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CARY SERVICES Abilene, Texas

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SECTION 20 01 00

COMMON PLUMBING AND HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. Basic and supplemental requirements common to Plumbing and HVAC Work.

1.3 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 Contract Documents.

1.4 DEFINITIONS

- A. These definitions are included to clarify the direction and intention of these Specifications. For further clarification, contact the Architect/Engineer.
 - 1. Concealed / Exposed: "Concealed" areas are those areas that cannot be seen by the building occupants. "Exposed" areas are all areas, which are exposed to view by the building occupants, including under counters, inside cabinets and closets, plus all mechanical rooms. "Exterior" areas are those that are outside the building exterior envelope and exposed to the outdoors.
 - 2. Furnish: The term "furnish" is used to mean "supply and deliver to the Project Site, ready for unloading, unpacking, assembly, installation, and similar operations.
 - 3. Install: The term "install" is used to describe operations at Project Site including the actual "unloading, unpacking, assembly, erection, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, and similar operations.

4. Provide: The term "provide" means "to furnish and install, complete and ready for the intended use.

1.5 QUALITY ASSURANCE

- A. Plumbing and HVAC systems shall be coordinated with other systems and trades.
- B. Verification of Dimensions: The contractor shall be responsible for the coordination and proper relation of contractor's work to the building structure and to the work of all trades. The contractor shall visit the premises and become thoroughly familiar with all details of the work and working conditions, to verify all dimensions in the field, and to advise the Architect/Engineer of any discrepancy before performing any work. Adjustments to the work required in order to facilitate a coordinated installation shall be made at no additional cost to the Owner or the Architect/Engineer.
- C. All dimensional information related to new structures shall be taken from the appropriate drawings. All dimensional information related to existing facilities shall be taken from actual measurements made by the contractor on the site.
- D. The drawings are subject to the requirements of reference standards, structural and architectural conditions. The Contractor shall carefully investigate structural and finish conditions and shall coordinate the separate trades in order to avoid interference between the various phases of work. Work shall be organized and laid out so that it will be concealed in furred chases and suspended ceilings, etc., in finished portions of the building, unless specifically noted to be exposed. All exposed work shall be installed parallel or perpendicular to the lines of the building unless otherwise noted.
- E. When the drawings do not give exact details as to the elevation of pipe and ducts, the contractor shall physically arrange the systems to fit in the space available at the elevations intended with proper grades for the functioning of the system involved. Piping and duct systems are generally intended to be installed true and square to the building construction, and located as high as possible against the structure in a neat and workmanlike manner. The drawings do not show all required offsets, control lines, pilot lines and other location details. Work shall be concealed in all finished areas.
- F. Where core drilling of floor or wall penetrations is required, Work shall be performed in accordance with Division 03 Specifications. Where applicable Division 03 Specifications are not included in the project, core drilling shall be in accordance with generally accepted standards, and be performed by licensed personnel where applicable.
- G. Certify in writing that neither the contractor nor any of contractor's subcontractors or suppliers will supply any materials that contain asbestos in any form for this project.

1.6 DELIVERY, STORAGE AND HANDLING

- A. All equipment, ductwork, and materials shall be delivered to the project site clean and sealed for protection.
- B. Take particular care not to damage the existing construction in performing work. All finished floors, step treads and finished surfaces shall be covered to prevent any damage by workers or their tools and equipment during the construction of the project.
- C. Equipment and materials shall be protected from rust and dust/debris both before and after installation. Any equipment or materials found in a rusty condition at the time of final inspection must be cleaned of rust and repainted as specified elsewhere in these specifications.
- D. All material affected by weather shall be covered and protected to keep the material free from damage while material is being transported to the site and while stored at the project site.
- E. During the execution of the work, open ends of all piping and conduit, and all openings in equipment shall be closed when work is not in progress, and shall be capped and sealed prior to completion of final connections, so as to prevent the entrance of foreign matter.
- F. All equipment shall be protected during the execution of the work. All ductwork and equipment shall be sealed with heavy plastic and tape to prevent build-up of dust and debris.
- G. All ductwork and air handling equipment shall be wiped down with a damp cloth immediately before installation to ensure complete removal of accumulated dusts and foreign matter.
- H. All plumbing fixtures shall be protected and covered to prohibit usage. All drains shall be covered until placed in service to prevent the entrance of foreign matter.

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. All equipment installed shall have local representation, local factory authorized service, and a local stock of repair parts.
- C. Responsibility for furnishing proper equipment and/or material and ensuring that equipment and/or material is installed as intended by the manufacturer, rests entirely upon the contractor. Contractor shall request advice and supervisory assistance from the representative of specific manufacturers during the installation.

- D. All materials, unless otherwise specified, shall be new, free from all defects, suitable for the intended use and of the best quality of their respective kinds. Materials and equipment shall be installed in accordance with the manufacturer's recommendations and the best standard practice for the type of work involved. All work shall be executed by mechanics skilled in their respective trades, and the installations shall provide a neat, precise appearance. Materials and/or equipment damaged in shipment or otherwise damaged prior to installation shall not be repaired at the job site but shall be replaced with new materials and/or equipment.
- E. Materials and equipment manufactured domestically are preferred when possible. Materials and equipment that are not available from a domestic manufacturer may be by a non-domestic manufacturer provided they fully comply with contract documents.
- F. Prevention of Rust: standard factory finish will be acceptable on equipment specified by model number; otherwise, surfaces of ferrous metal shall be given a rust inhibiting coating.

