.	2"	NOTE 2
AIR HANDLING UNITS (SUSP)	1.0	SPEC V-6 SPEC F-1	1.5"	SPEC S-2
VAV (NON-FAN) TERM. < 20	1.0	NONE	N/A	NONE

EQUIPMENT TAG	Ip (Note 7)	ISOLATION SPEC.	ISOLATION DEFL.	SEISMIC REST. SPEC. (NOTE 1)
LB				
VAV (NON-FAN) TERM. $\geq$ 20 LB	1.0	NONE	N/A	SPEC S-2
FAN VAV TERMINAL	1.0	SPEC V-4	.5"	SPEC S-2
INLINE FANS	1.0	SPEC V-6	1.5"	SPEC S-2
CEILING FANS $\geq$ 20 LB	1.0	SPEC V-4	.5"	SPEC S-2
CEILING FANS $<$ 20 LB	1.0	NONE	N/A	NONE
CEILING DIFFUSERS $\geq$ 20 LB	1.0	NONE	N/A	(2) 12 GA WIRES TO STRUCTURE, NOTE 3
WALL MOUNT FANS	1.0	NONE	N/A	NOTE 2
UTILITY SETS (FLOOR)	1.0	SPEC SV-2	1"	SPEC SV-2
UTILITY SETS (SUSP.)	1.0	SPEC V-6	1.5"	SPEC S-2
ROOF EXHAUST FANS	1.0	NONE	N/A	SPEC B-3
CHILLERS (ON GRADE)	1.0	SPEC V-1 SPEC F-1	.15"	NOTE 2
CHILLERS (ROOF OR UPPER FLOORS)	1.0	SPEC SV-1 SPEC F-1	2.0"	SPEC SV-1
BOILERS (ON GRADE)	1.5	SPEC V-1	.15"	NOTE 2
BOILERS (UPPER FLOORS)	1.5	SPEC SV-1	1"	SPEC SV-1
PUMPS (ON GRADE) $<$ 7.5 HP	1.0	NONE SPEC F-1	.15"	NOTE 2
PUMPS (ON GRADE) $\geq$ 7.5 HP	1.0	SPEC B-3 & SV-2 SPEC F-1	1"	SPEC SV-2
PUMPS (UPPER FLOORS)	1.0	SPEC B-3 & SV-2 SPEC F-1	2"	SPEC SV-2
INLINE PUMPS $<$ 5 HP	1.0	NONE	N/A	SPEC S-2

EQUIPMENT TAG	Ip (Note 7)	ISOLATION SPEC.	ISOLATION DEFL.	SEISMIC REST. SPEC. (NOTE 1)
INLINE PUMPS $\geq$ 5 HP	1.0	SPEC V-6	1.5"	SPEC S-2
AIR SEPARATORS & EXP. TANKS	1.0	NONE	N/A	NOTE 2
COOLING TOWERS (ON GRADE)	1.0	SPEC B-2 & V-1	.15"	NOTE 2
COOLING TOWERS (ROOF)	1.0	SPEC B-2 & SV-1	2.0"	SPEC SV-1
GAS PIPING	1.5	NOTE 6	N/A	SPEC S-2
GAS UNIT HEATERS (SUSP)	1.5	NONE	N/A	SPEC S-2
UNIT HEATERS (SUSP)	1.0	NONE	N/A	SPEC S-2
CABINET HEATERS (SUSP)	1.0	SPEC V-4	.5"	SPEC S-2
FAN COILS	1.0	SPEC V-6	1.5"	SPEC S-2
KITCHEN HOODS	1.5	NONE	N/A	SPEC S-2
WATER SOURCE HEAT PUMP (SUSP.)	1.0	SPEC V-6	1.5"	SPEC S-2
WATER SOURCE HEAT PUMP (FLOOR)	1.0	SPEC SV-2	1"	SPEC SV-2
STEAM TO WATER HEAT EXCHANGER	1.5	NONE	N/A	NOTE 2
WATER TO WATER HEAT EXCHANGER	1.0	NONE	N/A	NOTE 2
EXPANSION TANK	1.0	NONE	N/A	NOTE 2
AIR SEPARATOR	1.0	NONE	N/A	NOTE 2
FLASH TANK	1.5	NONE	N/A	NOTE 2
CHILLED WATER PIPING	1.0	NOTE 6	N/A	SPEC S-2
HOT WATER PIPING	1.0	NOTE 6	N/A	SPEC S-2
STEAM PIPING	1.5	NOTE 6	N/A	NOTE 4
STEAM CONDENSATE PIPING	1.5	NOTE 6	N/A	NOTE 4

EQUIPMENT TAG	I_p (Note 7)	ISOLATION SPEC.	ISOLATION DEFL.	SEISMIC REST. SPEC. (NOTE 1)
DUCT	1.0	NOTE 6	N/A	SPEC S-2
DUCT USED FOR SMOKE CONTROL	1.5	NOTE 6	N/A	SPEC S-2

NOTES

1. Seismic restraint to be provided where required on equipment in the project drawings.
2. Anchor bolts for non-isolated and internally isolated equipment shall be sized by the seismic engineer. If required, Spec. S-1 snubbers or Spec. S-2 cable kits shall be provided.
3. Diffusers weighing less than 20 lbs must be mechanically attached to ceiling grid, but require no additional restraint.
4. Anchors and guides to be designed to accommodate thermal expansion and seismic loads.
5. Roof curbs provided by others must be certified by a professional engineer for the required seismic loads.
6. Provide Type V-6 isolator for the first three hangers from all equipment specified with spring isolation.
7. All components in a Risk Category IV building are assigned a Component Importance Factor I_p equal to 1.5.

END OF SECTION

SECTION 230110
BASIC VALVES FOR HVAC

PART 1 - GENERAL

- 1.01 Valves specified in this section are for general use. See specifications for specific systems and special valves.
- 1.02 SUBMITTALS
- A. Product Data: Provide for each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories. Provide valve schedule with product data listing valves used for each service application.
- 1.03 QUALITY ASSURANCE:
- A. Single Source Responsibility: Where possible valves shall be by the same manufacturer.
- B. MSS Standard Practices: Comply with the MSS standards for valves specified.
- C. ASME: Comply with ASME B31.1 for power piping valves and ASME B31.9 for building services piping valves.
- D. NSF: Comply with NSF 61 for valve materials for potable water service.
- 1.04 DELIVERY, STORAGE, AND HANDLING:
- A. Preparation for Transport:
1. Ensure valves are dry and internally protected against rusting and galvanic corrosion.
 2. Protect valve ends against mechanical damage to threads, flange faces, and weld end preps.
 3. Set valves in best position for handling. Globe and gate valves shall be closed to prevent rattling; plug valves shall be open to minimize exposure of functional surfaces; butterfly valves shall be shipped closed or slightly open; and swing check valves shall be blocked in either closed or open position.
- B. Storage:
1. Do not remove valve end protectors unless necessary for inspection; reinstall for storage.
 2. Protect valves against weather. Where practical store valves indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement and protect in watertight enclosures.
- C. Handling: Valves whose size requires handling by crane or lift shall be slung or rigged to avoid damage to exposed valve parts. Handwheels and stems, in particular, shall not be used as lifting or rigging points.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering valves which may be incorporated in the work include the following. For majority of valves, Milwaukee has been used as basis of design. Equal valves of other manufacturers may be submitted without substitution requests.

1. APCO
2. Apollo
3. CPV
4. Crane
5. DeZurick
6. Grinnell
7. Hammond
8. Jamesbury
9. Jenkins
10. Keflex
11. Metraflex
12. Milwaukee
13. Mueller
14. Nibco
15. Nordstrom
16. Powell
17. Stockham
18. Walworth
19. Watts

2.02 VALVE FEATURES:

- A. Valve Design: Valves shall have rising stem, or rising outside screw and yoke stems; except, non-rising stem valves may be used where headroom prevents full extension of rising stems.
- B. Pressure and Temperature Ratings: Not less than indicated and required to suit system pressures and temperatures.
- C. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.
- D. Operators: Provide the following special operator features:
1. Handwheels, fastened to valve stem, for valves other than quarter turn.

2. Lever handle on quarter-turn valves 4 inch and smaller, except for plug valves. Provide one wrench for every 10 plug valves.
 3. Chain-wheel operators for valves 2-1/2 inch and larger installed 72 inches or higher above finished floor elevation. Extend chains to an elevation of 5'-0" above finished floor elevation.
 4. Gear drive operators on quarter-turn valves 6 inches and larger.
- E. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.
- F. Bypass and Drain Connections: Provide bypass and drain connections required by manufacturer and as indicated on the drawings.
- G. End Connections: As specified in the individual valve specifications.
1. Threads: Comply with ANSI B1.20.1.
 2. Flanges: Comply with ANSI B16.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
- H. Valves for Condenser Water and Chilled Water.
1. Gate Valves:
 - a. 2 inch and Smaller: Class 125, body and bonnet of ASTM B62 cast bronze, threaded ends, solid disc, copper-silicon alloy stem, brass packing gland, and malleable iron handwheel. Class 150 valves meeting the above shall be used where pressure requires. Milwaukee #105.
 - b. 2-1/2 Inch and Larger: Class 125 iron body, bronze mounted, with body and bonnet conforming to ASTM A 126 Class B, flanged ends, and packing gland assembly. Milwaukee #F-2885A.
 2. Ball Valves:
 - a. Valves 2 Inches and Smaller: Threaded ends, rated for 400 psi WOG pressure; 3 piece construction, bronze body conforming to ASTM B 62, full port, chrome-plated brass ball, replaceable "Teflon" or "TFE" seats and seals, blowout proof stem, and vinyl-covered steel handle. Provide insulator type handle for chilled water and condensate drain. Milwaukee BA-300.
 3. Plug Valves:
 - a. 2 Inch and Smaller: 150 psi WOG, bronze body, straightaway pattern, square head, threaded ends. Lunkenheimer 454.
 - b. 2-1/2 Inch and Larger: 175 psi, lubricated plug type, semi-steel body, single gland, wrench operated, flanged ends. Nordstrom 143.
 4. Globe Valves:
 - a. 2 Inch and Smaller: Class 125, body and screwed bonnet of ASTM B 62 cast bronze, threaded ends, brass or replaceable composition disc, copper-silicon alloy stem, brass packing gland, and malleable iron handwheel.

Class 150 valves meeting the above shall be used where pressure requires. Milwaukee #502T.

- b. 2-1/2 Inch and Larger: Class 125 iron body and bolted bonnet conforming to ASTM A 126, Class B; outside screw and yoke, bronze mounted, flanged ends, and packing gland assembly. Milwaukee F2981A.

- 5. Butterfly Valves: 2-1/2 Inch and Larger: 200 psi, cast iron body conforming to ASTM A 126, Class B. Valves shall have field replaceable EPDM sleeve, with nickel-plated ductile iron disc (except valves installed in condenser water piping which shall have aluminum bronze disc), stainless steel stem, and EPDM O-ring stem seals. Valves shall have gear operator with extended wheel handle and position indicator. Valves shall be lug type, drilled and tapped. Valves shall be suitable for dead end service, Class I, tight shut off. Milwaukee CL 223E.

- 6. Check Valves:

- a. Swing Check Valves:

- 1. 2 Inch and Smaller: Class 125, cast bronze body and cap conforming to ASTM B 62, horizontal swing, Y-pattern, with a bronze disc, and having threaded ends. Valve shall be capable of being reground while the valve remains in the line. Class 150 valves meeting the above specifications may be used where pressure requires or Class 125 are not available. Milwaukee #509.
- 2. 2-1/2 Inch and Larger: Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line. Milwaukee #F2974A.

- b. Spring Loaded (Non-Slam Check Valves for Pumps: Valves shall be iron body, globe typed silent check valves, bronze mounted, stainless steel spring with flanged (125-pounds drilling) end connections for installation between ASA 150 lbs. flat face steel slip on weld flanges. Valves shall be comparable to Mueller #105-AP, APCO Series 600, CPV Globe Type Silent Check Valve, Kelflex K-Check Silent Check Valve, or Metraflex Globe Style Silent Check Valve.

- I. Valves for Heating Hot Water, Low Pressure Steam, and Low Pressure Condensate Return (15 PSI and lower):

- 1. Gate Valves:

- a. 2 Inch and Smaller: Class 150, body and union bonnet of ASTM B 62 cast bronze, threaded ends, solid disc, copper-silicon alloy stem, brass packing gland, and malleable iron handwheel. Milwaukee # 1151
- b. 2-1/2 Inch and Larger: Class 125 iron body, body and bonnet conforming to ASTM A 126 Class B, flanged ends, and packing gland assembly. Milwaukee #F2885.

- 2. Ball Valves (Hot Water only):

- a. Valves 2 Inches and Smaller: Threaded ends, rated for 150 psi saturated steam pressure, 400 psi WOG pressure; 3 piece construction, bronze

body conforming to ASTM B 62, full port, chrome-plated brass Butterfly Valves (Hot Water only): 2-1/2 Inch and Larger: 200 psi, cast iron body conforming to ASTM A 126, Class B. Valves shall have field replaceable EPDM sleeve, with nickel-plated ductile iron disc (except valves installed in condenser water piping which shall have aluminum bronze disc), stainless steel stem, and EPDM O-ring stem seals. Valves shall have gear operators with extended wheel handle with position indicator. Valves shall be lug type, drilled and tapped. Valves shall be suitable for dead end service, Class I, tight shut off. Milwaukee CL 223E.

3. Check Valves:

a. Swing Check Valves:

- (i) 1. 2 Inch and Smaller: Class 150, cast bronze body and cap conforming to ASTM B 62, horizontal swing, Y-pattern, with a bronze disc, and having threaded ends. Valve shall be capable of being reground while the valve remains in the line. Milwaukee #510.
- (ii) 2. 2-1/2 Inch and Larger: Class 125 (Class 175 FM approved for fire protection piping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends. Valve shall be capable of being refitted while the valve remains in the line. Milwaukee #F2974A

- b. Spring Loaded (Non-slam) Check Valves for Pumps: Valves shall be iron body, globe type silent check valves, bronze mounted, stainless steel spring with flanged (125-pounds drilling) end connections for installation between ASA 150 lbs. flat face steel slip on weld flanges. Valves shall be comparable to Mueller #105-AP, APCO Series 600, CPV Globe Type Silent Check Valve, Kelflex K-check Silent Check Valve, or Metraflex Globe Style Silent Check Valve.

J. Valves for High Pressure Steam and High Pressure Condensate Return (16 PSI and higher):

1. Gate Valves:

- a. 2 Inch and Smaller: Class 200, body and union bonnet of ASTM B 61 cast bronze, threaded ends, solid disc, stainless steel seat, bronze stem, bronze packing gland, and aluminum handwheel. Milwaukee # 1174
- b. 2-1/2 Inch and Larger: Class 250, body and bonnet conforming to ASTM A 126 Class B, flanged ends, OS&Y, and packing gland assembly. Milwaukee #F2894.

2. Globe Valves:

- a. 2 Inch and Smaller: Class 200, body and union bonnet of ASTM B 61 cast bronze, threaded ends, hardened stainless steel seat ring and disc, bronze stem, brass packing gland, aluminum handwheel. Milwaukee #592A.

- b. 2-1/2 Inch and Larger: Class 250 iron body and bolted bonnet conforming to ASTM A 126, Class B; solid disc, flanged ends, and packing gland assembly. Milwaukee #F2983.

3. Check Valves:

a. Swing Check Valves:

- (i) 2 Inch and Smaller: Class 200, cast bronze body and cap conforming to ASTM B 61, Y-pattern, bronze regrinding disc, and threaded ends. Milwaukee #508.
- (ii) 2-1/2 Inch and Larger: Class 250, cast iron body and bolted cap conforming to ASTM A 126 Class B, horizontal swing, with a bronze disc, bronze disc ring, and flanged ends. Milwaukee #F2970.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. Examine piping systems for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine valve interior, threads, and flanges for cleanliness, and signs of damage or corrosion. Remove all shipping materials.
- C. Actuate valve through an open-close cycle to determine if operation is proper.
- D. Examine the piping for cleanliness and alignment.
- E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gaskets are of proper size, that material composition is suitable for service, and are free from defect.
- F. Do not attempt to repair a defective valve. Replace all defective valves with new valves.

3.02 VALVE SELECTION:

- A. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select valves with the following ends or types of pipe/tube connections:
 - 1. General Application: Use gate, ball, and butterfly valves for shut-off duty; globe and butterfly for throttling duty. Refer to piping system specification sections for specific valve applications and arrangements.
- B. Valves shall be located in an accessible position, or made accessible through access panel.
- C. Where several valves are related as to function, they shall be grouped in a battery.
- D. Install valves and unions for each fixture and item of equipment in a manner to allow equipment removal without system shutdown. Unions are not required on flanged devices.
- E. Install a valved bypass around each pressure reducing valve, using a globe valve for throttling.

- F. Installation of check valves:
 - 1. Swing Check Valves: Install in horizontal position with hinge pin level.
 - 2. Wafer Check Valves: Install between two flanges in horizontal or vertical position.
 - 3. Lift Check Valves: Install in piping with stem upright and plumb.
- G. No valve shall be installed with stem below horizontal position without prior approval.
- H. Provide special handles or operators as required or as indicated on the drawings.
- I. Valves specified under specific systems shall take precedence over those as specified herein.
- J. Valves in copper pipe shall have threaded ends (except where size dictates flanged ends), use copper to MPT adapters as required.
- K. Provide non-slam type check valves at pumps.

3.03 FIELD QUALITY CONTROL:

- A. Testing: After piping systems have been tested and put into service but before final adjusting and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.

3.04 ADJUSTING AND CLEANING:

- A. Cleaning: Clean mill scale, grease, and protective coatings from exterior of valves and prepare to receive finish painting or insulation.

3.05 VALVE BOXES

- A. Valves located below slabs or grade shall be housed in cast iron boxes and covers. Covers shall be properly identified as to service controlled by the valves.
- B. Furnish Owner with proper key or valve operator extension.

END OF SECTION

SECTION 23 0120

PIPING SPECIALTIES

PART 1 - GENERAL

- 1.01 Specific requirements for specialties indicated on drawings or in other sections of these specifications shall take precedence over items as specified in this section.
- 1.02 Submit brochures and other supportive product data for all items.
- 1.03 Ranges for thermometer, gages, or similar instruments shall be selected so that normal operation will be near center of scale. Range shall not be longer than required. Use compound gage where vacuum may be encountered.
- 1.04 Combination instruments for thermometers and gages will not be acceptable.

PART 2 - PRODUCTS

2.01 THERMOMETERS:

- A. Thermometers shall be equal to Trerice Series BX9, 9-inch, adjustable type. Stem length shall be a minimum of 3/4 of the pipe diameter, plus well extension length. Use 12-inch stem length in tanks.
- B. Provide brass wells and stems.

2.02 THERMOMETER WELLS:

- A. Provide wells with extension neck for insulated piping.
- B. Wells shall be Trerice Series 138 type.
- C. Test wells to be Trerice Series 169 type with cap and chain.

2.03 GAGES:

- A. Gages shall be equal to Trerice Series 800, 3-1/2-inch size.
- B. Provide snubber and cock for each gage.
- C. Provide coil syphon and cock for each steam gage.
- D. Gauges shall be liquid filled.

2.04 TEST PLUGS:

- A. Test plugs shall be equal to Peterson Engineering Company #110, 1/4" size, with brass body, dust cap and "Nordel" valve core material.

2.05 STRAINER:

- A. "Y" Type (Haywood, Muessco, or Sarco):

- 1. 1/2" through 2": Haywood Model 80, bronze, 300 lb. WP, 500 lb. WOG or Haywood Model 80 iron body, 250 lb. WP, 900 lb. WOG. Provide Monel or stainless steel screen, blow-off outlet, screwed ends.
- 2. 2-1/2" through 12": Haywood Model 80 iron body, 125 lb. SWP, 175 lb. WOG, brass screen, blow-off outlet, flanged ends.

- B. Screens - Steam:

- 1. Monel or stainless steel.
- 2. Perforations - .057 diameter, 144 per sq. in.

- C. Screens - Water:

- 1. Brass.
- 2. Perforations: Up to 2" - 1/10" diameter, 49 per sq. in.; 2-1/2" to 4" - 1/8" diameter, 32 per sq. in.; 5" up - 1/4" diameter, 8 per sq. in.

2.06 FLEXIBLE CONNECTORS:

- A. Pumps and Chillers: Bellows Type 3, equal to Keflex #151-TR-1250, with 150 lb. flanges and tie rods. 150 psig maximum working pressure. 304 stainless steel. Bellows welded to flanges. Tie rods with chatter proof spacers. Unit rated at 800°F.

- B. Coils, Valves, And Miscellaneous Equipment: Stainless steel braided hose type.

2.07 ELECTRICAL HEAT TAPE:

- A. Heat tape shall be equal to Emerson Chromalox.
- B. Electrical heat tape shall be installed where indicated on the drawings to prevent pipe freezing.
- C. Heat tape shall be approved for use in hazardous areas as indicated and U.L. listed.

2.08 CALIBRATED BALANCE VALVE:

A. For valves 2" and smaller:

1. Bronze body.
2. Ball or globe type.
3. 250 psig at 250° F rating.
4. Threaded ends.
5. Calibrated orifice or venturi.
6. Meter connections with integral seals.
7. Memory stop.

B. For valves 2-1/2" and larger:

1. Iron or steel body.
2. Ball or globe type.
3. 125 psig at 250° F rating.
4. Flanged connection.
5. Calibrated orifice or venturi.
6. Meter connections with integral seals.
7. Memory stop.

C. Acceptable manufacturers:

1. Flow Design
2. Bell and Gossett
3. Taco
4. Armstrong
5. Nibco

PART 3 - EXECUTION

3.01 GAGES, THERMOMETERS, AND TEST PLUGS:

- A. Provide thermometers in inlet and outlet piping of chillers, boilers, water heaters, air handling unit coils, and elsewhere as indicated on the drawings.
- B. Provide gages on inlet and outlet piping of all pumps, except domestic hot water circulators, steam gages on boiler headers, and elsewhere as indicated on the drawings.
- C. Arrange thermometers and gages so they might be read standing in a normal position on the floor.
- D. Provide test plugs on inlet and outlet piping of all heat exchanger equipment not equipped with thermometers. This includes all heating and cooling coils in air handling units, fan coil units, and other terminal devices with coils.
- E. Locate gages, thermometers, and test plugs as close as possible to equipment being monitored.

3.02 FLEXIBLE PIPE CONNECTORS:

- A. Install flexible pipe connectors where indicated on the drawings.
- B. Install connectors as close as possible to equipment inlets and outlets.
- C. Support pipe work independently of flexible connectors. Brace and anchor piping as required to prevent movement of piping ends of flexible connectors and align all equipment, pipe work, and flanges so that no flexible connectors shall be misaligned and/or stressed beyond the manufacturer's recommended maximum limits.

3.03 HEAT TAPE:

- A. Install the heat tape below the pipe insulation in a uniform distribution to obtain the watts/linear foot as indicated.
- B. Wiring installation shall be done in accordance with the NEC and the manufacturer's requirements.
- C. Power for heat tape shall come from an emergency circuit. If no emergency circuit is available, the power shall come from a dedicated circuit, marked heat tape in the panel.
- D. Unless indicated otherwise on the plans, install heat tape with a minimum capacity of 5 watts/foot.
- E. Heat tape shall be thermostatically controlled and shall be preset to energize before freezing. An indicator light shall energize when the heat tape is "on."

END OF SECTION

SECTION 230150 MECHANICAL HYDRONIC PIPING

PART 1 – GENERAL

1.01 SCOPE

- A. This Section includes piping for heating water, chilled-water, make-up water, and associated drain piping.
- B. Provide materials suitable for system pressures and temperatures.

1.02 SUBMITTALS

- A. Product Data: For each type of pipe and specialty indicated.
- B. Welding Certificates: Copies of certificates for welding procedures and personnel.
- C. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Failed test results and corrective action taken to achieve requirements.
- D. Maintenance Data: Include hydronic specialties in maintenance manuals.

1.03 COORDINATION

- A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.
- B. Coordinate pipe sleeve installations for foundation wall penetrations, for exterior walls and floor assemblies.
- D. Coordinate pipe fitting pressure classes with products specified in related Sections.
- E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base.
- F. Coordinate with requirements for fire stopping.

1.04 DELIVERY AND STORAGE

- A. Deliver, store, and protect piping and devices.
- B. Maintain hydronic specialties in shipping containers with labeling left in place.

PART 2 – PRODUCTS

2.01 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Fittings: ASME B16.22.
- E. Wrought-Copper Unions: ASME B16.22.
- F. Solder Filler Metals: ASTM B 32, 95-5 tin antimony.
- G. Brazing Filler Metals: AWS A5.8, Classification BAg-1 (silver).
- H. ProPress Mechanical Joints, or equal.

2.02 STEEL PIPE AND FITTINGS

- A. Steel Pipe, NPS 2 and Smaller: ASTM A 53, ERW, Grade B, Schedule 40, black steel, plain ends.
- B. Steel Pipe, NPS 2-1/2 through NPS 12: ASTM A 53, ERW, Grade B, Schedule 40, black steel, plain ends.
- C. Steel Pipe, NPS 14 through NPS36: ASTM A 53, ERW, Grade B, standard weight, black steel, plain ends.
- D. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; ERW.
- E. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250.
- F. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
- G. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300.
- H. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced.
- I. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- J. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
 - 1. Material Group: 1.1.

2. End Connections: Butt welding.
3. Facings: Raised face.

PART 3 - EXECUTION

3.01 PIPING APPLICATIONS

- A. Chilled Water and Heating Water, NPS 2 and Smaller: Type L drawn-temper copper tubing with soldered joints, or Schedule 40 steel pipe with threaded joints.
- B. Chilled Water and Heating Water, NPS 2-1/2 and Larger: Schedule 40 steel pipe with welded and flanged joints.
- C. Equipment Drains: Same as hydronic system connected to equipment, DWV copper, SCH 80 PVC, or clear vinyl tubing.

3.02 PIPING INSTALLATIONS

- A. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- B. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- C. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- D. Unless otherwise indicated, install branch connections to new mains using tee fittings in main pipe. Use forged tees or forged weld-o-lets for branch connections to existing mains.
- F. Anchor piping for proper direction of expansion and contraction. Install anchors at minimum of 300 linear feet.
- G. Route piping plumb and square with the building structure.
- H. Install piping to conserve building space, and not interfere with use of space and other work.
- I. Group piping whenever practical at common elevations.
- J. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Prepare pipe, fittings, supports, and accessories for finish painting.

- M. Install with proper access around device for service clearance.
- N. Set and level all floor mounted equipment.
- O. For systems requiring drains, install drain and route to nearest drainage point or as indicated on the drawings.
- P. Make-up water and relief:
 - 1. For each system, provide pressure-reducing valve for feeding make-up water and a pressure relief valve.
 - 2. Provide make-up water from nearest domestic water with reduced pressure backflow preventer.
 - 3. Operating pressures of PRV and relief valves shall be determined by required system pressures.

3.04 TERMINAL EQUIPMENT CONNECTIONS

- A. Size for supply and return piping connections shall be same as for equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure and temperature gages at coil inlet connections.

3.05 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
 - 1. Leave joints, including welds, uninsulated and exposed for examination during test.
 - 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 - 3. Flush system with clean water. Clean strainers.
 - 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 - 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Test all piping systems as hereinafter specified and advise the Engineer, General Contractor and Owner 5 days in advance for witnessing the testing. Furnish to the Engineer copies of the test reports signed by the Contractor.
2. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
3. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
4. Check expansion tanks to determine that they are not air bound and that system is full of water.
5. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
6. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

3.06 ADJUSTING

A. Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

B. Perform these adjustments before operating the system:

1. Open valves to fully open position.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Check and set operating temperatures of chilled water and hot water systems.
8. Lubricate motors and bearings.

3.07 CLEANING: Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping systems, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION 230150

SECTION 23 0160 - MECHANICAL SYSTEMS INSULATION

PART 1 GENERAL

1.01 Provide required insulation for HVAC ductwork and plumbing piping.

1.02 All ductwork and piping is insulated unless otherwise noted.

1.03 SUBMITTTALS

A. Submit product data for each system. Product data shall include but not be limited to the following:

1. Manufacturer's name
2. Insulation material and thickness
3. Jacket
4. Adhesives
5. Fastening methods
6. Fitting materials
7. Manufacturer's data sheets indicating density, thermal characteristics, temperature ratings
8. Insulation installation details (manufacturer's installation instructions/details, Contractor's installation details, MICA plates where applicable)
9. Other appropriate data

1.04 QUALITY ASSURANCE

A. All ductwork and piping requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.

B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this Section of the Specifications. No material may be used that, when

tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

- C. Application Company Qualifications: Company performing the Work of this Section must have a minimum of three (3) years' experience specializing in the trade.
- D. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.
- E. All insulation shall be applied in strict accordance with these Specifications and with adequate factory-printed recommendations on items not herein mentioned. Unsightly, inadequate, damaged or water-soaked Work will not be acceptable.

PART 2 PRODUCTS

2.01 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.

2.02 HVAC PIPING:

- A. Condensate Drain (Above Ground): Armstrong's "Armaflex AP" pipe insulation, 1/2" thick.
- B. Refrigerant
 - 1. Insulate with "Armaflex AP" pipe insulation, 1/2" thick for the following:
 - a. All Suction Lines.
 - b. Mixed Phase lines for ductless split systems.
 - c. Suction and Liquid lines for dedicated 100% outside air split systems.

2.03 MANUFACTURERS

- A. CertainTeed Corporation.
- B. Johns Manville Corporation.
- C. Knauf Corporation.
- D. Owens-Corning.
- E. Unifrax 1 LLC (FyreWrap).
- F. Armacell

2.04 INSULATION MATERIALS

- A. Type D1: Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.
- B. Type D2: Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.
- C. Type D3: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable acrylic surface coating specifically formulated to:
 - 1. Be no more corrosive than sterile cotton when tested in accordance with the test method for corrosiveness in ASTM C665.
 - 2. Absorb no more than 3 percent by weight when tested in accordance with the test method for moisture vapor sorption in ASTM C1104.
 - 3. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM C1071, ASTM C1338, ASTM G21, and ASTM G22.
 - 4. Show no signs of warpage, cracking, delaminating, flaming, smoking, glowing, or any other visibly negative changes when tested in accordance with the test method for temperature resistance in ASTM C411.
 - 5. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
 - 6. Meet the sound absorption requirements when tested in accordance with the test method for sound absorption in ASTM C423.
 - 7. Show no evidence of continued erosion, cracking, flaking, peeling, or delamination when tested in accordance with the test method for erosion resistance in UL181.
- D. Type D4: Fire Rated Grease Duct Insulation (High Temperature Flexible Blanket); 1-1/2-inch thick refractory grade fibrous fire barrier material with minimum service temperature design of 2,000 degrees F; aluminum foil laminated on both sides; with a minimum 'k' value of 0.25 and a minimum density of 6 lbs/cu ft; containing no asbestos. Listed by a nationally recognized testing laboratory (NRTL) UL to meet ASTM E 2336, ASTM E119, and with flame spread/smoke minimum rating of 25 / 50 when tested as per ASTM E84/UL 723.

- E. Type D5: Outdoor Duct Insulation (Closed Cell Flexible Elastomeric Insulation); 1 inch thick material that has a service temperature range from –60 degrees F to 180 degrees F. This outdoor duct insulation meets ASTM C 177 or C 518 and shall have minimum ‘k’ value of 0.27 Btu-in. / hr-ft²- degrees F at minimum density measurement of 3 lb/cu ft. The insulation and outside surface must be protected with a white Thermo Plastic Rubber Membrane formulated to:
1. Be resistant to UV, and ozone, acid rain, and physical elements produced from outdoor weather per ASTM E 96 Procedure A.
 2. Have aflame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
 3. Show no evidence of continued erosion, delaminating, cracking, flaking, or peeling when tested in accordance with the test method for erosion resistance in UL181. Be resistant to mold growth resistance, ASTM G 21/C 1338 resistant to fungi, and resistant to bacteria growth per ASTM G 22.
- F. Type D6: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, ‘k’ value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable polyacrylate copolymer emulsion specifically formulated to:
1. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM D 5590 with “0” growth rating.
 2. Act as a fungicidal protective coating: water based, VOC < 50 g/l. Fungicidal coating must be EPA registered for use in HVAC duct systems. Manufacturer: H.B. Fuller Construction Products Inc., Foster 40-20 (white) or 40-30 (black) Fungicidal Protective Coating or approved equal. Coatings may also be used to repair damage to duct liner insulation.
- G. High Density Duct Insulation Insert, see Type D2.

2.05 INSULATION ACCESSORIES

- A. Adhesives: Waterproof vapor barrier type, meeting requirements of ASTM C916; Childers CP-82 or Foster 85-20/85-60.
- B. Weather Barrier: Breather Mastic: Childers CP-10/CP-11 or Foster 46-50 White.
- C. Vapor Barrier Coating: Permeance - ASTM E 96, Procedure B, 0.08 perm or less at 45-mil dry film thickness, tested at 100F and 50%RH; Foster 30-65 or Childers CP-34

1. When higher humidity levels may be of concern, only specify the following fungus/mold resistant coating: Foster 30-80 AF (anti-fungal). Coating must meet ASTM D 5590 with 0 growth rating**
- D. Reinforcing Mesh: 10x10 or 9x8 glass mesh; Foster Mast a Fab or Childers #10
- E. Jacket: Pre-sized glass cloth, minimum 7.8 oz/sq yd.
- F. Type D4 Insulation Adhesive: Fire resistive to ASTM E84, Childers CP-82 or Foster 85-20.
- G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- H. Joint Tape: Glass fiber cloth, open mesh.
- I. Tie Wire and Wire Mesh: Annealed steel, 16 gage.
- J. Stainless Steel Banding: 3/4-inch wide, minimum 22 gage, 304 stainless.
- K. Armaflex 520, 520 BLV, or Foster 85-75 contact adhesive.
- L. Armatuff 25 white seal seam tape.

PART 3 EXECUTION

3.01 GENERAL

- A. The application of all insulation shall be performed by experienced mechanics, regularly employed in the trade, in a neat and workmanlike manner. Unless otherwise specified to a greater quality, the application of all insulation shall be in accordance with the manufacturer's recommendations.
- B. Omit insulation from the following items:
 1. Exposed plated plumbing pipe.
 2. Vents to atmosphere, discharge from safety and relief valves, overflow pipes, and hot only drain pipes.
 3. Valves, unions, flanges, traps, strainers, and devices in HOT ONLY piping.
- C. Foil-Faced (FF) Duct Insulation shall comply with NFPA Standards 90A and 90B.
- D. All exposed ends of pipe insulation shall be pointed up neatly with appropriate insulating cement, or use pre-molded PVC end caps on cold only piping and preformed aluminum end caps on dual-temp, hot or steam piping.
- E. Provide high density insert at duct hangers. Maintain vapor barrier between insulation and duct hanger. Do not insulate duct hangers or supports.

3.02 DUCT AND PIPE PREPARATION

- A. Verify that piping and ductwork has been tested before applying insulation materials.
- B. Verify that surfaces are clean, foreign material removed, and dry.
- C. Maintain required ambient temperature during and after installation for a minimum period of 24 hours.

3.03 ARMAFLEX PIPE INSULATION

- A. Apply in strict accordance with latest edition of Armstrong's "Installation Instructions to the Contractor". Joints and seams shall be sealed moisture tight without gaps and openings in the insulation

3.04 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Extend duct insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated.
- D. Provide external insulation on all round ductwork connectors to ceiling diffusers and on top of diffusers as indicated in the Ductwork Insulation Application and Thickness Schedule and the Drawings. Secure insulation to the top of ceiling diffusers with UL181B-FX listed polypropylene duct tape Do not insulate top of ceiling diffuser if it is used in ceiling return air plenum or in an open space with no ceiling.
- E. Flexible and Rigid fiberglass insulation (Types D1 and D2) application for exterior of duct:
 - 1. Secure flexible insulation jacket joints with vapor barrier adhesive, tape. Tape shall be UL181B-FX listed polypropylene duct tape.
 - 2. Install without sag on underside of ductwork. Use 4-inch wide strips of adhesive on 8-inch centers and mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
 - 3. Insulate standing seams and stiffeners that protrude through the insulation with 1-1/2 inch thick, unfaced, flexible blanket insulation. Cover with reinforcing mesh and coat with vapor barrier finish coating.

4. On circumferential joints, the 2-inch flange on the facing shall be secured with 9/16 inch outward clinch steel staples on 2-inch centers, and taped with minimum 3-inch wide strip of glass fabric and finish coating.
 5. Vapor seal all seams, joints, pin penetrations and other breaks with vapor barrier coating reinforced with reinforcing mesh.
- F. Duct Liner (Type D3 or D6) application for interior of return air sound boots or return air plenums:
1. Secure insulation with 100 percent coverage of duct liner adhesive, pins and clips not more than 18 inches on center.
 2. Secure bottom of duct insulation using alternate single and double clips. The first pin will secure the insulation and the second clip will be used to secure the cladding. Isolate the exterior clip from the cladding by using two 1/8 inch closed cell neoprene (Armaflex) washers on either side of the cladding. Pre-drill holes in cladding and avoid contact with pin during installation.
 3. For round duct, secure insulation with 100 percent coverage of duct liner adhesive. Secure cladding with 3/4 inch, 0.020 inch stainless steel bands on 12-inch centers.
 4. For joints and overlaps, fold cladding to form a double thickness hem 2 inches minimum. Seal with a non-shrink, non-hardening sealing compound.
 5. Type D6: Provide fungicidal coating in air handlers ten feet on either side, first ten feet downstream of cooling coils, ten feet downstream of mix boxes, in mechanical rooms or as otherwise specified in potentially high humidity areas in the duct system shall be coated with an fungicidal coating; EPA registered for use in HVAC duct systems at a coverage rate of 80 ft²/gallon.
- G. Insulation (Type D4) application for exterior of grease ducts:
1. External duct wrap system requires two (2) 1.5-inch layers of lightweight, flexible wrap overlapped to provide an effective fire barrier. The barrier is installed in 24-inch or 48-inch wide sections. Insulation pins are welded in certain locations to maintain the fire barrier material up against the duct.
 2. Grease duct doors to be installed so the door can be removed and re installed and meet code requirements.
 3. Install duct wrap as tested per manufacturer's instructions to assure the duct wrap is mechanically attached per the manufacturer's spacing of bands or weld pins.
 4. Vertical and horizontal members of the support hanger system shall be wrapped with one layer of the insulation. Vertical and horizontal portions shall be wrapped independent of one another. The horizontal hanger shall be removed from the

vertical support rods and wrapped and then immediately replaced so that an adjacent horizontal support can be removed, wrapped, and reinstalled. The end of the threaded vertical rod shall extend 6-inch past the horizontal member at the beginning of the installation.

5. Penetrations: Where ducts penetrate fire rated walls, floors and roofs, the duct wrap shall be used in conjunction with a firestop system that is listed by a nationally recognized laboratory and rated for penetration of a rated wall or floor by the fire rated grease duct system used.

H. Insulation (Type D5) application for outdoor ducts:

1. Horizontal ductwork located outdoors shall be sloped at a minimum 2-degree angle to prevent the accumulation of water on top of the finished insulated duct. Support members that connect directly to the ductwork are to be insulated with this same material. Keep compression or sharp creases of outdoor insulation to a minimum by distributing the weight of the duct resting on horizontal duct support members.
 2. Follow the insulation manufacturer's installation instructions and procedures to assure the ductwork is properly insulated and that the insulation will meet the manufacturer's warranty requirements.
- I. All ductwork, accessories, and all plenums including metal and masonry construction, etc., shall be insulated as indicated on the Drawings, as specified herein and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.
- J. Flexible ductwork connections to equipment shall not be insulated.
- K. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.
- L. Extreme care shall be taken in insulating high and medium pressure ductwork including all ductwork between the fan discharge and all mixing boxes to ensure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these Specifications are classified as high velocity ductwork.
- M. Where canvas finish is specified use lagging adhesive/coating to prevent mildew in securing canvas. Do not use wheat paste. Use only anti-fungal lagging adhesive that adheres to ASTM D 5590 with 0 growth rating. (Foster 30-36AF, Childers CP-137AF). In addition, cover all exterior canvas-covered insulation with a fire retardant weather barrier mastic.

- N. All supply ductwork in the Project shall be insulated; all exhaust and fume hood exhaust ductwork shall not be insulated, unless used for energy recovery purposes or noted on drawings.
- O. Flexible round ducts shall be factory insulated.

3.05 INSPECTION

- A. Visually inspect the completed insulation installation per manufacturers recommended materials, procedures and repair or replace any improperly sealed joints.
- B. Where there is evidence of vapor barrier failure or “wet” insulation after installation, the damaged insulation shall be removed, duct surface shall be cleaned and dried and new insulation shall be installed.

3.06 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

Ductwork System	Application	Insulation Type	Insulation Thickness
Supply Air (Hot, Cold, Combination)	Outside of Mechanical Rooms	D1	2"
	Inside of Mechanical Rooms	D2	1-1/2"
Return Air, Relief Air, and Exhaust Air	All	D1	1"
Outside Air	Treated and Untreated	D1	2"
Kitchen Grease Hood Exhaust Air	All	D4	3"
Duct mounted coils	Inside of Mechanical Rooms	D2	2"
Terminal Unit Heating Coils	All	D1	2"
Supply Air Diffusers	Top of Diffuser	D1	2"
Supply Air Duct	Outdoor Environment	D5	2"
Return, Exhaust Air Duct	Outdoor Environment	D5	1-1/2"
Return Air Sound Boots/Elbows/Return Air Plenums	All	D6	1"

END OF SECTION 23 0160

SECTION 230853

LOUVERS

PART 1 - GENERAL

- 1.01 Provide extruded aluminum louvers as shown on the plans and schedules.
- 1.02 SUBMITTTALS
 - A. Provide manufacturer's product data including dimensions, details of construction, assembly, performance characteristics, and pressure drop curves.
 - B. Provide certified product test data for water penetration.
 - C. Provide manufacturer's installation instructions with maintenance data.
- 1.03 REGULATORY REQUIREMENTS:
 - A. AMCA: louver to be AMCA certified for water penetration and performance.
- 1.04 DELIVERY, STORAGE, AND PROTECTION
 - A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product installation instructions.
 - B. Protect from weather and construction traffic, dirt, water, chemical and mechanical damage by storing in original shipping crates.

PART 2 - PRODUCTS

- 2.01 DETAILS OF CONSTRUCTION
 - A. Refer to Mechanical Schedule in the Project Drawings for Basis of Design. Louver construction shall be equal to Basis of Design.
 - B. Blades shall be drainable type with removable bird screen.
 - C. Color and finish to be as scheduled; coordinate with Architect or Owner's Representative for final finish and color if none are scheduled.
- 2.02 APPROVED MANUFACTURER
 - A. Provide louvers as manufactured by Ruskin, American Warming and Ventilating, Greenheck, or equal.

PART 3 - EXECUTION

- 3.01 EXAMINATION:
 - A. The Contractor, prior to installation, shall examine the conditions under which the louver is to be installed, and shall notify the Architect or Engineer of conditions detrimental to proper installation.

3.02 INSTALLATION:

- A. Install in accordance with manufacturer's instructions and applicable codes.
- B. Locate and place louver plumb, level and in proper alignment with adjacent work.
- C. Secure louver using concealed anchorages where possible.
- D. Protect non-ferrous metal surfaces from corrosion or galvanic action by applying bituminous paint on surfaces that will be in contact with concrete, masonry or dissimilar metal.
- E. As work progresses install concealed gaskets and flashings. Install sealant in joints as required to make installation weathertight.

END OF SECTION

SECTION 230895

AIR TERMINAL DEVICES

PART 1 - GENERAL

1.01 DESCRIPTION OF WORK:

- A. Extent of air terminals work required by this section is indicated on drawings and schedules and by requirements of this section.

1.02 QUALITY ASSURANCE:

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of air terminals with characteristics, sizes, and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Codes and Standards:
 - 1. ADC Compliance: Provide air terminals which have been tested and rated in accordance with ADC standards, and bear ADC Seal.
 - 2. AHRI Compliance: Provide air terminals which have been tested and rated in accordance with ARI 880 "Industry Standard for Air Terminals" and bear ARI certification seal.
 - 3. NFPA Compliance: Construct air terminals using acoustical and thermal insulations complying with NFPA 90A "Air Conditioning and Ventilating Systems."

1.03 SUBMITTALS:

- A. Product Data: Submit manufacturer's technical product data, including performance data for each size and type of air terminal furnished; schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.
- B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.
- C. Maintenance Data: Submit maintenance data and parts list for each type of air terminal; including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual.

1.04 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver air terminals wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of air terminal and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in boxes.
- B. Store air terminals in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering air terminals which may be incorporated in the work include, but are not limited to, the following or equal:
 - 1. Manufacturer: Subject to compliance with requirements, provide air terminals of one
 - a. Kreuger
 - b. Tuttle-Bailey
 - c. Price
 - d. Titus Products Div.; Philips Industries, Inc.

2.02 AIR TERMINALS – SUPPLY AND EXHAUST

- A. General: Provide factory-fabricated and tested air terminals as indicated, selected with performance characteristics which match or exceed those indicated on schedule.
- B. Terminals shall be pressure independent type. Provide with cross-shaped flow sensor, and factory damper ready for installation of box damper actuator and electronic controller provided by control system manufacturer.
- C. The casing shall be constructed of coated steel meeting SMACNA or ASHRAE Standards. Internal insulation shall meet the requirements of NFPA Bulletin 90A and UL 181. Boxes shall have solid galvanized sheet metal liner.
- D. Terminal box shall have 24 volt control voltage provided by control system manufacturer. (Spec writers coordinate with Elec. Engr. To provide necessary 120V circuits to control system transform.)
- E. Furnish each supply air terminal with heating coil as specified on the drawings. Hot water coils shall be a minimum of two rows.
- F. Supply terminal serving laboratories shall be equal to Siemens LGS.
- G. Control system contractor shall provide readout at the graphical computer interface of the following points:
 - 1. Airflow, CFM
 - 2. Box damper position, and commanded % open.
 - 3. Leaving air temperature, supply terminal only.
 - 4. Heating valve position, and commanded % open, supply terminal only.

2.03 Air Terminals – LABORATORY Fume Hood AND GENERAL EXHAUST:

- A. The exhaust terminal shall have an orifice-style sensor with inside diameter not more

than one inch smaller than the mounting duct's inside diameter and with at least two sets of pressure taps 90 degrees apart, offset from vertical by 45 degrees. Sensor shall be accurate to +/-1% of flow signal over the duct velocities of 600 FPM to 3000 FPM. Material of construction shall match duct material with series 304 or 316 stainless steel for stainless steel ductwork, or Teflon-coated steel for PVC-coated, PVC or FRP. The exhaust terminal will use a simple butterfly blade type damper and actuator. Damper will be constructed of 304 series stainless steel.

- B. Each exhaust terminal will have a factory-mounted airflow transmitter with output of 4-20 mA proportional to velocity pressure. The airflow transmitter will have an accuracy of at least +/-0.5% of the transmitter range. Any electronic (hot-wire or cool-wire, thermistor, etc.) airflow sensor directly exposed to exhaust airflow shall be UL 913 listed. Airflow transmitter shall be Siemens approved model of Dresser Industries/Ashcroft XLDp or Setra C264 Lab, or equal.
- C. The terminal will have a mounted, galvanized steel equipment enclosure with exterior supply connection. The actuator and transmitter will all be housed within this enclosure.
- D. Venturi metering devices are not acceptable.
- E. All volume damper actuators shall be electric. Damper actuator shall be Siemens LA546 or equal.
- F. Terminal box shall have 24 volt control voltage provided by control system manufacturer.
- G. Terminal shall equal to Siemens LGE
- H. Control system contractor shall provide readout at the graphical computer interface of the following points:
 - 1. Airflow, CFM
 - 2. Box damper position, and commanded % open.

PART 3 - EXECUTION

3.01 INSPECTION:

- A. Examine areas and conditions under which air terminals are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 INSTALLATION OF AIR TERMINALS:

- A. General: Install air terminals as indicated, and in accordance with manufacturer's installation instructions.
- B. Location: Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.
- C. Label: Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 2300075 "Mechanical Identification" for equipment labels and warning signs and labels.

3.03 FIELD QUALITY CONTROL:

- A. Upon completion of installation and prior to initial operation, test and demonstrate that air terminals, and duct connections to air terminals, are leak-tight.
- B. Repair or replace air terminals and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

3.04 CLEANING:

- A. Clean exposed factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION

SECTION 23 0990 - TESTING, ADJUSTING, AND BALANCING (TAB)

PART 1 - GENERAL

1.0 NARRATIVE: This project is a replacement of the mechanical equipment and controls in the central mechanical plant at Tucker Coliseum on the Arkansas Tech University Campus. Major elements include:

- Upgrade of the plant's ventilation and exhaust system(s)
- Installation of a new full condensing heating water boiler system to include new variable speed heating water pumps.
- Installation of a new centrifugal water chillers to include new variable speed chilled water pumps.
- Conversion of the three way control valves at the existing air handling units to two way operation.
- Install new controls for variable pumping of chilled and heating water loop.
- Execute NEBB certified test-adjust-balance on all new equipment and at the heating and cooling coils of the existing air handlers.

1.01 SUMMARY:

A. This section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities and temperatures of the mechanical systems as required to meet design specifications, and recording and reporting the results.

1. Test, adjust, and balance the following mechanical systems:
 - a. Exhaust air systems.
 - b. Outside air systems.
 - c. Verify control system operation.
 - d. Hydronics systems, Chilled Water, Heating Water and Condenser Water
2. Contractor shall:
 - a. Put heating water, chilled water, condenser water and ventilating-exhaust systems, and equipment into full operation and continue the operation of same during each working day of testing and balancing.
 - b. Allow the TAB agency to schedule this work in cooperation with other trades involved and comply with the completion date.
 - c. Make available to the TAB agency a complete copy of submittal data on mechanical and process equipment including pump performance curves,

fan curves, manufacturer's balancing factors and other manufacturers ratings for installed equipment.

- d. Make any changes in pulleys, belts, flow regulating devices, hydronic circuit setting devices as required for correct balance as recommended by TAB agency, at no additional cost to the Owner.
- e. Clean and verify strainers and filters clean prior to starting of testing and balancing activity.

B. This section does not include:

- 1. Specifications for materials for patching mechanical systems.
- 2. Specifications for materials and installation of adjusting and balancing devices. If devices must be added to achieve proper adjusting and balancing, refer to the respective system sections for materials and installation requirements.
- 3. Requirements and procedures for piping systems leakage tests.

1.02 DEFINITIONS:

- A. Systems testing, adjusting, and balancing is the process of checking and adjusting building environmental systems to produce design objectives. It includes:
 - 1. Balance of air and water distribution;
 - 2. Adjustment of total system to provide design qualities;
 - 3. Electrical measurements.
 - 4. Verification of performance of equipment and automatic controls;
- B. Test: To determine quantitative performance of equipment.
- C. Adjust: To regulate the specified fluid flow rate and air patterns at the terminal equipment according to specified design quantities.
- D. Report Forms: Test data sheets arranged for collecting test data in logical order for submission and review. These data should also form the permanent record to be used as the basis for required future testing, adjusting and balancing.
- E. Terminal: The point where controlled fluid enters or leaves the distribution system. These are supply inlets on water terminals, supply outlets on air terminals, return outlets on water terminals, and exhaust or return inlets on air terminals such as registers, grilles, diffusers, louvers, and hoods.

1.03 SUBMITTALS:

- A. Agency Data: Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below.
- B. Technicians Data: Submit proof that the Test and Balance Staff assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

- C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.
- D. Maintenance Data: Submit maintenance and operating data that include how to test, adjust, and balance the building systems.
- E. Sample Forms: Submit sample forms.
- F. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Technician. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.
- G. Draft Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
- H. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 2 complete sets of final reports.
- I. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide contents of binder into the below listed divisions, separated by divider tabs:
 - 1. General Information and Summary
 - 2. Air Systems
 - 3. Hydronic Systems
 - 4. Temperature Control Systems
- J. Report Contents: Provide the following minimum information, forms and data:
 - 1. Provide reports in compliance with the current procedural standards of the National Environmental Balancing Bureau. No Exceptions
 - 2. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor and Project. Include addresses, and contact names and telephone numbers. Also include a sheet containing the seal and name address, telephone number, and signature of the Certified Test and Balance Technician. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.

3. The remainder of the report shall contain the appropriate forms for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
4. Air systems report shall include the following:
 - a. blower RPM;
 - b. motor full load amperes and voltages; system static pressures, suction and discharge;
 - c. cfm outside air (for ventilation and refrigerant release management)
 - d. entering air temperatures; DB/WB
 - e. leaving air temperatures; DB/WB
 - f. outside air and exhaust air ducts cfm, (pitot transverse);
 - g. copies of start-up logs;
 - h. pressure drops across coils, filters, dampers, and other equipment in ducts.
 - i. pressure profiles of each system.
 - j. sheave size, brand name, and number.
 - k. belt quantity, stock name, and number.
5. Hydronic systems report shall include the following:
 - a. operating temperatures of equipment;
 - b. pump flows;
 - c. water flow through equipment;
 - d. leaving water temperatures and return water temperature of equipment;
 - e. water temperatures at inlet side and leaving side of coils. Note rise or drop of temperatures from source. Sample one existing Air Handling unit as selected by the engineer of record.
 - f. flow rate on coils for full flow.
 - g. pumps operating suction and discharge pressure and final total dynamic head (TDH);
 - h. rated and actual running amperage of pump motor;
 - i. copies of start-up logs.
- K. Calibration Reports: Submit proof that required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of 12 months prior to starting the project.

1.04 QUALITY ASSURANCE:

A. Agency Qualifications:

1. Employ the services of an independent testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.
2. The independent testing, adjusting, and balancing agency shall be certified by National Environmental Balancing Bureaus (NEBB) in those testing and balancing disciplines required for this project, and having at least one Technician, certified by NEBB on site during all balancing activities.

3. Acceptable NEBB providers:

- A. Members in good standing with the Arkansas Chapter of NEBB.
- B. Technicians registered with the Arkansas HVACR authority.
- C. Codes and Standards:
 1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems".
- D. Pre-Balancing Conference: Prior to beginning testing, adjusting, and balancing procedures, schedule and conduct a conference with the Owner's representative and representatives of installers of the mechanical systems. The objective of the conference is final coordination and verification of system operation and readiness for testing, adjusting, and balancing.

1.05 PROJECT CONDITIONS:

- A. Systems Operation: Systems shall be fully operational prior to beginning procedures.

1.06 ACCEPTANCE:

The Owner will not accept the facility until the systems have been properly started, balanced, and the TAB Report is approved.

PART 2 - PRODUCTS: NOT USED

PART 3 - EXECUTION

3.01 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING:

Before operating the system, perform these steps:

- A. Obtain design drawings and specifications and become thoroughly acquainted with design intent.
- B. Compare design to installed equipment and field installations.

- C. Check filters cleanliness.
- D. Check dampers (both volume and fire) for correct and locked position, and temperature control for completeness of installation before starting fans.
- E. Determine best locations in main and branch ductwork for most accurate duct traverses.
- F. Place outlet dampers in full open position.
- G. Prepare schematic diagrams of system "as-built" ductwork to facilitate reporting.
- H. Verify that motors and bearings have been lubricated.
- I. Check fan belt tension.
- J. Check fan rotation.

3.02 PRELIMINARY PROCEDURES FOR HYDRONIC SYSTEM BALANCING:

Before operating the system, perform these steps:

- A. Open valves to full open position. Close coil bypass valves.
- B. Verify that all strainers have been cleaned.
- C. Examine hydronic systems and determine if water has been treated and cleaned.
- D. Check pump rotation.
- E. Clean and set automatic fill valves for required system pressure.
- F. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.
- G. Check air vents at high points of systems and determine if all are installed and operating freely (automatic type) or to bleed air completely (manual type).
- H. Set temperature controls so all coils are calling for full flow.
- I. Check operation of automatic bypass valves.
- J. Check and set operating temperatures of equipment to design requirements.
- K. Verify pump alignment and pump base grouting if required.
- L. Verify that pump motors and bearings have been lubricated.

3.03 MEASUREMENTS:

- A. Provide required instrumentation to obtain proper measurements, calibrated to the tolerances specified in NEBB standards. Instruments shall be properly maintained and protected against damage.
- B. Provide instruments meeting the specifications of the NEBB standards.
- C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

- D. Apply instrument as recommended by the manufacturer.
- E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

3.04 PERFORMING TESTING, ADJUSTING, AND BALANCING:

- A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the NEBB Procedural Standards.
- B. Seal insulation to re-establish integrity of the vapor barrier.
- C. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar control and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.
- D. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.05 RECORD AND REPORT DATA:

- A. Record data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by NEBB standards, and as approved on sample report forms.
- B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.
- C. Provide on site verification of the TAB report with the engineer of record and the owner. Demonstrate at a minimum 10% of the reported findings. If the site verification readings are substantially different (+/- 10%) from the report the TAB report will be rejected and the TAB contractor will be required to rebalance the system.

3.06 DEMONSTRATION:

- A. Training:
 - 1. Train maintenance personnel on troubleshooting procedures and testing, adjusting, and balancing procedures. Review with personnel the information contained in Operating and Maintenance Data.
 - 2. Schedule training through the Owner with at least 7 days' prior notice.

END OF SECTION

SECTION 239000

AUTOMATIC CONTROL SYSTEM

PART 1 GENERAL

1.01. WORK INCLUDED

- A. Furnish a totally native BACnet-based system. Control system shall be an addition to and an extension of the existing Building Automation system that serves the existing facility.
- B. System
- C. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications.
- D. Prepare individual hardware layouts, interconnection drawings, and software configuration from project design data.
- E. Implement the detailed design for all analog and binary objects, system databases, graphic displays, logs, and management reports based on control descriptions, logic drawings, configuration data, and bid documents.
- F. Design, provide, and install all equipment cabinets, panels, data communication network cables needed, and all associated hardware.
- G. Provide and install all interconnecting cables between supplied cabinets, application controllers, and input/output devices.
- H. Provide and install all interconnecting cables between all equipment controllers.
- I. Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied.
- J. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and commissioning.
- K. Provide a comprehensive operator and technician training program as described herein.
- L. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the sum total of which accurately represents the final system.
- M. All measurable points on each piece of hardware, duct, or equipment monitored by the building control system shall be made available to view, control, and trend from the user interface.

1.02. SYSTEM DESCRIPTION

- A. A distributed logic control system complete with all software and hardware functions shall be provided and installed. System shall be completely based on ANSI/ASHRAE Standard 135-2001, BACnet. This system is to control all mechanical equipment, using native BACnet-compliant components. Non-BACnet-compliant or proprietary equipment or systems

(including gateways) shall not be acceptable and are specifically prohibited.

- B. Room sensors shall be provided with digital readout that allow the user to view room temperature, view outside air temperature, adjust the room setpoint within preset limits and set desired override time. User shall also be able to start and stop unit from the digital sensor. Include all necessary wiring and firmware such that room sensor includes field service mode.

1.03. APPROVED MANUFACTURERS

- A. Siemens Desigo or approved equal.

1.04. QUALITY ASSURANCE

- A. Responsibility: The supplier of the EMCS shall be responsible for inspection and Quality Assurance (QA) for all materials and workmanship furnished.
- B. Component Testing: Maximum reliability shall be achieved through extensive use of high-quality, pre-tested components. Each and every controller, sensor, and all other DDC components shall be individually tested by the manufacturer prior to shipment.
- C. Tools, Testing and Calibration Equipment: The EMCS supplier shall provide all tools, testing, and calibration equipment necessary to ensure reliability and accuracy of the system.
- D. The systems control contractor shall have been in business a minimum of five years and be the authorized installing contractor for the manufacturer of the BACnet components.
- E. Control system shall be engineered, programmed and supported completely by representative's local office that must be within 75 miles of project site.

1.05. SUBMITTALS

- A. Drawings
 - 1. The system supplier shall submit engineered drawings, control sequence, and bill of materials for approval.
 - 2. Drawings shall be submitted in the following standard sizes: 11" x 17" (ANSI B).
 - 3. Eight complete sets (copies) of submittal drawings shall be provided.
 - 4. Drawings shall be available on CD-ROM.

1.06. WARRANTY

- A. Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of one year from completion of system acceptance.
- B. Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours Monday through Friday, 48 hours on Saturday and Sunday.
- C. This warranty shall apply equally to both hardware and software.

PART 2 PRODUCTS

2.01. BACnet APPLICATION EQUIPMENT CONTROLLERS

- A. Provide one or more native BACnet application controllers for each controlled piece of equipment. All controllers shall interface to building controller via MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident at the operator workstation.
- B. BACnet Conformance
 - 1. Application controllers shall as a minimum support MS/TP BACnet LAN types. They shall communicate directly via this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as native BACnet devices. Application controllers shall be of BACnet conformance class 3 and support all BACnet services necessary to provide the following BACnet functional groups:
 - a. Files Functional Group
 - b. Reinitialize Functional Group
 - c. Device Communications Functional Group
 - 2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
 - 2. Standard BACnet object types supported shall include as a minimum—Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
- C. Application controllers shall include universal inputs with 10-bit resolution that accept 3K and 10K thermistors, 0–10VDC, 0–5 VDC, 4–20 mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of 3 inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs shall be switch selectable as either 0–10VDC or 0–20mA. Software shall include scaling features for analog outputs. Application controller shall include 24VDC voltage supply for use as power supply to external sensors.
- D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal. Programming of application

controller shall be completely modifiable in the field over the installed BACnet LANs from the Touch Screen Interface.

- E. Application controller shall include support for intelligent room sensor (see section 2.9.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor.

2.02. OPERATOR'S WORKSTATION

- A. Contractor shall furnish and install (1) new operator workstation and associated software for graphical user interface (GUI).

2.03. SENSORS and MISCELLANEOUS DEVICES

A. Temperature Sensors

- 1. All temperature sensors to be solid state electronic, factory-calibrated to within 0.5°F, totally interchangeable with housing appropriate for application. Wall sensors to be installed as indicated on drawings. Mount top of thermostat at approximately 44 inches above finished floor, align with light switch of associated room. Duct sensors to be installed such that the sensing element is in the main air stream.

B. Room Sensor with LCD Readout

- 1. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions as described in sequence of operation.
- 2. Room Sensor shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application.
- 3. Override time may be set and viewed in half-hour increments. Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.

2.04. ENCLOSURES

- A. All controllers, power supplies and relays shall be mounted in enclosures.
- B. Enclosures may be NEMA 1 when located in a clean, dry, indoor environment. Indoor enclosures shall be NEMA 12 when installed in other than a clean environment.
- C. Enclosures shall have hinged, locking doors.
- D. Provide laminated plastic nameplates for all enclosures in any mechanical room or electrical room. Include location and unit served on nameplate. Laminated plastic shall be 1/8" thick sized appropriately to make label easy to read.

PART 3 EXECUTION

3.01. EXAMINATION

- A. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.
- B. Notify the owners' representative in writing of conditions detrimental to the proper and timely completion of the work.
- C. Do not begin work until all unsatisfactory conditions are resolved.

3.02. INSTALLATION (GENERAL)

- A. Install in accordance with manufacturer's instructions.
- B. Provide all miscellaneous devices, hardware, software, interconnections installation and programming required to ensure a complete operating system in accordance with the sequences of operation and point schedules.

3.03. INTERLOCKING AND CONTROL WIRING

- A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 16 and all national, state and local electrical codes.
- B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.
- C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.
- D. Provide auxiliary pilot duty relays on motor starters as required for control function.
- E. Provide power for all control components from nearest electrical control panel or as indicated on the electrical drawings—coordinate with electrical contractor.
- F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit).

3.04. TRAINING

- A. Provide application engineer to instruct owner in operation of systems and equipment.
- B. Provide on-site training above as required, up to 8 hours as part of this contract.

END OF SECTION

SECTION 220030

ELECTRICAL REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.01 SUMMARY:

- A. This section specifies the basic requirements for electrical components which are to be provided for operation of mechanical equipment. These components include, but are not limited to, motors, starters, and disconnect switches when indicated, furnished as an integral part of packaged mechanical equipment, or furnished separately for mechanical equipment.
- B. Furnish all motor controllers and contactors, not furnished as part of a motor control center, for proper operation of all motors.
- C. Specific electrical requirements (i.e., horsepower and electrical characteristics) for mechanical equipment are specified within the individual equipment specification sections and scheduled on the drawings.

1.02 REFERENCES:

- A. NEMA Standards MG 1: Motors and Generators.
- B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.
- C. NEMA Standard 250: Enclosures for Electrical Equipment.
- D. NEMA Standard KS 1: Enclosed Switches.
- E. National Electric Code (NFPA 70).

1.03 SUBMITTALS:

- A. Separate submittal is not required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.04 QUALITY ASSURANCE:

- A. Electrical components and materials shall be UL labeled.
- B. The electrical work shall comply with the National Electric Code.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Equipment shall be by same manufacturer, except those items furnished by an equipment manufacturer as an integral part of his equipment. Where possible the equipment shall be by the same manufacturer specified by electrical.

- 2.02 MOTORS: The following are basic requirements for simple or common motors. For special motors, more detailed and specific requirements are included in the individual equipment specifications.
- A. Torque characteristics shall be sufficient to satisfactorily accelerate the driven loads.
 - B. Motor sizes shall be large enough so that the driven load will not require the motor to operate in the service factor range.
 - C. 2-speed motors shall have 2 separate windings on poly-phase motors.
 - D. Temperature Rating: Rated for 40 degrees C (104 degree F). environment with maximum 90 degree C (194 degree F) rise for continuous duty at full load (Class B insulation).
 - E. Starting Capability: Frequency of starts as indicated by automatic control system, and not less than 5 evenly spaced starts per hour for manually controlled motors.
 - F. Service Factor: 1.15 for poly-phase motors and 1.35 for single phase motors.
 - G. Motor Construction: NEMA Standard MG 1, general purpose, continuous duty, Design "B", except "C" where required for high starting torque.
 - 1. Frames: NEMA Standard No. 48 or 56; use driven equipment manufacturer's standards to suit specific application.
 - 2. Bearings:
 - a. Ball or roller bearings with inner and outer shaft seals.
 - b. Re-greasable, except permanently sealed where motor is normally inaccessible for regular maintenance.
 - c. Designed to resist thrust loading where belt drives or other drives produce lateral or axial thrust in motor.
 - d. For fractional horsepower, light duty motors, sleeve type bearings are permitted.
 - 3. Enclosure Type:
 - a. Open drip-proof motors for indoor use where satisfactorily housed or remotely located during operation.
 - b. Guarded drip-proof motors where exposed to contact by employees or building occupants.
 - c. Weather protected Type I for outdoor use, Type II where not housed.
 - 4. Overload Protection: Built-in thermal overload protection and, where indicated, internal sensing device suitable for signaling and stopping motor at starter.
 - 5. Noise Rating: "Quiet".
 - 6. Efficiency:

- a. Motor shall comply with the efficiency requirements of the Energy Independence and Security Act of 2007.
 - b. Motors smaller than 1 HP shall have minimum full load efficiencies levels per NEMA Standards.
 - c. Motors 1 HP and larger shall be premium efficiency.
7. Nameplate: Indicate the full identification of manufacturer, ratings, characteristics, construction, special features and similar information.

2.03 STARTERS, ELECTRICAL DEVICES, AND WIRING:

A. Motor Starter Characteristics:

- 1. Enclosures: NEMA 1, general purpose enclosures with padlock ears, except in wet locations shall be NEMA 3R or NEMA 12 with conduit hubs installed by contractor, or units in hazardous locations which shall have NEC proper class and division.
- 2. Type and size of starter shall conform to adopted standards and recommended practices of the National Electric Code and Underwriters' Laboratories.

B. Manual Switches: Manual switches shall have:

- 1. Pilot lights and extra positions for multi-speed motors.
- 2. Overload protection: Melting alloy type thermal overload relays.
- 3. Manual starters / switches are to be used on fractional horsepower motors only.

C. Magnetic Starters:

- 1. Momentary contact push buttons and pilot lights, properly arranged for single speed or multi-speed operation as indicated.
- 2. Trip-free thermal overload relays, each phase.
- 3. Interlocks, witches and similar devices as required for coordination with control requirements of controls sections.
- 4. Built-in 120 volt control circuit transformer, with 2 primary and one secondary fuse, where service exceeds 240 volts. Fuses sized to carry holding coil circuit and other connected devices.
- 5. Externally operated manual reset.
- 6. Under-voltage release or protection (3-wire control).
- 7. Branch circuit protection shall meet type 2 coordination protection.
- 8. A hand-off-auto selector switch shall be provided in addition to start-stop buttons for all devices being controlled automatically.
- 9. Phase loss relay.

- a. Provide protective relays with DPDT 600V rated contacts, locking potentiometer undervoltage adjustment, and LED indicating light at each starter for motors greater than 5 HP. Equal to Square D Class 8430, Type MPD, mounted in suitable enclosure.
- D. Motor Connections:
 - 1. Flexible conduit, except where plug-in electrical cords are specifically indicated.
- E. Heater Contactors:
 - 1. Contactors for resistance heat shall be by same manufacturer as starters unless furnished with heaters. Contactors shall be of the magnetic type and mounted in NEMA Type 1 general purpose enclosure. Contactors shall carry a UL listing and shall be rated for 100,000 cycles.
- F. Disconnect Switches:
 - 1. Fusible Switches: Fused, each phase; heavy duty; horsepower rated; non-teasible, quick-make, quick-break mechanism; dead front line side shield; solderless lugs suitable for copper or aluminum conductors; spring reinforced fuse clips; electro silver plated current carrying parts; hinged doors; operating lever arranged for locking in the "open" position; arc quenchers; capacity and characteristics as indicated.
 - 2. Non-fusible Switches: For equipment less than 1 horsepower, switches shall be horsepower rated; toggle switch type; quantity of poles and voltage rating as indicated. For equipment 1 horsepower and larger, switches shall be the same as fusible type.

2.04 CAPACITORS:

- A. Features:
 - 1. Individual unit cells, all welded steel housing, each capacitor internally fused, non-flammable synthetic liquid impregnant, craft tissue insulation, and aluminum foil electrodes.
 - 2. KVAR size shall be as required to correct motor power factor to 90 percent or better and shall be installed on all motors 1 horsepower and larger that have an uncorrected power factor of less than 85 percent at rated load.

PART 3 - EXECUTION

3.01 GENERAL

- A. Install motors on motor mounting systems in accordance with motor manufacturer's instructions, securely anchored to resist torque, drive thrusts, and other external forces inherent in mechanical work. Secure sheaves and other drive units to motor shafts with keys and Allen set screws, except motors of 1/3 hp and less may be secured with Allen set screws on flat surface of shaft. Unless otherwise indicated, set motor shafts parallel with machine shafts.

- B. Deliver starters and wiring devices which have not been factory-installed on equipment unit to electrical installer for installation.
- C. Install starters and wiring devices at locations indicated, securely supported and anchored, and in accordance with manufacturer's installation instructions. Locate for proper operation access, including visibility, and for safety. Do not cover equipment data or informational tags when device is to be mounted on equipment.
- D. Install control connections for motors to comply with NEC and applicable provisions of Electrical. Install equipment grounding except where non-grounded isolation of motor is indicated.
- E. Connect protective relays to line side lugs of the motor starter and wire control contacts into motor starter circuit.
- F. Label starters with engraved plastic nameplate describing the equipment served, e.g., "A.C. Unit No. 1". Nameplates shall be U.V. stabilized for use indoor / outdoor. Attach nameplates with clear silicone sealant.

END OF SECTION

SECTION 22 00 75

PLUMBING IDENTIFICATION

PART 1 GENERAL

1.1 SUMMARY

A. This Section includes the following mechanical identification applications:

1. Equipment identification.
2. Pipe identification.
3. Valve tags.
4. Valve schedule.

1.2 SUBMITTALS

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

B. Product Schedule: Provide schedule indicating each type of identification material to be used for equipment, piping, and ductwork. Indicate colors to be used.

C. Valve Schedule: Submit a valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Provide three (3) copies. Mark valves which are intended for emergency shut-off, normally open, normally closed, and similar special uses by special flag in the margin of the schedule. Include the following for each valve:

1. Valve identification number
2. System
3. Purpose
4. Location
5. Type
6. Size
7. Manufacturer

1.3 QUALITY ASSURANCE

A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems", for letter size, length of color field, for colors not included in the schedule herein, and for viewing angles of identification devices for piping.

1.4 COORDINATION

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

B. Coordinate installation of identifying devices with location of access panels and doors.

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

PART 2 PRODUCTS

2.1 EQUIPMENT IDENTIFICATION

A. Engraved Plastic Laminate Identification Signs

1. General: Provide engraving stock melamine plastic laminate in the sizes and thicknesses indicated, with engraver's standard letter style, black with white core (letter color) except as otherwise indicated, punched for mechanical fastening except where using adhesive mounting.
2. Thickness: 1/16 inch for units up to 20 inches square or 8 inch length; 1/8 inch for larger units.
3. Fasteners: Self tapping stainless steel screws except use contact-type, permanent adhesive where screws cannot or should not penetrate the substrate. Where sign cannot be attached directly to device or equipment, attach with brass chain.
4. Letter sizes: Minimum ¼ inch for names of units if viewing distance is less than 24 inches, ½ inch for viewing distances up to 72 inches, and proportionally larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of the principal lettering.

2.2 PIPE IDENTIFICATION

A. Subject to compliance with requirements, provide pipe markers by one of the following:

1. Seton
2. Brady
3. Brimar
4. EMED

- B. All above grade piping shall be identified with pipe markers with colors as indicated. Identification shall have proper legend and meet OSHA specifications. Comply with ASME A13.1, unless otherwise noted.
- C. For piping where diameter including insulation is less than 8 inch, pipe markers shall be plastic, pre-tensioned, semi-rigid type that encircles entire pipe without the use of adhesives. Tape and sticker types are unacceptable.
- D. For piping where diameter including insulation is 8 inch or greater, pipe markers shall be plastic, full-band, semi-rigid type strapped to pipe using manufacturer's standard stainless steel bands.
- E. Underground line markers: Manufacturer's standard permanent, bright colored, continuous printed, plastic tape intended for direct burial service, not less than 6" wide and 4 mils thick. Provide tape with printing which most accurately indicates the type of buried pipe.

F. Identification Schedule:

<u>Piping System</u>	<u>Legend</u>	<u>Band/Text Color</u>
1. Plumbing Piping System		
Cold Water	Cold Water	Green/White
Hot Water	Hot Water	Green/White
Hot Water Return	Hot Water Return	Green/White
2. Gas Piping System		
Low Pressure Natural Gas	Low Pressure Gas	Yellow/Black
High Pressure Natural Gas	High Pressure Gas	Yellow/Black
Gas Vent	Gas Vent	Yellow/Black
LP Gas	Propane Gas	Yellow/Black
3. Sanitary Sewer System		
Sanitary Waste	Sanitary Sewer	Green/White
Sanitary Vent	Sanitary Vent	Green/White
Acid Waste	Acid Waste	Orange/Black
4. Storm Drain System		
Storm Drain	Storm Drain	Green/White
5. Miscellaneous Piping Systems		
Compressed Air	Air (PSI)	Blue/White
Vacuum - Process	Vacuum	White/Black
Fuel Oil Supply	Fuel Oil Supply	Yellow/Black
Fuel Oil Return	Fuel Oil Return	Yellow/Black
De-Ionized Water	De-Ionized Water	Green/White
Distilled Water	Distilled Water	Green/White
Oxygen	Oxygen	Green/White
Lawn Sprinkler	Non-Potable Water	Green/White
6. Medical Gas Piping System		
Oxygen	Oxygen	Green/White
Nitrous Oxide	Nitrous Oxide	Blue/White
Nitrogen	Nitrogen	Blue/White
Medical Air	Medical Air	Yellow/Black
Medical Vacuum	Medical Vacuum	White/Black
Helium	Helium	Brown/White
Carbon Dioxide	Carbon Dioxide	Grey/White
7. Waste Anesthetic Gas Disposal		
Waste Gas	Evac	Purple/White
Non Medical Air	Non Med Air	Yellow & White Diagonal Stripe/Black

Non Medical Vac Boxed	Non Med Vac	White & Black Diagonal Stripe/Black
Laboratory Air Board/Black	Lab Air	Yellow & White Checker
Laboratory Vac Boxed	Lab Vac	White & Black Checker Board/Black

- G. Arrows and lettering shall be black. Arrows shall point in the direction of flow. Locate downstream of pipe legend.
- H. Arrows shall be of same color as bands and shall point in direction of flow. Locate downstream of pipe legend.
- I. Valve Identification: Provide brass tags for all valves and steam traps with legend describing function of each valve and trap. Tag shall also indicate normally open or normally closed, where position is noted on the drawings.
- J. Valve Tags: Brass tags shall be a minimum of 2" diameter or 3-1/2" oval, to accommodate 1" high numbers. Tag shall be equipped with a 3/16" X 6" long brass chain.

2.3 STENCILS

- A. Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4" for ducts; and minimum letter height of 3/4" for equipment and access door signs. Use alkyd paint. Use stencils only as directed herein.

PART 3 EXECUTION

3.1 EQUIPMENT IDENTIFICATION

- A. Provide permanent, factory, operational data, nameplate on each item of power operated mechanical equipment, indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location. Where manufacturer's nameplate is not stamped or engraved, provide additional heavy gauge, aluminum or brass, stamped or engraved nameplate. Do not remove manufacturer's nameplates. When manufacturer's nameplates are to be covered by insulation or other material, provide a separate nameplate for mounting on the exterior of the covering.
- B. In addition to factory nameplate, provide an engraved plastic laminate (stenciled) identification sign for each major item of mechanical equipment and each operational device. Provide identification signs for the following general categories of equipment.
 1. Main control and operating valves, including safety devices and hazardous units such as gas outlets.
 2. Compressors, pumps, and similar motor-driven units.
 3. Tanks and pressure vessels.
 4. Strainers, filters, humidifiers, water treatment systems, and similar equipment.

5. Control panels.
 6. Fuel burning units, such as boilers, furnaces, and heaters.
- C. Provide engraved sign at each access door, indicating equipment or device to be accessed.
- D. Coordinate names, abbreviations, and other designations used in equipment identification with corresponding designations shown, specified, scheduled, or as designated by the Owner's representative. Provide numbers, lettering, and wording as indicated or as directed by the Owner's representative. Owner shall set priority for lettering and graphics. Where multiple systems of the same generic name are shown and specified, provide identification which indicates individual system number as well as service (as examples; Boiler No. 3, AHU-1H, Standpipe G14).
- E. Provide Ceiling Grid Labels for Equipment:
1. Letter Color: Black
 2. Background Color: White
 3. Minimum Label Size: Length may vary for required label content, but dimensions shall not be less than 2-1/2 by 3/4 inch.
 4. Minimum Letter Size: 1/2 inch.
 5. Self adhesive, compatible with label and with substrate.
 6. Locate on ceiling grid or access door nearest access side of equipment.

3.2 PIPE IDENTIFICATION

- A. Provide 1" thick molded fiberglass insulation with jacket under each plastic pipe marker to be installed on uninsulated pipes where fluid temperatures will be 125°F or greater. Insulation shall extend 4" beyond edges of marker.
- B. Valve tags and steam traps shall be numbered as indicated on the valve listing provided to the Owner.
- C. As a minimum, identification shall be applied to piping at the following locations:
1. Adjacent to each valve.
 2. At each branch and riser take-off.
 3. At each pipe passage through wall, floor, and ceiling construction.
 4. At each pipe passage to underground.
 5. At not more than forty feet spacing on straight pipe runs.

- D. Place identification so it can be easily read. Arrows shall be applied to indicate direction of flow.
- E. Underground Piping: During back-filling of each exterior underground piping system, install plastic line marker, located directly over buried line no deeper than 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install a single line marker.

END OF SECTION

SECTION 22 0090

SUPPORTS, HANGERS AND ANCHORS

PART 1 GENERAL

1.01. WORK INCLUDED

- A. Inserts, Anchors, and Upper Attachments
- B. Pipe Hangers, Rods, Supports, and Accessories
- C. Fabricated Steel Support

1.02. QUALITY ASSURANCE

- A. Design of pipe supporting elements shall be in accordance with ANSI B31.1
- B. Fabrication and installation of pipe hangers and supports shall be in accordance with the following Manufacturers Standardization Society (MSS) Standards:
 - 1. SP-58 Pipe Hangers and Supports: Materials, Design and Manufacture.
 - 2. SP-69 Pipe Hangers and Supports: Selection and Application.
 - 3. SP-89 Pipe Hangers and Supports: Fabrication and Installation Practices.
- C. Steel angles, channels and plate shall be in accordance with ASTM A36, red primed or hot dipped galvanized for interior applications and hot galvanized for exterior applications.
- D. Bolts, including nuts and washers, used for fabricating steel members shall be in accordance with ASTM A325 and shall be stainless steel or plated for corrosion protection. Plain steel components are unacceptable.
- E. Welding of steel members shall be in accordance with AWS D1.1.
- F. Steel supports for ducts, pipe anchors, pipe guides, and piping supported from below shall be fabricated in accordance with AISC Specification for the Design, Fabrication and Erection of Structural Steel for buildings. If required, the Contractor shall include the cost of the services of a structural engineer to design or review the system.

1.03. APPLICABLE PUBLICATIONS

- A. Applicable sections of the publications listed below form a part of this Section. The publications are referenced by the basic designation only.
 - 1. American Institute of Steel Construction (AISC)
 - 2. American National Standards Institute (ANSI)

3. American Society for Testing and Materials (ASTM)
4. American Welding Society (AWS)
5. The Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS)
6. National Fire Protection Agency (NFPA)
7. Sheet Metal and Air Conditioning Contractor's National Association, Inc. (SMACNA)

1.04. SUBMITTALS

- A. Submit schedule indicating type of hanger to be used by system and pipe size. Include rod size for each hanger size.
- B. Product data, along with installation operation and maintenance instructions, shall be included in the operation and maintenance manuals.
- C. Provide shop drawings for fabricated steel supports.

PART 2 PRODUCTS

2.01. ACCEPTABLE MANUFACTURERS

- A. Inserts, Anchors, and Upper Attachments:
 1. Anvil International, Inc.
 2. Carpenter Paterson, Inc.
 3. Cooper B-Line, Inc.
 4. Elcen Metal Products
 5. Hilti
 6. Unistrut
 7. ITW Red Head
- B. Pipe Hangers, Rods, Supports and Accessories:
 1. Anvil International, Inc.
 2. Carpenter Paterson, Inc.
 3. Cooper B-Line, Inc.
 4. Elcen Metal Products
 5. Hilti

6. Unistrut

- C. Fabricated Steel Support: As indicated on Drawings.

2.02. DESIGN REQUIREMENTS

- A. Supports capable of supporting the pipe for all service and testing conditions. Provide 4-to-1 safety factor.
- B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.
- C. Design supports and hangers to allow for proper pitch of pipes.
- D. For chemical and waste piping, design, materials of construction, and installation of pipe hangers, supports, guides, restraints, and anchors:
1. ASME B31.3.
 2. MSS SP-58 and MSS SP-69.
 3. Except where modified by this Specification.
- E. For steam and hot and cold water piping, design, materials of construction and installation pipe hangers, supports, guides, restraints and anchors:
1. ASME B31.1
 2. MSS SP-58 and MSS SP-69.
- F. Check all physical clearances between piping, support system, and structure. Provide for vertical adjustment after erection.
- G. Support vertical pipe runs in pipe chases at base of riser. Support pipes for lateral movement with clamps or brackets.
- H. Place hangers on outside of pipe insulation. Use a pipe covering protection saddle for insulated pipe at support point.
- I. Fabricated Steel Supports: As detailed on the drawings.

2.03. INSERTS AND ANCHORS

- A. Inserts: MSS Type 18; malleable iron body and nut, galvanized finish, opening in top of insert for reinforcing rod, lateral adjustable.
- B. Anchors: Steel shell and expander plug, snap off end fastener

2.04. HORIZONTAL PIPING HANGERS AND SUPPORTS

- A. Select size of hangers and supports to exactly fit pipe size for bare piping, and around piping insulation with saddle or shield for insulated piping.

- B. For suspension of non-insulated or insulated stationary pipe lines: Adjustable steel clevises, MSS Type I.
- C. For suspension of non-insulated stationary pipe lines: Adjustable band hangers, MSS Type 7 or 9; or split pipe rings, MSS Type II.
- D. For support of piping where horizontal movement due to expansion and contraction may occur, and where a low coefficient of friction is desired: Pipe slides and slide plates, MSS Type 35, including guided plate mounted on a concrete pedestal or structural steel support.
- E. For support from floor stanchion, using floor flange to secure stanchion to floor: Adjustable pipe stanchion saddles, MSS Type 37 or 38, including steel pipe base support and cast-iron floor flange.
- F. For suspension of pipe from two (2) rods where longitudinal movement due to expansion and contraction may occur: Adjustable roller hangers, MSS Type 43.
- G. For suspension of pipe from a single rod where horizontal movement due to expansion and contraction may occur: Adjustable roller hangers, MSS Type 43.
- H. For support of pipe from a single rod where vertical adjustment is not necessary: Pipe roll stands, MSS Type 45.
- I. For support of pipe where small horizontal movement due to expansion and contraction may occur, but vertical adjustment is not necessary: Pipe rolls and plates, MSS Type 45.
- J. For support of pipe lines where vertical and lateral adjustment during installation may be required in addition to provision for expansion and contraction: Adjustment pipe rolls stands, MSS Type 46.

2.05. VERTICAL PIPING CLAMPS

- A. Select size of vertical piping clamps to exactly fit size of bare pipe.
- B. For support and steadying of pipe risers: Two-bolt riser clamps, MSS Type 8 or 42.

2.06. HANGER ROD ATTACHMENTS

- A. Select size of hanger rod attachments to suit hanger rods.
- B. For adjustment up to six (6) inches for heavy loads: Steel turnbuckles, MSS Type 13.
- C. For use on high temperature piping installations: Steel clevises, MSS Type 14.
- D. For use with split pipe rings, MSS Type II: Swivel turnbuckles, MSS Type 15.
- E. For attaching hanger rod to various types of building attachments: Malleable iron sockets, MSS Type 16 or 17.
- F. Rods:
 - 1. Size 3/8" and up: All thread steel rod electro galvanized. Sizing for pipe or equipment support as follows:

Copper Tube, Plastic	Steel, Cast Iron		
Pipe Size (Copper, Plastic)	Pipe Size (Steel, Cast Iron)	Rod Size	Max. Equip. Load
1/4" to 2"	1/4" to 2"	3/8"	730 lbs.
2-1/2" to 4"	2-1/2" to 3"	1/2"	1,350 lbs.
6"	4"	5/8"	2,160 lbs.
8" to 12"	6"	3/4"	3,230 lbs.
14"	8" to 12"	7/8"	4,480 lbs.
16"	14" to 16"	1"	5,900 lbs.
18" to 20"	18" to 20"	1-1/4"	9,500 lbs.
22" to 42"	22" to 42"	1-1/2"	13,800 lbs.

2. Rods may be reduced one size for double rod hangers with 3/8" minimum diameter, or when other paragraphs require a minimum of 2 hangers per section, provided the minimum diameter of 3/8" is maintained.

G. For upper attachment for suspending pipe hangers from concrete: Concrete inserts MSS Type 18.

H. For attachment to top flange of structural shape: Top beam C-clamps, MSS Type 19.

I. For attachment to bottom flange of structural shape: Side beam or channel clamps, MSS Type 20 or 27.

J. For attachment to center of bottom flange of beams: Center beam clamps, MSS Type 21.

K. For attachment to bottom of beams where heavy loads are encountered and hanger rod sizes are large: Welded attachments, MSS Type 22.

L. For attachment to structural shapes: C-clamps, MSS Type 23.

M. For attachment to top of beams when hanger rod is required tangent to edge of flange: Top I-beams clamps, MSS Type 25.

N. For attachment to bottom of steel I-beams for heavy loads: Steel I-beam/WF-beam clamps with eye nut, MSS Type 28 or 29.

O. Steel brackets, for indicated loading:

1. Light duty, 750 pounds, MSS Type 31.
2. Medium duty, 1,500 pounds, MSS Type 32.
3. Heavy duty, 3,000 pounds, MSS Type 33.

P. For use on sides of steel beams: Side beam brackets, MSS Type 34.

2.07. SPRING HANGERS AND SUPPORTS

A. Select spring hangers and supports to suit pipe size and loading.

B. For control of piping movement: Restraint control devices, MSS Type 47.

- C. For light loads where vertical movement does not exceed 1-1/4 inch: Springs cushion hangers, MSS Type 48.
- D. For equipping Type 41 roll hanger with springs: Spring cushion roll hangers, MSS Type 49.
- E. For retardation of sway or thermal expansion in piping systems: Spring way braces, MSS Type 50.
- F. For absorbing expansion and contraction of piping system from hanger: Variable spring hangers, MSS Type 51; preset to indicated load and limit variability factor to 25%.
- G. For absorbing expansion and contraction of piping system from base support: Variable spring base supports, MSS Type 52; preset to indicated load and limit variability factor to 25%; include flange.
- H. For absorbing expansion and contraction of piping system from trapeze support: Variable spring trapeze hangers, MSS Type 53; preset to indicated load and limit variability factor to 25%.
- I. Constant supports: Provide one of the following types, selected to suit piping system. Include auxiliary stops for erection and hydrostatic test, and field load-adjustment capability.
 - 1. Horizontal Type: MSS Type 54.
 - 2. Vertical Type: MSS Type 55.
 - 3. Trapeze Type: MSS Type 56.

2.08. SUPPLEMENTARY SUPPORTS

- A. Where support spacing is more frequent than distance between structural members, provide steel angles, channels or beams sized to provide a deflection of less than 1/240 of span when fully loaded, to transfer pipe support loads to structural members.
- B. Where deflection of center of trapeze support exceeds 1/240 of distance between hanger rods, provide additional hanger rods.
- C. Where multiple risers are supported within shafts, provide steel angles, channels or beams, sized to provide a deflection of less than 1/240 of span when fully loaded, to transfer loads to the concrete floor slab. Anchor supplemental supports to the slab, and provide resilient element where required by other Sections of this Division.

2.09. ACCESSORIES

- A. Protective Shields, MSS Type 40: Carbon steel, galvanized minimum of 12" length sized for required insulation.
- B. Protective Saddles, MSS Type 39: Carbon steel plate, minimum of 12" length, sized for required insulation.
- C. Steel Turnbuckle, MSS Type 13: Forged steel, galvanized finish with locknuts. Rated at a minimum of 730 lbs. at 3/8" size.
- D. Steel Clevis, MSS Type 1: Forged steel, galvanized finish with steel pin and cotter pin. Rated for a minimum of 730 lbs. at 3/8" size.
- E. Weldless Eye Nut, MSS Type 17: Forged steel, galvanized finish. Rated for a minimum of 730 lbs. at 3/8" size.

2.10. PIPE INSULATION HANGER SHIELDS

- A. Where hangers are placed outside the jackets of pipe insulation, provide shields equal to "Thermal Hanger Shields" as manufactured by Pipe Shields, Inc. or equivalent by Elcen Metal Products Company.
- B. Shields shall consist of a 360-degree insert of high-density, 100 psi, waterproof calcium silicate, encased in a 360-degree galvanized sheet steel shield. Insert shall be same thickness as adjoining pipe insulation, and shall extend 1 inch beyond sheet metal shield in each direction on cold lines. Shield lengths and minimum sheet metal gauges shall be as directed below:

PIPE SIZE	SHIELD LENGTH	MINIMUM GAUGE
1/2" to 1-1/2"	4"	26
2" to 6"	6"	20
8" to 10"	9"	16
12" to 18"	12"	16
20" & Larger	18"	16

- C. Shields shall be Model CS-CW, except for pipe roller applications: then provide Model CSX-CW.
- D. At the Contractor's option, shop-fabricated galvanized metal shields may be provided based on approved shop drawings. Length and gauge of sheet metal shall be as specified above.
- E. For all insulated piping 4" and larger, provide insulation insert at a minimum of 12" long. Insert shall extend a minimum of one inch beyond shield. Insulation inserts shall be minimum 12" long section of foam glass insulation.

2.11. METAL FRAMING: Provide products compliant with NEMA ML-1.

2.12. STEEL PLATES, SHAPES AND BARS: Provide products compliant with ANSI/ASTM A-36.

2.13. PIPE GUIDES: Provide factory-fabricated guides, of cast semi-steel or heavy fabricated steel, consisting of a bolted two-section outer cylinder and base, with a two-section guiding spider bolted tight to pipe or as shown on Drawings. Size guides and spiders to clear pipe, cylinder and insulation, if any. Provide guides of length recommended by manufacturer to allow indicated travel.

PART 3 EXECUTION

3.01. GENERAL REQUIREMENTS

- A. Where applicable, install in accordance with the manufacturer's written installation instructions.
- B. Where supports are in contact with copper pipe, provide copper plated support.
- C. Where supports are in contact with glass, aluminum or brass pipe, provide plastic coating on supports.
- D. Interior hangers, supports, including attachments, that are plain steel shall be primed and painted.
- E. Hangers and supports, including attachments, exposed to weather or located in utility tunnels or

accessible utility trenches or subject to spillage shall be hot dip galvanized after fabrication.

- F. Fabricated steel supports exposed to weather or located in utility tunnels and accessible utility trenches or subject to spillage shall be primed and painted. Cut, welded, drilled or otherwise damaged surfaces of coating shall be repaired.

3.02. PREPARATION

- A. Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including but not limited to proper placement of inserts, anchors and other building structural attachments.

3.03. INSTALLATION OF HANGERS AND SUPPORTS

- A. Install hangers, supports, clamps and attachments to support piping properly from building structure in compliance with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together in trapeze-type hangers where possible. Install supports with maximum spacing as specified in this Section. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for small diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping.
- B. Install hangers and supports complete with necessary bolts, rods, nuts, washers, and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.
- C. Support fire protection water piping independently of other piping
- D. The location of hangers and supports shall be coordinated with the structural work to ensure that the structural members will support the intended load.
- E. Provide hex head nut on rod at top and bottom of clevis hanger yoke, and at each rod connection to intermediate and upper attachment. Rod nuts shall be securely locked in place.
- F. Hanger rods shall be subject to tensile loading only. Where lateral or axial movement is anticipated, use suitable linkage in hanger rod to permit swing.
- G. Hangers shall be fabricated to permit adequate adjustment after erection while still supporting the load. Turnbuckles shall be provided where required for vertical adjustment of the piping.
- H. Supports for vertical piping shall be located at each floor or at intervals of not more than 15 feet and at intervals of not more than 8 feet from end of risers. Where supports are provided on intermediate floors spaced 15 feet or less between floors, no additional supports are required other than those specified for end of risers.
- I. A hanger or support shall be provided adjacent to each piece of equipment to ensure that none of the pipe weight is supported from the equipment.
- J. Provide protective shields on all piping required to be insulated.
- K. Provide protective saddles sized to match insulation thickness on all hot piping required to be insulated. Fill void between saddle and pipe with insulation as specified.
- L. Provide turnbuckles on all hangers that require leveling or aligning.
- M. Provide steel clevis where detailed and/or required.

N. Provide weldless eye nuts on hanger terminations where disassembly or swing may be required. Use in combination with steel clevis.

O. Supports

1. Provide additional supports at:
 - a. Changes in direction.
 - b. Branch piping and runouts over 5 feet.
 - c. Concentrated loads due to valves, strainers and similar items.
 - d. At valves 4 inches and larger in horizontal piping.
 - e. Support piping on each side of valve.
 - f. Brace hubless piping to prevent horizontal and vertical movement.
 - g. Where number of grooved couplings exceeds 3 between supports or provide continuous steel between supports.
2. Sanitary waste and vent, roof drains per UPC Section 316: Vertical supports are not required within 2.5 feet of wall penetrations for pipes 8 inches in diameter and smaller, and not more than 3 feet for 10 inches and larger.
3. Other piping support spacing shall be as scheduled on Drawing or as required by referenced standard.

3.04. HANGER SPACING

- A. The maximum spacing between pipe supports for straight runs shall be in accordance with the following chart. If any deviation from the table exists within the manufacturer's written installation instruction, whichever spacing reflecting the smaller centerline to centerline dimension shall be used.

MAXIMUM HORIZONTAL PIPE HANGER AND SUPPORT SPACING TABLE

1. Steel Pipe (Schedule 40 & 80):
 - Up to 1" 7 ft. on center
 - 1-1/4" and greater 10 ft. on center
2. Copper Pipe (Types L, K and M):
 - Up to 1" size: 5 ft. on center
 - 1-1/4" to 2-1/2" 7 ft. on center
 - 3" and larger..... 10 ft. on center
3. Ductile Iron and Cast Iron: Two hangers per section length.
4. Polyvinyl Chloride (PVC):
 - Up to 1-1/2" 3 ft. on center
 - 2" to 4" 4 ft. on center
 - 5" to 8" 5 ft. on center
 - 10" and larger..... 6 ft. on center
5. Sprinkler and Standpipe: Pipe hangers to be as per NFPA-13 and NFPA-14 standards.

- B. Hanger centerline spacing shall be reduced by 50% in areas of concentrated valves and/or fittings, also no more than a maximum distance of 12 inches from valves, fittings and/or couplings, or 24 inches from a change in direction.

3.05. ATTACHMENT TO STRUCTURE

- A. For plain steel devices, prime and paint.
- B. Adjust attachment location for proper alignment and no more than 4 degrees offset from a perpendicular alignment.
- C. If proper alignment cannot be achieved from the existing building structure, provide a trapeze type support sized to handle the design load with a minimum safety factor of 5.

3.06. INSERTS

- A. Contractor shall have inserts at site and dimensional location drawings ready at the beginning of the involved concrete work.
- B. Install inserts by securing to concrete forms and inserting reinforcing rod through the opening provided in the insert in accordance with shop drawings.
- C. Provide necessary supervision while concrete is being poured to correct any misalignment caused by the concrete.

3.07. INSTALLATION OF ANCHORS

- A. Install anchors at proper locations to prevent stresses from exceeding those permitted by ANSI B-31, and to prevent transfer of loading and stresses to connected equipment.
- B. Fabricate and install anchor by welding steel shapes, plates and bards to piping and to structure. Comply with ANSI B-31, with AWS standards, and with the Details shown on the drawings.
- C. Where expansion compensators are indicated, install anchors in accordance with expansion unit manufacturer's written instructions to limit movement of piping and forces to maximums recommended by manufacturer for each unit.
- D. Anchor Spacing: Where not otherwise indicated, install anchors at ends of principal pipe runs and at intermediate points in pipe runs between expansion loops and bends. Make provisions for preset of anchors as required, accommodating both expansion and contraction of piping.
- E. Size anchor shell length to assure a minimum of 1" solid concrete remaining from shell and to concrete face.

3.08. INSTALLATION OF TRAPEZES OR PIPE RACKS

- A. Light/Medium Duty: Assemble from standard manufactured metal framing systems, in accordance with manufacturer's recommendations.
- B. Heavy Duty: Fabricate from structural steel shapes selected for loads required. Weld steel in accordance with AWS standards.

3.09. AUXILIARY STEEL

- A. Furnish all miscellaneous structural members necessary to hang or support ductwork, piping, and mechanical equipment.
- B. Notify Engineer of any adjustment necessary in main structural system for proper support of

major equipment.

- C. Fabricated Steel Supports: Steel for supports shall be saw cut, with sharp edges ground smooth. After fabrication, remove all foreign material, including welding slag and spatter, and leave ready for painting.

END OF SECTION

SECTION 220160 - NATURAL GAS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

- A. This section covers the complete natural gas system installation, within and to five (5) feet beyond building perimeter unless noted otherwise on Contract Drawings, including but not limited to piping, regulators, unions, valves, installation, testing and other normal parts that make the systems complete, operable, code compliant and acceptable to the authorities having jurisdiction.

1.2 REFERENCE STANDARDS

- A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
- B. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
- C. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
- D. 2018 Edition of the International Fuel Gas Code.
- E. Latest Edition of NFPA 54, National Fuel Gas Code.

1.3 QUALITY ASSURANCE

- A. All materials, equipment and Work shall meet or exceed all applicable federal, state and local requirements and conform to codes and ordinances of authorities having jurisdiction.
- B. Valves: Manufacturer's name, size, standards compliance and pressure rating clearly marked on outside of valve body.
- C. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

1.4 SUBMITTALS

- A. Product Data:
- B. Provide code and standards compliance verification, manufacturer's product data and ratings on pipe materials, pipe fittings, regulators, valves and accessories.

1.5 DELIVERY, STORAGE and HANDLING

- A. Accept valves on Site in shipping containers with labeling in place, inspect for damage and store with a minimum of handling. Store plastic piping under cover out of direct sunlight. Do not store materials directly on the ground.
- B. Provide temporary protective coating on cast iron and steel valves.

- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work and isolating parts of completed system.

1.6 EXTRA MATERIALS

- A. Provide one (1) plug valve wrench for every ten (10) plug valves sized 2 inches and smaller, minimum of one. Provide each plug valve sized 2-1/2 inches and larger with a wrench incorporating a setscrew.

PART 2 - PRODUCTS

2.1 GENERAL

- A. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
- B. Natural gas pressures shall not exceed five (5) pounds per square inch gauge on Owner's side of the meter.
- C. Pipe joint compound shall be lead-free, non-toxic, non-hardening, insoluble in the presence of natural gas and compliant with ANSI/NSF 61 and Federal Specification TT-S-1732. Temperature service range of -15 degrees F to +400 degrees F, manufactured by Hercules "MegaLoc" or approved equal by Rectorseal, La-Co or Oatey.

2.2 PIPING

- A. Buried Piping Outside of Building:
 - 1. Polyethylene, SDR-11, ASTM D2513 pipe and fittings with heat fusion socket joints.
 - 2. Polyethylene pipe and fitting materials shall be compatible and by same manufacturer to ensure uniform melting and a proper bond. Fabricated fittings shall not be used.
 - 3. Provide connection between buried plastic gas service piping and metallic riser in accordance with the gas code. Provide metallic riser consisting of HDPE fused coating on steel pipe for connection to above ground building distribution piping. Underground horizontal metallic portion of riser shall be at least twenty four inches in length before connecting to the plastic service pipe. An approved transition fitting or adaptor meeting design pressure rating and plastic pipe manufacturers recommendations shall be used where the plastic joins the metallic riser.
- B. Above Ground Piping Outside of Building (Including roof):
 - 1. Piping 2 inches and smaller shall be seamless Schedule 40 black steel, ASTM A106 or ASTM A53 Type "S", Grade A or B, with Class 150 black malleable iron threaded fittings conforming to ASME B16.3.

2. Piping 2½ inches and larger shall be Type "S" seamless or Type "E" electric resistance welded Schedule 40 black steel, ASTM A53, Grade A or B, with Schedule 40 wrought carbon steel fittings, ASTM A 234 and butt weld joints.
 3. Provide factory-applied, three-layer coating of epoxy, adhesive, and PE or field applied primer and epoxy paint coating on all pipe and fittings. Field applied coating is restricted to fittings and short sections of pipe necessarily stripped for threading or welding. Field coating shall be manufactured by Amercoat Type 240 or approved equal and applied in accordance with manufacturer's recommendations. Galvanizing shall not be considered adequate protection.
- C. Above Ground Piping Inside of Building:
1. Piping 2 inches and smaller shall be seamless Schedule 40 black steel, ASTM A106 or ASTM A53 Type "S", Grade A or B, with Class 150 black malleable iron threaded fittings conforming to ASME B16.3.
 2. Piping 2½ inches and larger shall be Type "S" seamless or Type "E" electric resistance welded Schedule 40 black steel, ASTM A53, Grade A or B, with Schedule 40 wrought carbon steel fittings, ASTM A 234 and butt weld joints.
- D. Above Ground Piping Concealed Inside of Building ("Concealed Piping" as defined by the International Fuel Gas Code, 2018):
1. Piping 2 inches and smaller shall be seamless Schedule 40 black steel, ASTM A106 or ASTM A53 Type "S", Grade A or B, with welded joints with Schedule 40 socket welded forged steel fittings conforming to ASME B16.11.
 2. Piping 2½ inches and larger shall be Type "S" seamless or Type "E" electric resistance welded Schedule 40 black steel, ASTM A53, Grade A or B, with Schedule 40 wrought carbon steel fittings, ASTM A 234 and butt weld joints.
 3. Piping above ceilings 2 inches and smaller may be installed as threaded in lieu of welded provided that all piping is encased within steel sleeve vented to the exterior of the building. Sleeve piping shall be Schedule 10 black steel pipe conforming to ASTM A53, Grade A or B, electric resistance welded or seamless, with roll-grooved ends. Sleeve pipe couplings shall be Victaulic Style 75 with Grade T nitrile gasket. Sleeve fittings shall be Victaulic grooved malleable or steel. Sleeve piping and fittings must be two pipe sizes, but not less than 1 inch larger than encased gas piping.

2.3 UNDERGROUND WARNING TAPE

- A. Minimum 3 inch wide polyethylene detectable type marking tape. The tape shall be resistant to alkalis, acids and other destructive agents found in soil and impregnated with metal so that it can be readily recognized after burial by standard locating equipment.
- B. Lamination bond of one (1) layer of Minimum 0.35 mils thick aluminum foil between two (2) layers of minimum 4.3 mils thick inert plastic film.
- C. Minimum tensile strength: 63 LBS per 3 IN width.
- D. Minimum elongation: 500 percent.

- E. Provide continuous yellow with black letter printed message repeated every 16 to 36 inches warning of pipe buried below (e.g.: "CAUTION GAS LINE BURIED BELOW").
- F. Manufactured by Reef Industries "Terra Tape" or approved equal.

2.4 VALVES

- A. All valves shall be designed, manufactured and approved for natural gas service.
- B. Line Shut-off Valves sizes 2 inches and smaller shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, wrench operation, rated for 200 WOG service pressure and -20 to 200 degrees F., manufactured by Resun Model R-1430, Nordstrom Model 142, or approved equal.
- C. Line Shut-off Valves sizes 2½ inches and larger shall be iron body lubricated plug valve conforming to ASTM-A-126, U.L. Listed and A.G.A. Approved for natural gas service with flanged ends, wrench operation, rated for 200 WOG service pressure and -20 to 200 degrees F., manufactured by Resun Model R-143, Nordstrom Model 143, or approved equal.
- D. Appliance/Equipment Shut-off Valves at local connections sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL, Milwaukee Model BB2-100, or approved equal.
- E. Manual Emergency Shut-off Valves sizes 2 inches and smaller shall be bronze body, full port ball or butterfly type, U.L. Listed and A.G.A. Approved for natural gas service with threaded ends, quarter turn lever handle operation, rated for 175 W.O.G. service pressure and 30 to 275 degrees F., manufactured by Nibco Model T585-70-UL, Model T580-70-UL, Milwaukee Model BB2-100, or approved equal.
- F. Automatic Emergency Shut-off Valves shall be U.L. Listed F.M. Approved for natural gas service, 2-way electrically tripped solenoid type; fail safe closed; manual reset; Type 1 solenoid enclosure; NBR seals and disc; stainless steel core tube and springs; copper coil; manufactured by ASCO Red Hat Series 8044, or approved equal.

2.5 PRESSURE REGULATORS

- A. All pressure regulators shall be designed, manufactured and approved for natural gas service.
- B. Pressure regulators for individual service lines shall be capable of reducing distribution line pressure to pressures required for users. Pressure relief shall be set at a lower pressure than would cause unsafe operation of any connected user. Regulator shall have a single port with orifice diameter no greater than that recommended by manufacturer for the maximum gas pressure at the regulator inlet. Regulator vent valve shall be of resilient materials designed to withstand flow conditions when pressed against valve port. Regulator shall be capable of limiting build-up of pressure under no-flow conditions to 50 percent or less of the discharge pressure maintained under flow conditions. Commercial grade diaphragm type with internal relief valve, vent valve, cast iron body, Buna-N diaphragm. Manufactured by Rockwell or Fisher.

- C. Install pressure gauge adjacent to and downstream of each line pressure regulator.

2.6 UNIONS

- A. Unions in 2 inches and smaller in ferrous lines shall be right and left hand nipple/coupling assembly, or ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends, 2-1/2 inches and larger shall be ground flange unions. Companion flanges on lines at various items of equipment, machines and pieces of apparatus may serve as unions to permit disconnection of piping.
- B. Unions connecting ferrous pipe to copper or brass pipe shall be dielectric type.
- C. Above grade flexible stainless steel appliance/equipment connectors shall conform with AGA under the ANSI Z21.69 Standard. Hose shall be braided stainless steel with a polyolefin heat-shrink tubing with high flame-retardant qualities. Hose shall be equipped with malleable iron unions and spring loaded brass quick-link couplings. An easily accessible manual shut-off valve shall be installed ahead of all hose connections. Specify T&S Brass "Safe-T-Link" or approved equal.

2.7 FLANGES

- A. All 150 lb. and 300 lb. ANSI flanges shall be domestically manufactured, weld neck forged carbon steel, conforming to ANSI B16.5 and ASTM A-181 Grade I or II or A-105-71. Slip on flanges shall not be used. Each fitting shall be stamped as specified by ANSI B16.9 and, in addition, shall have the laboratory control number stenciled on each fitting for ready reference as to physical properties and chemical composition of the material. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. Bolts shall have a tensile strength of 60,000 psi and an elastic limit of 30,000 psi. Flat-faced flanges shall be required to match flanges on check valves, strainers, and other valves and devices. Only one manufacturer of weld flanges will be approved.
- B. All flanges shall be gasketed. Contractor shall place gasket between flanges of flanged joints. Gaskets shall fit within the bolt circle on raised face flanges and shall be full face on flat face flanges. Gaskets shall be cut from 1/16 inch thick, non metallic, non asbestos gasket material suitable for operating temperatures from -150 degrees F to +75 degrees F, Klingsil C-4400, Manville Style 60 service sheet packing, or equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe ends and remove cutting burrs. Bevel plain end ferrous pipe.
- B. Remove cutting oil, scale and dirt, on inside and outside of piping, before assembly.

3.2 EQUIPMENT CONNECTIONS

- A. Provide specified connections, shutoff valves, regulators and unions at each and every appliance and piece of equipment requiring natural gas.

- B. Provide and install union type connections at all equipment to permit removal of service piping.
- C. Gas service connections shall have a diameter at least one pipe size larger than that of the inlet connection to the equipment as provided by the manufacturer and be of adequate size to provide the total input demand of the connected equipment.
- D. Provide listed and labeled appliance connectors complying with ANSI Z21.69 and listed for use with food service equipment having casters, or that is otherwise subject to movement for cleaning, and other large movable equipment. Connectors shall have listed and labeled quick-disconnect devices and shall have retaining cables attached to structures and equipment. Connectors shall not be concealed within or extended through wall, floor or partition and shall be located entirely in the same room as the connected equipment. Provide an accessible shut-off valve not less than the nominal size of the equipment connector, immediately ahead of the connector.
- E. Rigid metallic pipe and fittings shall be used at service connections to all stationary equipment.

3.3 INSTALLATION

- A. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
- B. All installation shall be in accordance with manufacturer's published recommendations.
- C. Provide support for and connections to natural gas service meter in accordance with requirements of the utility company, when so indicated on the Drawings.
- D. All installation shall be in accordance with manufacturer's published recommendations.
- E. Distribution piping shall be as short and as direct as practicable between the point of delivery and the outlets.
- F. Do not install underground piping when bedding is wet or frozen.
- G. Bury all underground piping at least 3 feet below finished grade. Provide a continuous detectable warning tape on tamped backfill, 12 inches above all buried non-metallic gas lines.
- H. Do not install gas piping in the same trench with other utilities. The minimum horizontal clearance between gas pipe and parallel utility pipe shall be 2 feet. Do not install gas pipe through catch basins, vaults, manholes or similar underground structures.
- I. Install and support all polyethylene piping in accordance with manufacturer's recommendations. All heat fusion welds shall be performed by welders qualified to the manufacturer's procedures.
- J. Polyethylene piping shall not be installed above ground.
- K. Provide connection between buried plastic gas piping and metallic riser in accordance with the gas code.

- L. All above ground gas piping shall be electrically continuous and bonded to electrical system ground conductor in accordance with NFPA 70.
- M. Provide and install union type fittings at proper points to permit dismantling or removal of pipe. No unions will be required in welded lines except at equipment connections. Where union type fittings are necessary for piping dismantling purposes, right and left nipples and couplings shall be used. Flanges, ground-joint unions or approved flexible appliance connectors may be used at exposed fixture, appliance or equipment connections.
- N. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment, such as dielectric coupling or dielectric flange fitting.
- O. Valves, regulators, flanges, union type fittings and similar appurtenances shall be accessible for operation and servicing and shall not be located above ceilings, within chases, walls/partitions, spaces utilized as return air plenums or non-accessible locations.
- P. Route piping in orderly manner and maintain gradient. Install piping to conserve building space. Group piping whenever practical at common elevations.
- Q. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- R. Make service connections at the top of the main, whenever the depth of the main is sufficient to allow top connections. When service connections cannot be made at the top of the main, they shall be made on the side of the main no lower than the horizontal midpoint of the gas main.
- S. Close nipples, bushing and cross type fittings shall not be installed in any gas piping system.
- T. Slope piping and arrange to drain at low points. Install drip/sediment traps at points where condensate and debris may collect. Locate drip/sediment traps where readily accessible for cleaning and emptying. Do not install where condensate would be subject to freezing. Construct drip/sediment traps using tee fitting with capped nipple connected to bottom outlet. Use minimum-length nipple of 3 pipe diameters, but not less than 4 inches long, and same size as connected pipe. Cap shall be screwed pattern, black, standard weight, malleable iron. Install with adequate space for removal of cap.
- U. Install valves for shut off and to isolate equipment, parts of systems, or vertical risers. All valves shall be located such that servicing and operation is possible. All flanged valves shown in horizontal lines with the valve stem shall be positioned so that the valve stem is inclined one bolt hole above the horizontal position. Screw pattern valves placed in horizontal lines shall be installed with their valve stems inclined at an angle of a minimum of 30 degrees above the horizontal position. All valves must be true and straight at the time the system is tested and inspected for final acceptance.
- V. Install line shut-off valve at each branch connection to riser.
- W. Provide adequate clearance for access to and operation of all valves.
- X. Install valves with stems upright or horizontal, not inverted unless required otherwise by the valve manufacturer.

- Y. Pipe vents from gas pressure reducing valves and pipe casing sleeves to the exterior of the building and terminated with outlet turned down and capped with corrosion resistant insect screen. Vent terminations shall be at least seven feet above grade or pedestrian traffic and a minimum three (3) feet above or twenty-five (25) feet horizontally from all air intakes or building openings.
- Z. Above ground horizontal natural gas and encasement piping shall be supported at intervals of no greater than 6 foot for 1/2 inch piping, 8 foot for 3/4 inch and 1 inch piping and 10 foot for 1-1/4 inches and larger piping. Vertical piping shall be supported at each floor level and at intervals as specified for horizontal piping.
- AA. Extension bars shall not be used for supporting gas or encasement piping. Gas or encasement piping shall not be used to support any other piping or component.
- BB. Provide piping and valve identification in accordance with Project Specification Section 20 05 53.

3.4 INSTALLATION OF WELDED PIPING

- A. Welding of pipe in normally occupied buildings is prohibited. Off-Site welding is acceptable. Should welding be required in a normally occupied building for connecting to an existing welded system, obtain written approval from the Owner and comply with Owner's fire and life safety requirements.
- B. Piping and fittings shall be welded and fabricated in accordance with ASME/ANSI the latest editions of Standard B32.1 for all systems from the Code for Pressure Piping. Machine beveling in shop is preferred. Field beveling may be done by flame cutting to recognized standards.
- C. Ensure complete penetration of deposited metal with base metal. Provide filler metal suitable for use with base metal. Maintain inside of fittings free from globules of weld metal. All welded pipe joints shall be made by the fusion welding process, employing a metallic arc or gas welding process. All pipes shall have the ends beveled 37-1/2 inch degrees and all joints shall be aligned true before welding. Except as specified otherwise, all changes in direction, intersection of lines, reduction in pipe size and the like shall be made with factory-fabricated welding fittings. Mitering of pipe to form elbows, notching of straight runs to form tees, or any similar construction will not be permitted.
- D. Align piping and equipment so that no part is offset more than 1/16 inch. Set all fittings and joints square and true and preserve alignment during welding operation. Use of alignment rods inside pipe is prohibited.
- E. Contractor shall not permit any weld to project within the pipe so as to restrict it. Tack welds, if used, must be of the same material and made by the same procedure as the completed weld. Otherwise, remove tack welded during welding operation.
- F. Do not split, bend, flatten or otherwise damage piping before, during or after installation.
- G. Remove dirt, scale and other foreign matter from the inside of piping, by swabbing or flushing, prior to the connection of other piping sections, fittings, valves or equipment.

- H. In no cases shall Schedule 40 pipe be welded with less than three passes including one stringer/root, one filler and one lacer. Schedule 80 pipe shall be welded with not less than four passes including one stringer/root, two filler and one lacer. In all cases, however, the weld must be filled before the cap weld is added.

3.5 TESTING

- A. All natural gas systems shall be inspected, tested, purged and placed into operation in accordance with NFPA 54 and as required herein.
- B. All necessary apparatus for conducting tests shall be furnished by the Contractor and comply with the requirements of NFPA 54.
- C. All new rough-in distribution piping and affected portions of existing systems connected to, shall be subjected to a pneumatic test pressure utilizing clean, dry air and must be demonstrated to be absolutely tight when subjected to the pressures and time durations listed herein. All equipment and components designed for operating pressures of less than the test pressure shall not be connected to the piping system during test.
- D. Systems on which the normal operating pressure is less than 0.5 pounds per square inch gauge (psig), the test pressure shall be 5.0 psig and the time interval shall be 30 minutes.
- E. Systems on which the normal operating pressure is between 0.5 psig and 5.0 psig, the test pressure shall be 1.5 times the normal operating pressure or 5.0 psig, whichever is greater, and the time interval shall be 30 minutes.
- F. Systems on which the normal operating pressure is 5.0 psig or greater, the test pressure shall be 1.5 times the normal operating pressure, and the time interval shall be one (1) hour.
- G. After testing is complete, the entire gas system shall be purged with dry nitrogen to eliminate all air, debris and moisture from the piping before natural gas is introduced into the system.
- H. After successful results of pressure test and purging have been completed, a leakage test shall be performed in accordance with NFPA 54 Appendix D.
- I. Connect, inspect and purge gas utilization equipment, lab hook-ups and outlets, and place into operation only after successful results of pressure test, leakage test and purging have been completed and accepted.
- J. Testing operations shall be repeated until gas-piping systems are absolutely tight at the pneumatic test pressures indicated above.
- K. Pressure test gas piping sleeve system with clean, dry compressed air at 15 psig by temporarily sealing all openings between gas carrier pipe and sleeve and vent openings. Sleeve systems must be demonstrated to be absolutely tight when subjected to this pressure for a period of four hours.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

- A. The intent of these specifications and the accompanying drawings is to provide complete and workable systems as shown, specified and required by applicable codes.

1.2 CODES

- A. All material and equipment provided and installed as part of these construction documents shall be in compliance with the latest edition of the adopted codes and applicable standards by the State in which the work is performed.

1.3 RESPONSIBILITY

- A. The Construction Manager/General Contractor (CM/GC) shall be responsible for all work included in Division 22. The delegation of work to the contractors shall not relieve him of this responsibility. Contractors who perform work under this Division shall be responsible to the CM/GC.

1.4 PERMITS

- A. Obtain and pay for permits, fees, certificates of inspection and approval, etc. required for this work. Furnish Owner with certificates of final inspection and approval prior to final acceptance of the work.
- B. Laws and regulations which bear upon or affect the work shall be complied with.

1.5 SITE VISIT

- A. Prior to preparing the bid, the mechanical plumbing subcontractor shall visit the site and become familiar with all existing conditions. Make all necessary investigations as to locations of utilities and all other matters which can affect the work. No additional compensation will be made to the contractor as a result of his failure to familiarize himself with the existing conditions under which the work must be performed.

1.6 OUTAGES

- A. For all work requiring an outage, the plumbing contractor shall submit an outage request to the Engineer / Owner.
- B. The existing plumbing system shall remain operational unless coordinated with the Engineer / Owner during the construction of the project.
- C. Unless otherwise specified, outages of any services required for the performance of this contract and affecting areas other than the immediate work area shall be scheduled at least ten business days (10) days in advance. Outages shall be performed so as to minimize disruption to the owner. If necessary, some outage work may be performed outside normal hours if approved by Owner.
- D. All plumbing outages which will interfere with the normal use of the building in any manner shall be done at such times as shall be mutually agreed upon by the contractor and the Owner.
- E. The plumbing contractor shall include in his price the cost of all premium time required for outages and other work which interferes with the normal use of the building, which will be performed, in most cases, during other than normal work time and at the convenience of the Owner.

1.7 REQUESTS FOR INFORMATION

- A. Submit all questions, requests for information (RFIs) and similar queries through the formally established RFI process for the project that has been accepted by the Owner's Representative, Design Professionals, CM/GC, and subcontractors.

1.8 SUBMITTALS

- A. Provide submittals for all material, equipment and supports as specified in Division 22 and where indicated on the drawings and details. At a minimum the following submittals shall be provided as required by the project unless otherwise noted:
 - 1. Pipe, fittings and accessories
 - 2. Valves, strainers and unions
 - 3. Insulation
 - 4. Hangers and supports
 - 5. Plumbing fixtures and trim
 - 6. Safety fixtures and equipment
 - 7. Backflow preventers
 - 8. Identification labels and tags
 - 9. Floor drains

10. Roof drains
 11. Hot water heating equipment
 12. Trap priming system
 13. Plumbing pumps
 14. RO/DI equipment and pipe
 15. Laboratory compressed air system
 16. Laboratory vacuum system
 17. Laboratory gas outlets
- B. Warranties and maintenance instructions shall be included in the O & M Manual only. Do not include this data in the Product Submittals.
- C. The Contractor shall provide to the Engineer for review electronic copies of required submittals, in PDF format, unless noted otherwise. All Catalog Data, Shop Drawings, Calculations, and Certificates of Compliance shall be submitted as a single package. Failure of the contractor to provide a complete submittal package may result in delay in processing time. All such delays to the job resulting from the contractor's failure to provide submittals at one time will be the responsibility of the Contractor. Submittals shall clearly identify the contract documents specification section or drawing referenced, identifying and highlighting each item to be reviewed.
- D. Submittals provided for review shall clearly and completely describe the specific product(s) they represent. Where differences exist between the item specified and that submitted for review, the submittal shall be highlighted.
- E. Submittals shall bear the review stamp of the Contractor. The review stamp of the Contractor shall be affixed to shop drawings to indicate:
1. The Contractor has coordinated the electrical characteristics of the equipment.
 2. The Contractor has verified that the equipment submitted will physically fit into the space allocated with adequate clearances for maintenance, access, and egress requirements.
 3. The Contractor shall bear all associated costs that may accrue due to failure to completely represent a given product.
- F. Material and equipment shown on the drawings or specified herein shall not be incorporated in the work of this Contract until shop drawings, engineering data, and catalog information have been reviewed and accepted by the Engineer.
- G. The installing contractor shall maintain as-built drawings; and, shall provide the complete set at the time of final close out. As-built drawings are to be provided, in PDF format on compact disk or DVD.

1.9 VARIANCES

- A. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quantity or higher cost shall be included in the contract price. The Engineer shall decide on the item and manner in which the work shall be provided.

1.10 PERFORMANCE REQUIREMENTS

- A. Contract drawings are generally diagrammatic and do not indicate all offsets, fittings, transitions, access panels and other specialties required. Furnish and install all items as may be required to fit the work to the conditions encountered. Install all new work in such manner as to conform to the structure, avoid obstructions, provide required service clearances and preserve headroom. Do not scale from drawings, all measurements should be taken in the field.
- B. Arrange plumbing piping, equipment and other work generally as shown on the contract drawings, providing proper clearances and access.
- C. Coordinate all work with all other contractors and installers in addition to existing building obstructions and install accordingly. Comply with requirements of architectural drawings including but not limited to mounting height and locations. Fully research peculiarities and limitations of space available for installation of work with materials being provided. Work around material lead times to not extend project schedule.

1.11 QUALITY ASSURANCE

- A. Contractor shall have a minimum five (5) years experience in the installation of systems similar to the systems specified. Contractor, if requested, shall demonstrate his ability to perform all work to be included under the contract. Assurance if requested, shall be in the form of a list of past projects of similar size and complexity and a list of six (6) references pertaining to those projects. Failure to demonstrate these quality assurances shall be taken as a statement of the contractor's inability to perform.

1.12 WARRANTY / GUARANTEE

- A. Provide a warranty/guarantee in written form as part of O&M manual stating that all work, materials, equipment and parts are warranted to be free of defect for a minimum period of one year from the date of Substantial Completion. Warranty period and requirements may be expanded in drawings or subsequent specification sections. Repair or replace (owner's option) any defects or failures at no cost to the owner within the warranty period. Issues arising within warranty period must be attended to in a timely manner and in no case exceed four (4) working days. State this in writing as part of O&M manual. Replace defective items to the satisfaction of the Owner's Representative and the Design Professional.

PART 2 PRODUCTS

2.1 GENERAL

- A. The listed manufacturers represent the basis for design and identify the minimum level of quality for materials and equipment, specified in this Division, that are acceptable. Contractors may submit material and equipment by non-listed manufacturers provided submittals meet the requirements of these specifications. All submitted materials and equipment are subject to approval by the Engineer.
- B. Provide materials that are new, full weight, and of the best quality. Obtain equipment, components and materials from single manufacturer for products of the same kind or category. Provide materials that are listed and labeled and marked for intended location and application.
- C. The equipment layouts and the related mechanical and electrical service connections, access space and supports indicated on the construction documents represent equipment provided by the specified basis of design manufacturer and model number. When the successful bidder chooses to provide equipment by another approved manufacturer, the bidder shall be responsible for providing all adjustments and modifications to the services necessary to make connections to the equipment, the bidder shall be responsible for installing the equipment such that all required clear access space is maintained, and the bidder shall be responsible for providing all adjustments and modifications to the equipment mounting and supports. All adjustments and modifications shall be provided by the bidder and appropriate subcontractors at no additional cost to the project.

PART 3 EXECUTION

3.1 GENERAL

- A. Unless specifically indicated, provide all specified and drawn work as required to render all equipment and systems fully operational, including all ancillary, accessory, and support work. Install equipment and materials in strict accordance with manufacturer's written instructions.
- B. In cases where products or materials are furnished by Owner or others, provide the following services: receive, transport and securely store materials on site; remove materials and components from packaging; assemble all materials and components per factory instructions; install, wire and connect materials and components as recommended by manufacturer for a fully operational installation.
- C. Examine surfaces to receive products for suitable mounting conditions and verify compliance with installation tolerances and other conditions affecting performance of the work. Proceed with installation only after unsatisfactory conditions have been corrected.

- D. Equipment shall be installed in accordance with manufacturer's installation recommendations. Provide and maintain service, maintenance and operating clearances as required by the manufacturer.
- E. Workmanship throughout shall conform to the standards of best practice and all labor employed must be competent and qualified to do all the work required.

3.2 COORDINATION ITEMS

- A. Coordinate sizes and locations of concrete housekeeping pads with architectural and structural elements. Concrete housekeeping pads shall be provided with all equipment provided. Concrete shall be 3,500 psi twenty-eight (28) day compressive strength concrete with reinforcement bars as specified in the architectural specifications.
- B. Cut and drill all openings in roofs, walls, and floors required for the installation. Neatly patch all openings cut. Hold cutting and patching to a minimum by arranging with other contractors for all sleeves and openings before construction is started. When drilling/cutting concrete slabs, utilize ground penetrating radar (GPR) and/or X-ray scanning equipment to verify the location is free from obstructions, including but not limited to: structural rebar/strands/tendons, electrical conduit/wiring, and/or piping/ductwork.

3.3 DELIVERY, STORAGE, HANDLING, AND PROTECTION

- A. Receive, inspect, store and protect all materials required for new work. Do not accept or install any product damaged in any way.
- B. Comply with all manufacturer guidelines and requirements for movement, storage, and protection of new work. All new work must be stored in a clean, dry place protected from weather and construction traffic. Maintain acceptable temperature and humidity per manufacturer recommendations.
- C. Prior to installation, all products shall have the ability to be returned to the supplier or manufacturer after purchase and charged a reasonable restocking fee equal to a small portion of the cost.
- D. Protect all new work through construction from damage. Take safeguards necessary to protect from damage. Items damaged during construction will not be accepted and shall be replaced with new.
- E. Remove and replace all materials that have been installed improperly, physically damaged, moisture or water damaged, or mold damaged.
- F. Protect drains throughout all phases of construction to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- G. Place plugs in ends of uncompleted piping at end of each day or when work stops.

3.4 EXCAVATING AND BACKFILLING

- A. Perform all excavation and backfilling required for admittance of work. Execute work safely providing slope sides, shoring and bracing as required for stability.
- B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations. Properly restore streets, sidewalks, concrete and blacktop surfaces that were broken during the excavation process.
- C. Underground drainage piping shall be laid on a 6" of well-tamped bedding course of a sand/gravel mix with a maximum 3/8" particle size. Bedding shall be scooped out at the bells or couplings to ensure the piping is well supported throughout its entire length. Sand/gravel mix should be firmly compacted under, around, and above the pipe in 6" lifts to grade. Compaction should be a minimum of 95 percent of standard proctor according to ASTM D698.
- D. Underground piping installations shall conform with ASTM D2321/F1668 and CISPI 301.
- E. Install piping materials in accordance with the manufacturer's requirements and in conjunction with the standards referenced in this specification. Installation methods shall comply with the more restrictive standards.

3.5 STARTUP, TESTING, AND ADJUSTMENTS

- A. Adjust fixtures, equipment, accessories, and moving parts to function smoothly and lubricate as recommended by manufacturer.
- B. Provide necessary power to fixtures, equipment, and accessories to ensure proper functionality.
- C. Complete installation and startup checks according to manufacturer's written instructions.

3.6 CLEANING EQUIPMENT AND PREMISES

- A. Vacuum, clean and wipe down all new work and equipment inside and out. Exposed parts which are to be painted shall be cleaned of all foreign objects and prepped for paint.
- B. During the progress of work, clean up and leave the premises and portions of the building in which work has occurred in a clean and safe condition. Provide this cleaning on a per-shift basis.

3.7 DEMONSTRATION / TRAINING

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain equipment.

END OF SECTION

SECTION 22 05 05

SELECTIVE DEMOLITION FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

- A. This section describes the demolition, removal, relocation, rerouting, and reconnection of existing plumbing fixtures, equipment, and related piping and supports, as required, shown and specified herein, to accomplish alteration, restoration and to accommodate new construction.
- B. The work shall include but not limited to, draining, disconnecting, relocating, removing and dismantling, in a neat and workmanlike manner, the items and their accessories as indicated or shown on the contract drawings.

1.2 REFERENCES

- A. ANSI A10.6 – Safety Requirements for Demolition
- B. National Association of Demolition Contractors (NADC) – Demolition Safety Manual
- C. NFPA 51B – Cutting and Welding Processes
- D. NFPA 70 – National Electrical Code
- E. NFPA 241 – Safeguarding Building Construction and Demolition Operations
- F. OSHA 29 CRF 1910 – Occupational Safety and Health Standards
- G. US EPA – Clean Air Act Amendment of 1990

1.3 SUBMITTALS

- A. Demolition Schedule
- B. Fire Watch Procedures
- C. Inspection Report of Underground Piping Systems
- D. Welding/Burning Permit
 - 1. Obtain a welding/burning permit from the local Fire Official prior to the start of any welding or burning in accordance with the local Fire Code or as required by the Owner.

1.4 QUALITY ASSURANCE

- A. Cutting, patching, and removal shall be performed by workers skilled in the specific trades involved.
- B. Prior to start of work, contractor will make an inspection of job site accompanied by the Engineer.
 - 1. This inspection will include, but not limited to, verification of site conditions and determining physical condition of construction that is to remain.
- C. The plumbing contractor shall also review the architectural demolition drawings for additional information and requirements.

1.5 SPECIAL PRECAUTIONS

- A. Torch cutting of plumbing equipment and pipe will be permitted only as directed by the Engineer.
- B. Any cutting method, which may create sparks, must include Fire Watch Procedures as required by State and local code or Owner's fire insurance carrier. Submit Fire Watch Procedures for approval.
- C. Any draining operations must not damage building components.

PART 2 PRODUCTS

2.1 GENERAL

- A. Provide adequately sized rubbish containers for the proper and safe disposal of all debris.

PART 3 EXECUTION

3.1 GENERAL

- A. Provide alteration and demolition of plumbing facilities as required by the contract drawings and specifications. The drawings are diagrammatic and do not show the exact location of all existing plumbing work. Where existing equipment shall remain in service during construction, provide rerouting and reconnection of plumbing as required to maintain continuous service.
- B. Review all equipment with the engineer and owner prior to disposal. Existing plumbing to be abandoned that are not embedded in walls or floor slabs shall be completely removed unless otherwise shown on the drawings. Cap open ends at all walls and floors.
- C. Remove, store and protect all equipment or materials to be reused by the owner as shown on the drawings. Coordinate location of storage with the owner. Items indicated to be removed, and not

designated for owner's salvage and reuse, may be salvaged by the contractor. Transport salvaged items that are not to be reused from site as they are removed. Storage or sale of removed items on site will not be permitted.

- D. Temporarily cap ends of sanitary and sanitary vent piping to avoid entry of dirt, debris, or discharge of foul odors and gases.
- E. Do not close or obstruct egress width to exits. Conduct demolition operations and removal of debris to ensure minimum interference with roads, streets, walkways, occupied areas, and other adjacent occupied or used facilities. Ensure safe passage of persons around or through area of demolition operations to prevent injury to adjacent buildings, structures, other facilities, and persons.
- F. Do not disable or disrupt building fire or life safety systems without five (5) days prior written notice to the engineer and owner.
- G. Conform to procedures applicable when discovering hazardous or contaminated materials.
- H. Conduct demolition to minimize interference with adjacent building structures or owner's operations.
- I. Cease operations immediately if structure appears to be in danger or hazardous materials are encountered. Notify architect and engineer and do not resume operations until directed.
- J. Demolish in an orderly and careful manner. Do not cut or remove more than is necessary to accommodate the new construction or alteration.
- K. Remove demolished materials from site daily. Do not burn or bury materials on site. Dispose of all material at an approved disposal facility.
- L. Cover and protect floors, furniture, equipment and fixtures to avoid soiling or damage when demolition work is performed in rooms or areas from which such items have not been removed. Protect finished surfaces at all times and repair or replace, if damaged, to match existing construction to the satisfaction of the owner.
- M. Provide temporary weather protection during interval between demolition and removal of existing construction on exterior surfaces and installation of new construction to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
- N. Protect new and existing roofs from damage.
- O. Do not interrupt existing utilities serving occupied portions of the facility, except when authorized in writing by owner's representative. Provide temporary services during interruptions to existing utilities, as acceptable to the owner. Contractor shall disconnect and seal only utilities to be demolished serving areas being demolished, prior to start of demolition work. If contractor is required to disconnect utility services or other services to an occupied area, the contractor shall provide temporary or alternative service to that area, as acceptable to the owner.

3.2 PREPARATION

- A. Construct temporary partitions prior to any demolition work enclosing respective work. Erect temporary fencing and signage around demolished materials. Use water sprinkling and other suitable methods to limit dust and dirt arising and scattering in air to lowest practical level. Comply with governing regulations pertaining to environmental protection.
- B. Protect existing materials and equipment which are not to be demolished.
- C. Provide any required bracing and shoring to prevent movement of structure.
- D. Do not begin the work until the time schedules and manner of operations have been approved by the engineer and owner. All interruptions of existing services shall be included in the schedules as approved by the engineer and owner.

3.3 PIPE REMOVAL

- A. Cut off all welded piping square at the locations indicated on the drawings. No cutting will be required where the demolition ends at a flanged valve or equipment. Close off all openings of any remaining valves, piping or fittings with weld caps or blind flanges to prevent debris from entering the existing system.
- B. Disconnect all threaded piping at the location indicated on the drawings. Close off all openings of remaining valves, piping, fittings and equipment with pipe plugs or pipe caps as required to prevent debris from entering the existing systems.
- C. Remove all pipe hangers, supports, miscellaneous steel and anchors with the piping.

3.4 PROTECTION FROM FREEZING

- A. It is intended that the building remain protected from damage due to freezing temperatures. To that end, existing equipment and systems used for heating shall remain in place and in operation until scheduling permits shutdown.
- B. Where the removal of equipment and existing systems will leave an area unprotected from freezing, notify the owner and engineer at least 72 hours in advance prior to removal so appropriate steps can be taken by the owner to protect the area. Provide temporary heating equipment sufficient to prevent freezing.
- C. It is the contractor's responsibility to ensure that piping systems that are being worked on are completely drained of water prior to the start of demolition. If water is not drained and the piping freezes, it is the contractor's responsibility to replace piping at his own expense.

3.5 DISCONNECTION AND INTERRUPTION OF PLUMBING SERVICES

- A. When portions of an existing piping systems are removed, and this removal causes loss of operation to another piece of equipment due to open (disconnected) piping, then cap piping or provide temporary piping to retain operation of various systems.

3.6 PLUMBING EQUIPMENT REMOVAL

- A. Remove all plumbing equipment as shown on the contract drawings. Coordinate removal of all electrical work, including wiring between equipment, and wiring to power source or point of origin with electrical contractor.
- B. Where equipment is supported by steel or structural supports, remove these supports.

3.7 INSULATION REMOVAL

- A. Remove insulation, together with all piping, fittings, valves and equipment designated for demolition.

END OF SECTION

SECTION 260000 - ELECTRICAL - GENERAL PROVISIONS

PART 1 GENERAL

1.1 SCOPE OF WORK

- A. Furnish all labor, materials and equipment required and install complete and make operational, electrical system as shown on the Drawings and as specified herein.
- B. The work shall include the following:
 - 1. Provide conduit, wire and field connections for all equipment, HVAC systems, panelboards, transformers, and electrical equipment furnished under Divisions 1, 11, 21, 22, 23, and 26.
- C. Each bidder or their authorized representatives shall, before preparing their proposal, visit all areas of the existing buildings and structures in which work under this sub-bid is to be performed and inspect carefully the present installation. The submission of the proposal by this bidder shall be considered evidence that their representative has visited the buildings and structures and noted the locations and conditions under which the work will be performed and that he/she takes full responsibility for a complete knowledge of all factors governing his/her work.

2.1 SUBMITTALS

- A. As a minimum all equipment specified in each Section of Division 26 shall be submitted at one time. As an example all lighting fixtures shall be submitted together, all motor control centers shall be submitted together, etc. Submittals that do not comply will be returned disapproved.
- B. Mark submittals to clearly identify proposed equipment including accessories, options, and features and to exclude parts not applicable to the project. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submittal piece of literature and each submittal drawing shall clearly reference the Project Specification and/or Contract Drawing that the submittal is to cover. General catalogs will not be accepted as cut sheets to fulfill submittal requirements.
- C. Check shop drawings for accuracy prior to submittal. Shop drawings shall be stamped with the date checked and a statement indicating that the shop drawings conform to this Section and the Drawings. This statement shall also list all exceptions to this Section and the Drawings. Mark submittals to identify proposed equipment including accessories, options and features being proposed for approval and exclude parts not to be used. Shop drawings not so checked and noted shall be returned marked NOT APPROVED.
- D. The Engineer's check shall be for conformance with the design concept of the project and compliance with this Section and the Drawings. Errors and omissions on approved shop drawings shall not relieve the Contractor from the responsibility of providing materials and workmanship required by this Section and the Drawings.

- E. All dimensions shall be field verified at the job site and coordinated with the work of all other trades.
- F. Material shall not be ordered or shipped until the shop drawings have been approved. No material shall be ordered or shop work started if shop drawings are marked "APPROVED AS NOTED - CONFIRM," "APPROVED AS NOTED - RESUBMIT" or "NOT APPROVED."
- G. Operation and Maintenance Data
 - 1. Submit operations and maintenance data for equipment furnished under this Division, in accordance with Section 017823. The manuals shall be prepared specifically for this installation and shall include catalog data sheets, drawings, equipment lists, descriptions, parts lists including replacement part numbers, to instruct operating and maintenance personnel unfamiliar with such equipment.
 - 2. Manuals shall include the following as a minimum:
 - a. A complete "As-Built" set of approved shop drawings.
 - b. A complete list of the equipment supplied, including serial numbers, ranges and pertinent data.
 - c. Detailed service, maintenance and operation instructions for each item supplied.
- H. Exceptions for Submittals
 - 1. Exceptions to the Specifications or Drawings shall be clearly defined by the Electrical Subcontractor in a separate section of each submittal package. The submittal shall contain the reason for the exception, the exact nature of the exception and the proposed substitution so that a proper evaluation may be made by the Engineer. The acceptability of any device or methodology submitted as an "or equal" or "exception" to the Specifications shall be at the sole discretion of the Engineer.
- I. Submittals will be returned to the Contractor under one of the following codes.

Code 1 -"APPROVED" is assigned when there are no notations or comments on the submittal. When returned under this code the Contractor may release the equipment and/or material for manufacture.

Code 2 -"APPROVED AS NOTED" - This code is assigned when a confirmation of the notations and comments IS NOT required by the Contractor. The Contractor may release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product.

Code 3 -"APPROVED AS NOTED/CONFIRM" - This combination of codes is assigned when a confirmation of the notations and comments IS required by the Contractor. The Contractor may, at his own risk, release the equipment or material for manufacture; however, all notations and comments must be incorporated into the final product. This confirmation shall specifically address each omission and nonconforming item that was noted. Confirmation is to be received by the Engineer within 10 calendar days of the date of the Engineer's transmittal requiring the confirmation.

Code 4 -"APPROVED AS NOTED/RESUBMIT" - This combination of codes is assigned when notations and comments are extensive enough to require a resubmittal of the package. This resubmittal is to address all comments, omissions and non-conforming items that were noted. Resubmittal is to be received by the Engineer within 15 calendar days of the date of the Engineer's transmittal requiring the resubmittal.

Code 5 -"NOT APPROVED" is assigned when the submittal does not meet the intent of the Contract Documents. The Contractor must resubmit the entire package revised to bring the submittal into conformance. It may be necessary to resubmit using a different manufacturer/vendor to meet the Contract Documents.

Code 6 -"COMMENTS ATTACHED" is assigned where there are comments attached to the returned submittal which provide additional data to aid the Contractor.

Code 7 -"RECEIPT ACKNOWLEDGED" - This code is assigned to acknowledge receipt of a submittal that is not subject to the Engineer's review and approval; and, is being filed for informational purposes only. This code is generally used in acknowledging receipt of *means and methods of construction* work plan, field conformance test reports, and Health and Safety plans.

Codes 1 through 5 designate the status of the reviewed submittal with Code 6 showing there has been an attachment of additional data.

3.1 REFERENCE STANDARDS

- A. Electric equipment, materials and installation shall comply with the National Electrical Code (NEC).
- B. Where reference is made to one of the above standards, the revision in effect at the time of bid opening shall apply.

4.1 PRIORITY OF THE CONTRACT DOCUMENTS

- A. If, during the performance of the work, the Contractor finds a conflict, error or discrepancy between or among one or more of the Sections or between or among one or more Sections and the Drawings, furnish the higher performance requirements. The higher performance requirement shall be considered the equipment, material, device or installation method which represents the most stringent option, the highest quality or the largest quantity.
- B. In all cases, figured dimensions shall govern over scaled dimensions, but work not dimensioned shall be as directed by the Engineer and work not particularly shown, identified, sized, or located shall be the same as similar work that is shown or specified.
- C. Detailed Drawings shall govern over general drawings, larger scale Drawings take precedence over smaller scale Drawings, Change Order Drawings shall govern over Contract Drawings and Contract Drawings shall govern over Shop Drawings.

- D. If the issue of priority is due to a conflict or discrepancy between the provisions of the Contract Documents and any referenced standard, or code of any technical society, organization or association, the provisions of the Contract Documents will take precedence if they are more stringent or presumptively cause a higher level of performance. If there is any conflict or discrepancy between standard specifications, or codes of any technical society, organization or association, or between Laws and Regulations, the higher performance requirement shall be binding on the Contractor, unless otherwise directed by the Engineer.
- E. In accordance with the intent of the Contract Documents, the Contractor accepts the fact that compliance with the priority order specified shall not justify an increase in Contract Price or an extension in Contract Time nor limit in any way, the Contractor's responsibility to comply with all Laws and Regulations at all times

5.1 SERVICE AND METERING

- A. Service is existing at 480 Volts, 3Phase, 4Wire, 60 Hz.

6.1 CODES, INSPECTION AND FEES

- A. Equipment, materials and installation shall comply with the requirements of the local authority having jurisdiction.
- B. Obtain all necessary permits and pay all fees required for permits and inspections.

7.1 INTERPRETATION OF DRAWINGS

- A. Unless specifically stated to the contrary, the Drawings do not show exact locations of conduit runs. Coordinate the conduit installation with other trades and the actual supplied equipment.
- B. Install each 3 phase circuit in a separate conduit unless otherwise shown on the Drawings.
- C. Conduit shown exposed shall be installed exposed; conduit shown concealed shall be installed concealed. Unless otherwise indicated install branch circuit conduits exposed in process/ industrial type spaces and concealed in finished spaces.
- D. Where circuits are shown as "home-runs" all necessary fittings and boxes shall be provided for a complete raceway installation. Where home-runs indicate conduit is to be installed concealed or exposed the entire branch circuit shall be installed in the same manner.
- E. Verify the exact locations and mounting heights of lighting fixtures, switches and receptacles prior to installation.
- F. Except where dimensions are shown, the locations of equipment, fixtures, outlets and similar devices shown on the Drawings are approximate only. Exact locations shall be determined by the Contractor and approved by the Engineer during construction. Obtain information relevant to the placing of electrical work and in case of any interference with other work, proceed as directed by the Engineer and furnish all labor and materials necessary to complete the work in an approved manner.

- G. Circuit layouts are not intended to show the number of fittings, or other installation details. Furnish all labor and materials to install and place in satisfactory operation all power, lighting and other electrical systems shown.
- H. Redesign of electrical or mechanical work, which is required due to the Contractor's use of an alternate item, arrangement of equipment and/or layout other than specified herein, shall be done by the Contractor at his/her own expense. Redesign and detailed plans shall be submitted to the Engineer for approval. No additional compensation will be provided for changes in the work, either his/her own or others, caused by such redesign.
- I. Raceways and conductors for low voltage (120 Volts) thermostats controlling HVAC unit heaters, exhaust fans and similar equipment are not shown on the Drawings. Provide raceways and conductors between the thermostats, the HVAC equipment and the motor starters for a complete and operating system. Raceways shall be installed concealed in all finished space and may be installed concealed or exposed in process spaces. Refer to the HVAC drawings for the locations of the thermostats.

8.1 SIZE OF EQUIPMENT

- A. Investigate each space in the structure through which electrical equipment furnished under Division 26 must pass to reach its final location. Coordinate shipping splits with the manufacturer to permit safe handling and passage through restricted areas in the structure.
- B. The equipment shall be kept upright at all times during storage and handling. When equipment must be tilted for passage through restricted areas, brace the equipment to ensure that the tilting does not impair the functional integrity of the equipment.

9.1 RECORD DRAWINGS

- A. As the work progresses, legibly record all field changes on a set of Project Contract Drawings, hereinafter called the "Record Drawings."

10.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment furnished under this contract shall be new.
- B. Material and equipment of the same type shall be the product of one manufacturer and shall be UL listed.

11.1 EQUIPMENT IDENTIFICATION

- A. Identify equipment, disconnect switches, separately mounted motor starters, control stations, etc. furnished under Division 26 with the name of the equipment it serves. Motor control centers, control panels, panelboards, switchboards, switchgear, junction or terminal boxes, transfer switches, etc, shall have nameplate designations as shown on the Drawings.
- B. Nameplates shall be engraved, laminated plastic, not less than 1/16-in thick by 3/4-in by 2-1/2-in with 3/16-in high white letters on a black background.
- C. Nameplates shall be screw mounted to NEMA 1 enclosures. Nameplates shall be bonded to all other enclosure types using an epoxy or similar permanent waterproof adhesive. Two sided

foam adhesive tape is not acceptable. Where the equipment size does not have space for mounting a nameplate the nameplate shall be permanently fastened to the adjacent mounting surface.

PART 2 EXECUTION

1.1 INSTALLATION

- A. Work not installed according to the Drawings and Specification shall be subject to change as directed by the Engineer at Contractor's expense.
- B. Electrical equipment shall be protected against mechanical and water damage. Store all electrical equipment in dry permanent shelters. Do not install electrical equipment in place until structures are weather-tight.
- C. Damaged equipment shall be replaced or repaired by the equipment manufacturer, at the Engineer's discretion and at the Contractor's expense.
- D. Repaint any damage to factory applied paint finish using touch-up paint furnished by the equipment manufacturer.

2.1 WORK SUPERVISION

- A. The Contractor shall designate in writing the qualified electrical supervisor who shall provide supervision to all electrical work on this project. The minimum qualifications for the electrical supervisor shall be a master electrician as defined by the Arkansas Board of Electrical Examiners. The supervisor or his appointed alternate possessing at least a journeyman electrician license shall be on site whenever electrical work is being performed. The qualifications of the electrical supervisor shall be subject to approval of the Owner and the Engineer.
- B. All master and journeyman electricians shall be licensed in accordance with Arkansas Code Title 17 Chapter 28 - Electricians. The website located at <http://www.arkleg.state.ar.us> publishes the text of this statutory requirement. No unlicensed electrical workers shall perform work on this project. Apprentice electricians in a ratio of not more than one apprentice per journeyman electrician will be allowed if the apprentices are licensed and actively participating in an apprenticeship program recognized and approved by the Arkansas Board of Electrical Examiners.

END OF SECTION 260000

SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Copper building wire rated 600 V or less.
2. Connectors, splices, and terminations rated 600 V and less.

B. Related Requirements:

1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2, and 3 control cables.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 COPPER BUILDING WIRE

A. Description: Flexible, insulated and uninsulated, drawn copper current-carrying conductor with an overall insulation layer or jacket, or both, rated 600 V or less.

B. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Cerro Wire LLC.
2. General Cable Technologies Corporation.
3. Okonite Company (The).
4. Southwire Company.

C. Standards:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
2. RoHS compliant.

- 3. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Conductors: Copper, complying with ASTM B 3 for bare annealed copper and with ASTM B 8 for stranded conductors.
- E. Conductor Insulation:
 - 1. Type NM: Comply with UL 83 and UL 719.
 - 2. Type RHH and Type RHW-2: Comply with UL 44.
 - 3. Type USE-2 and Type SE: Comply with UL 854.
 - 4. Type THHN and Type THWN-2: Comply with UL 83.
 - 5. Type THW and Type THW-2: Comply with NEMA WC-70/ICEA S-95-658 and UL 83.
 - 6. Type XHHW-2: Comply with UL 44.

2.2 CONNECTORS AND SPLICES

- A. Description: Factory-fabricated connectors, splices, and lugs of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- C. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
 - 1. Material: Copper.
 - 2. Type: One hole with long barrels.
 - 3. Termination: Compression.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper; solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- B. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Feeders in Cable Tray: Type THHN/THWN-2, single conductors in raceway.
- F. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- G. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN/THWN-2, single conductors in raceway
- H. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
 - 1. Use oxide inhibitor in each splice, termination, and tap for aluminum conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.7 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article.
- B. Qualification Data: For testing agency and testing agency's field supervisor.
- C. Field quality-control reports.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.2 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 3. Thomas & Betts Corporation; A Member of the ABB Group.

2.3 CONDUCTORS

- A. Conductors shall be as specified under Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- C. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.
- D. Beam Clamps: Mechanical type, terminal, ground wire access from four directions, with dual, tin-plated or silicon bronze bolts.
- E. Cable-to-Cable Connectors: Compression type, copper or copper alloy.
- F. Conduit Hubs: Mechanical type, terminal with threaded hub.
- G. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- H. Ground Rod Clamps: Mechanical type, copper or copper alloy, terminal with hex head bolt.
- I. Lay-in Lug Connector: Mechanical type, copper rated for direct burial terminal with set screw.
- J. Water Pipe Clamps:
 - 1. Mechanical type, two pieces with stainless-steel bolts.
 - a. Material: Die-cast zinc alloy.
 - b. Listed for direct burial.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.
- B. Ground Plates: 1/4 inch thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Connections to Structural Steel: Welded connectors.

3.2 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.3 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- C. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
- C. Grounding system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Report measured ground resistances that exceed 5 ohms.
- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Steel slotted support systems.
2. Conduit and cable support devices.
3. Support for conductors in vertical conduit.
4. Structural steel for fabricated supports and restraints.
5. Mounting, anchoring, and attachment components, including powder-actuated fasteners, mechanical expansion anchors, concrete inserts, clamps, through bolts, toggle bolts, and hanger rods.
6. Fabricated metal equipment support assemblies.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fabrication and installation details for electrical hangers and support systems.

1. Hangers. Include product data for components.
2. Slotted support systems.
3. Equipment supports.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32-inch- (10-mm-) diameter holes at a maximum of 8 inches (200 mm) o.c. in at least one surface.

1. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
2. Material for Channel, Fittings, and Accessories: Galvanized steel.
3. Channel Width: 1-5/8 inches.
4. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
5. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
6. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
7. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- B. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- C. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be made of malleable iron.
- D. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M steel plates, shapes, and bars; black and galvanized.
- E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units are similar to MSS Type 18 units and comply with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with the following standards for application and installation requirements of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 - 1. NECA 1.
 - 2. NECA 101

- B. Comply with requirements in "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Beam clamps (MSS SP-58, Type 19, 21, 23, 25, or 27), complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

END OF SECTION 260529

SECTION 260533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits and fittings.
2. Nonmetallic conduits and fittings.
3. Metal wireways and auxiliary gutters.
4. Nonmetal wireways and auxiliary gutters.
5. Boxes, enclosures, and cabinets.
6. Handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

A. Metal Conduit:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. Republic Conduit.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.
2. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with ANSI C80.1 and UL 6.
4. IMC: Comply with ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.

6. EMT: Comply with ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

B. Metal Fittings: Comply with NEMA FB 1 and UL 514B.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. Republic Conduit.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.
2. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. Fittings, General: Listed and labeled for type of conduit, location, and use.
4. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 1203 and NFPA 70.
5. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: Compression.
6. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
7. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

C. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS AND FITTINGS

A. Nonmetallic Conduit:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. CANTEX INC.
 - b. RACO; Hubbell.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.

B. Listing and Labeling: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1. ENT: Comply with NEMA TC 13 and UL 1653.
2. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
3. LFNC: Comply with UL 1660.

C. Nonmetallic Fittings:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. CANTEX INC.
 - b. RACO; Hubbell.
 - c. Thomas & Betts Corporation; A Member of the ABB Group.
2. Fittings, General: Listed and labeled for type of conduit, location, and use.
3. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
4. Fittings for LFNC: Comply with UL 514B.
5. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4, or Type 12 based on installation location, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Crouse-Hinds, an Eaton business.
 2. Hoffman; a brand of Pentair Equipment Protection.
 3. Hubbell Incorporated; Wiring Device-Kellems.
 4. Thomas & Betts Corporation; A Member of the ABB Group.
 5. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Metal Floor Boxes:
 - 1. Material: Cast metal.
 - 2. Type: Fully adjustable.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- G. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- J. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- K. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- L. Gangable boxes are prohibited.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: GRC.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC, direct buried
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
 - 1. Exposed and Subject to Severe Physical Damage: **GRC**. Raceway locations include the following:
 - a. Loading dock.
 - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
 - c. Mechanical rooms.

- d. Electrical rooms
 - e. Gymnasiums.
2. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 3. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 4. Damp or Wet Locations: GRC.
 5. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.
- H. Panel feeders shall not be installed on roofs unless specifically noted on plans or approve via RFI to engineer.

3.2 INSTALLATION

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- B. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- C. Raceways installed on roof shall be kept a minimum of 1" above roof deck and shall be supported using Dura-Blok rooftop supports with maximum spacing of 10' between supports.
- D. Do not install raceways or electrical items on any "explosion-relief" walls or rotating equipment.

- E. Do not fasten conduits onto the bottom side of a metal deck roof.
- F. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- G. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- J. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
- K. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- L. Support conduit within 12 inches of enclosures to which attached.
- M. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
 - 5. Change from ENT to GRC before rising above floor.
- N. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT, IMC, or RMC for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- O. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- P. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- Q. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal

bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

- R. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- S. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per degree F of temperature change for PVC conduits.
 - 4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- T. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- U. Mount boxes at heights indicated on Drawings or in Specification 262726 "Wiring Devices". If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- V. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.
- W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- X. Locate boxes so that cover or plate will not span different building finishes.
- Y. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

Z. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

AA. Set metal floor boxes level and flush with finished floor surface.

BB. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.4 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies.

3.5 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Color and legend requirements for raceways, conductors, and warning labels and signs.
 - 2. Labels.
 - 3. Tapes and stencils.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with NFPA 70.
- B. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- C. Comply with ANSI Z535.4 for safety signs and labels.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Color-Coding for Phase- and Voltage-Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - 1. Color shall be factory applied or field applied for sizes larger than No. 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208/120-V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.

3. Colors for 480/277-V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
4. Color for Neutral: White.
5. Color for Equipment Grounds: Green.
6. Colors for Isolated Grounds: Green with white stripe.

B. Warning Label Colors:

1. Identify system voltage with black letters on an orange background.

C. Equipment Identification Labels:

1. Black letters on a white field.

2.3 SIGNS

A. Laminated Acrylic or Melamine Plastic Signs:

1. Engraved legend.
2. Thickness:
 - a. For signs up to 20 sq. in. (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. in. (129 sq. cm), 1/8 inch (3.2 mm) thick.
 - c. Engraved legend with black letters on white face.
 - d. Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.4 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify and coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and operation and maintenance manual. Use consistent designations throughout Project.

- B. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of each item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.
- H. System Identification for Raceways and Cables under 600 V: Identification shall completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.
 - 1. Secure tight to surface of conductor, cable, or raceway.
- I. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- J. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from the floor.

3.2 IDENTIFICATION SCHEDULE

- A. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive label.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign.

END OF SECTION 260553

SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

- A. MCCB: Molded-case circuit breaker.
- B. SPD: Surge protective device.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard.
- B. Shop Drawings: For each panelboard and related equipment.
1. Include dimensioned plans, elevations, sections, and details.
 2. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 3. Detail bus configuration, current, and voltage ratings.
 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 5. Include evidence of NRTL listing for series rating of installed devices.
 6. Include evidence of NRTL listing for SPD as installed in panelboard.
 7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 8. Include wiring diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Panelboard schedules for installation in panelboards.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 FIELD CONDITIONS

A. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to repair or replace panelboards that fail in materials or workmanship within specified warranty period.

1. Panelboard Warranty Period: 18 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANELBOARDS COMMON REQUIREMENTS

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NEMA PB 1.

C. Comply with NFPA 70.

D. Enclosures: Flush or Surface-mounted, dead-front cabinets.

1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Outdoor Locations: NEMA 250, Type 3R.
 - c. Wash-Down Areas: NEMA 250, Type 4X,.
 - d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
2. Height: 84 inches maximum.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Trims shall cover all live parts and shall have no exposed hardware.

E. Phase, Neutral, and Ground Buses: Hard-drawn copper, 98 percent conductivity.

F. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type, with a lug on the neutral bar for each pole in the panelboard.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type, with a lug on the bar for each pole in the panelboard.

- 4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
- G. Future Devices: Panelboards shall have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed by an NRTL for 100 percent interrupting capacity.

2.2 PERFORMANCE REQUIREMENTS

- A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1 or Type 2 as shown on drawings.

2.3 POWER PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton.
 - 2. SIEMENS Industry, Inc.; Energy Management Division.
 - 3. Square D; by Schneider Electric.
 - a. If Square D, project shall be quoted, ordered, and managed by Randall Robinette in Little Rock Field Office. Phone# 501-803-9494.
- B. Panelboards: NEMA PB 1, distribution type.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton.
 - 2. SIEMENS Industry, Inc.; Energy Management Division.
 - 3. Square D; by Schneider Electric.
 - a. If Square D, project shall be quoted, ordered, and managed by Randall Robinette in Little Rock Field Office. Phone# 501-803-9494.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Eaton.
 - 2. SIEMENS Industry, Inc.; Energy Management Division.

3. Square D; by Schneider Electric.
 - a. If Square D, project shall be quoted, ordered, and managed by Randall Robinette in Little Rock Field Office. Phone# 501-803-9494.
- B. All circuit breakers 1200A and higher shall be equipped with energy-reducing maintenance switching with local status in order to provide arc energy reduction per NEC 240.87
- C. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Field-Adjustable Settings:
 - 1) Instantaneous trip.
 - 2) Long- and short-time pickup levels.
 - 3) Long and short time adjustments.
 - 4) Ground-fault pickup level, time delay, and I squared T response.
 4. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller; let-through ratings less than NEMA FU 1, RK-5.
 5. GFCI Circuit Breakers: Single- and double-pole configurations with Class A ground-fault protection (6-mA trip).
 6. Subfeed Circuit Breakers: Vertically mounted.
 7. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.

2.6 IDENTIFICATION

- A. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles shall be located on the interior of the panelboard door.
- B. Breaker Labels: Faceplate shall list current rating, UL and IEC certification standards, and AIC rating.
- C. Circuit Directory: Directory card inside panelboard door, mounted in transparent card holder.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Install panelboards and accessories according to NEMA PB 1.1.
- C. Mount panelboard cabinet plumb and rigid without distortion of box.
- D. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
- F. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
- G. Install filler plates in unused spaces.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- C. Tests and Inspections:

1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 262416

SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Straight-blade convenience receptacles.
2. USB charger devices.
3. GFCI receptacles.
4. Toggle switches.
5. Wall plates.

1.2 DEFINITIONS

A. Abbreviations of Manufacturers' Names:

1. Cooper: Copper Wiring Devices; Division of Cooper Industries, Inc.
2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
3. Leviton: Leviton Mfg. Company, Inc.
4. Pass & Seymour: Pass& Seymour/Legrand.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

PART 2 - PRODUCTS

2.1 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.
- D. Devices for Owner-Furnished Equipment:
 - 1. Receptacles: Match plug configurations.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 STRAIGHT-BLADE RECEPTACLES

- A. Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. All receptacle devices in childcare facilities and all education facilities shall be tamper-resistant. All devices shall meet requirements of NEC 406.12.

2.3 USB CHARGER DEVICES

- A. Tamper-Resistant, USB Charger Receptacles: 12 V, 2.0 A, USB Type A and 20V, 3A, Type C; Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, UL 1310, and FS W-C-596.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.
 - 3. USB Receptacles: Dual, Type A and Type C.
 - 4. Line Voltage Receptacles: Dual, two pole, three wire, and self-grounding.

2.4 GFCI RECEPTACLES

A. General Description:

1. 125 V, 20 A, straight blade, feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Leviton Manufacturing Co., Inc.
 - c. Pass & Seymour/Legrand (Pass & Seymour).

C. Tamper-Resistant, Duplex GFCI Convenience Receptacles:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Hubbell Incorporated; Wiring Device-Kellems.
 - b. Pass & Seymour/Legrand (Pass & Seymour).

D. Locations:

1. Install GFCI devices at all locations required by NEC Article 210.8, whether or not indicated on plans. These locations include:
 - a. Dwelling Units:
 - 1) Bathrooms
 - 2) Garages and similar accessory buildings
 - 3) Outdoors
 - 4) Crawl Spaces
 - 5) Basements
 - 6) Kitchens where receptacles are installed to serve countertop surfaces
 - 7) Within 6' of the top inside edge of the bowl of a sink
 - 8) Boathouses
 - 9) Within 6' of bathtubs or shower stalls
 - 10) Laundry areas
 - 11) Indoor damp and wet locations
 - b. Other than dwelling units:
 - 1) Bathrooms
 - 2) Kitchens or areas with sink and permanent provisions for food prep or cooking
 - 3) Rooftops
 - 4) Outdoors
 - 5) Within 6' of the top inside edge of the bowl of a sink
 - 6) Indoor damp and wet locations

- 7) Locker rooms with associated showering facilities
- 8) Garages, accessory buildings, service bays, and similar areas
- 9) Crawl Spaces
- 10) Unfinished areas of basements
- 11) Laundry areas
- 12) Within 6' of bathtubs or shower stalls

2.5 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Single Pole:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hubbell Incorporated; Wiring Device-Kellems.
 - 2) Leviton Manufacturing Co., Inc.
 - 3) Pass & Seymour/Legrand (Pass & Seymour).
 - 2. Two Pole:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hubbell Incorporated; Wiring Device-Kellems.
 - 2) Leviton Manufacturing Co., Inc.
 - 3) Pass & Seymour/Legrand (Pass & Seymour).
 - 3. Three Way:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Hubbell Incorporated; Wiring Device-Kellems.
 - 2) Leviton Manufacturing Co., Inc.
 - 3) Pass & Seymour/Legrand (Pass & Seymour).

2.6 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: Coordinate with architect for finish and color selection.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.

- B. Wet-Location, Weatherproof While-In-Use Cover Plates: NEMA 250, complying with Type 3R, weather-proof while in use, die-cast aluminum with lockable cover.

2.7 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. SPD Devices: Blue.
 - 4. Isolated-Ground Receptacles: Orange.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1 unless otherwise indicated.
- B. ARC-FAULT CIRCUIT-INTERRUPTER PROTECTION:
 - 1. Provide arc-fault circuit interrupter protection at all locations required per 210.12 whether indicated on plans or not.
 - 2. This includes any circuits serving outlets or devices in
 - a. dwelling units
 - b. dormitory units and their associated bedrooms, living rooms, hallways, closets, bathrooms, and similar rooms
 - c. guest rooms, guest suites, and patient sleeping rooms
 - d. For purposes of this requirement, all circuits serving outlets in bunk rooms or other associated sleeping rooms shall have AFCI protection
- C. Mount Devices at the heights listed below unless listed specifically on drawings:
 - 1. Exterior Outlet Boxes: 24" Above Finished Grade
 - 2. Interior Outlet Boxes: 18" Above Finished Floor (AFF)
 - 3. Device Boxes for Switches, Fire Alarm Pull Stations, Intercom Call Stations, etc.: 48" AFF
 - 4. Outlet Boxes for Wall-mounted clocks: 96" AFF or 6" below the ceiling when not possible. Center clock outlets located above doors between the ceiling and the top of the door trip.
 - 5. Above Counter Outlet and Junction Boxes: 8" above countertop surfaces or at backsplash level.
 - 6. Coordinate mounting height of specific-use receptacles with equipment and finishes.
 - 7. Coordinate mounting height to match mechanical devices (thermostats).
- D. Coordination with Other Trades:

1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

E. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtail existing conductors is permitted, provided the outlet box is large enough.

F. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

G. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

H. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.
- I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- J. GFCI Receptacles: Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.2 FIELD QUALITY CONTROL

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Perform the following tests and inspections:
 1. Tests for Convenience Receptacles:
 - a. Line Voltage: Acceptable range is 105 to 132 V.
 - b. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - c. Ground Impedance: Values of up to 2 ohms are acceptable.
 - d. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - e. Using the test plug, verify that the device and its outlet box are securely mounted.
 - f. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.

END OF SECTION 262726

SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Molded-case circuit breakers (MCCBs).
 - 4. Molded-case switches.
 - 5. Horsepower Rated Toggle Disconnect Switch
 - 6. Enclosures.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.

1.3 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.4 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single manufacturer.

- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with NFPA 70.

2.2 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton.
 - 2. SIEMENS Industry, Inc.; Energy Management Division.
 - 3. Square D; by Schneider Electric.
 - a. If Square D, project shall be quoted, ordered, and managed by Randall Robinette in Little Rock Field Office. Phone# 501-803-9494.
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Three pole.
 - 3. 600-V ac.
 - 4. 1200 A and smaller.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses.
 - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories (as required per plans):
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 - 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.3 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton.
 - 2. SIEMENS Industry, Inc.; Energy Management Division.

3. Square D; by Schneider Electric.
 - a. If Square D, project shall be quoted, ordered, and managed by Randall Robinette in Little Rock Field Office. Phone# 501-803-9494.
- B. Type HD, Heavy Duty, Three Pole, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories (as required per plans):
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Isolated Ground Kit: Internally mounted; insulated, labeled for copper and aluminum neutral conductors.
 4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 5. Service-Rated Switches: Labeled for use as service equipment.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Eaton.
 2. SIEMENS Industry, Inc.; Energy Management Division.
 3. Square D; by Schneider Electric.
 - a. If Square D, project shall be quoted, ordered, and managed by Randall Robinette in Little Rock Field Office. Phone# 501-803-9494.
- B. Circuit breakers shall be constructed using glass-reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
- C. Circuit breakers shall have a toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. The circuit-breaker handle shall be over center, be trip free, and reside in a tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon shall be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker. Circuit breakers shall be 100 percent rated or series rated as indicated on the Drawings. combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end-use equipment along with the statement "Caution - Series Rated System. _____ Amps Available. Identical Replacement Component Required."
- E. MCCBs shall be equipped with a device for locking in the isolated position.

- F. Lugs shall be suitable for 167 deg F rated wire.
- G. Standards: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the field-adjustable settings as indicated on drawings.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

2.5 Horsepower Rated, Toggle Switch Type Disconnect Switch

- A. Toggle type disconnect switches shall be manufactured of thermoplastic materials with screw-type terminals. The switches shall be rated 600 VAC and 20A at 600 VAC.
- B. Toggle type disconnect switches shall be similar to a manual non-reversing starter without overloads and shall be 3 Pole, capable of “on-off” control of a 10 horsepower motor at 460 VAC.
- C. Enclosure shall be provided with lock off provisions.
- D. NEMA 4 enclosures shall be die-cast zinc.
- E. Switches shall be as manufactured by the Square D Co.; Siemens Electrical Products; Cutler-Hammer or equal.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure rating shall be equal to or greater than the fuse or circuit breaker rating.
- C. Enclosure Finish: The enclosure shall be as indicated on drawings.
- D. Conduit Entry: NEMA 250 Types 4, 4X, and 12 enclosures shall contain no knockouts. NEMA 250 Types 7 and 9 enclosures shall be provided with threaded conduit openings in both endwalls.

- E. Operating Mechanism: The circuit-breaker operating handle shall be externally operable with the operating mechanism being an integral part of the box, not the cover. The cover interlock mechanism shall have an externally operated override. The override shall not permanently disable the interlock mechanism, which shall return to the locked position once the override is released. The tool used to override the cover interlock mechanism shall not be required to enter the enclosure in order to override the interlock.
- F. Enclosures designated as NEMA 250 Type 4, 4X stainless steel, 12, or 12K shall have a dual cover interlock mechanism to prevent unintentional opening of the enclosure cover when the circuit breaker is ON and to prevent turning the circuit breaker ON when the enclosure cover is open.
- G. NEMA 250 Type 7/9 enclosures shall be furnished with a breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 ENCLOSURE ENVIRONMENTAL RATING APPLICATIONS

- A. Enclosed Switches and Circuit Breakers: Provide enclosures at installed locations with the following environmental ratings.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
 - 4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
 - 5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

3.2 INSTALLATION

- A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
 - 1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
 - 2. Indicate method of providing temporary electric service.
 - 3. Do not proceed with interruption of electric service without Owner's written permission.
 - 4. Comply with NFPA 70E.
- B. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- C. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

- D. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- E. Install fuses in fusible devices. Fuse Ratings for mechanical equipment or transformers shall match the rating of the upstream circuit breaker feeding the equipment.
- F. Comply with NFPA 70 and NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.
 - a. Label on each disconnect means shall include both purpose and source, such as "AHU-1. Fed from Panel MDP"

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.
 - c. Verify that the unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on the Drawings.
 - i. Verify correct phase barrier installation.

- j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.

B. Tests and Inspections for Molded Case Circuit Breakers:

1. Visual and Mechanical Inspection:

- a. Verify that equipment nameplate data are as described in the Specifications and shown on the Drawings.
- b. Inspect physical and mechanical condition.
- c. Inspect anchorage, alignment, grounding, and clearances.
- d. Verify that the unit is clean.
- e. Operate the circuit breaker to ensure smooth operation.
- f. Inspect bolted electrical connections for high resistance using one of the two following methods:
 - 1) Use a low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of the lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels shall be in accordance with manufacturer's published data. In the absence of manufacturer's published data, use NETA ATS Table 100.12.
- g. Inspect operating mechanism, contacts, and chutes in unsealed units.
- h. Perform adjustments for final protective device settings in accordance with the coordination study.

- C. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

END OF SECTION 262816