2.2 IDENTIFICATION FOR PLUMBING AND HVAC PIPING AND EQUIPMENT

- A. Color Coding and Nomenclature for Building Piping: Conform to ASME (ANSI) A13.1.
- B. Provide marking system as manufactured by Brady Company, Seton, Craftmark, or approved equal.
- C. Provide all equipment, materials, labor, supervision, and services necessary for installation of identification items.
 - 1. Valve tags:
 - a. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart.
 - b. Valve tags shall include what room(s) the valve serves and piece of equipment served.
 - c. Valve tags shall be color coded 0.032" anodized aluminum tags, with engraved letters similar to Seton S Type 250 BL or approved equal.
 - 1) HVAC tags shall be round 2" diameter, equal to Seton 15426.
 - 2) Plumbing tags shall be square 2"x2" similar to Seton 42769.
 - 3) Fire Protection tags shall be square 2"x2" similar to Seton 42769 Red.
 - 4) Lettering shall be ¼" high for type service and ½" for valve number. Tag shall indicate service and valve number.
 - 5) Each service shall be a different color.

- d. Tag shall be attached to valves with chain similar to Seton No. 16 stainless steel jack chain.
 - e. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.
 - f. Provide a valve list in close out documents to include the following:
 - 1) Tag number,
 - 2) Service,
 - 3) Size,
 - 4) Operation,
 - 5) Location, Manufacture,
 - 6) Model number,
 - 7) Submittal reference.
2. Pipe marking:
- a. All piping except that piping which is within inaccessible chases, shall be identified with semi-rigid plastic identification markers equal to Seton Setmark pipe markers.
 - b. Direction of flow arrows are to be included on each marker.
 - c. Setmark snap-around markers shall be used for overall diameters up to 6" and strap-around markers shall be used above 6" overall diameters.
 - d. Markers shall be located:
 - 1) Near each valve and control device,
 - 2) Near each branch connection, excluding short takeoffs for fixtures and terminal units. Mark each pipe at branch where flow pattern is not obvious.
 - 3) At each cap for future,
 - 4) Near penetrations through walls, floors, ceilings, or non-accessible enclosures (each side),
 - 5) At access doors, manholes, and similar access points that permit view of concealed piping.
 - 6) Near major equipment items and other points of origination and termination.

7) Spaced at a maximum of 25-foot intervals along each run. Reduce intervals to 10 feet in areas of congested piping and equipment.

8) A minimum of (1) marker shall be provided at each room.

3. Equipment nameplates:

- a. Each major component of equipment shall have the manufacturer's name, address, and catalog number on a plate securely attached to the item of equipment. All data on nameplates shall be legible at the time of final inspection.
- b. Nameplates shall be black laminated rigid phenolic with white core. Nameplate minimum size shall be 1 inch high by 3 inches long with 3/16-inch-high engraved white letters.
- c. Nameplate Fasteners: Fasten nameplates to the front of equipment only by means of stainless steel self-tapping screws. Stick-on or adhesives will not be allowed unless the NEMA enclosure rating is compromised, then only epoxy adhesive shall be used to attach nameplates.
- d. Nameplate Information: In general, the following information is to be provided for the types of electrical components or enclosures supplied with equipment.
 - 1) Individual starters, contactors, disconnect switches, and similar equipment: identify the device, and voltage characteristics source and load served.
- e. Plate material shall be specifically suited for conditions surrounding the equipment. Outdoor equipment shall require special plate material for outdoor use.
- f. Nomenclature for plates shall be based on the equipment designations shown on the equipment schedules.

4. HVAC Duct System Stencils:

- a. Ductwork shall be labeled to identify the function, source, and flow direction. The ductwork identification marking shall be installed on the ductwork as follows:
- b. Minimum letter height of three (3) inches
- c. Spaced at a maximum of 25-foot intervals along each run. Reduce intervals to 10 feet in areas of congested ductwork and equipment or where there is a change in direction of the duct.
- d. Label at least once in each room or space the duct passes over or through.

- e. Label round ducts located above or below the normal site line of vision with the lettering placed below or above the horizontal centerline of the duct. Lettering shall be clearly visible from access locations.
 - f. Label rectangular ducts about the centerline on vertical sides. Both sides of the duct shall be labeled when accessible.
 - g. Label within three (3) feet, each side, of penetrations through walls, floors, ceilings, or other non-accessible enclosures.
5. Concealed Devices: Fire dampers, control dampers, and other operable devices and equipment located above ceilings shall be marked with color coded type markers.

2.3 WALL, FLOOR AND CEILING PLATES (ESCUTCHEONS)

- A. Except as otherwise noted, provide stainless steel or chrome plated brass floor and ceiling plates around all pipes, ducts, conduits, etc., passing exposed through walls, floors or ceilings, in any spaces except underfloor and plenum spaces.
- B. Plates shall be sized to fit snugly against the outside of the pipe or against the insulation on lines that are insulated and positively secured to such pipe or insulation.
- C. For finished ceiling installation, secure escutcheons to ceiling with escutcheon fasteners.
- D. Plates will not be required for piping where pipe sleeves extend $\frac{3}{4}$ -inch or more above finished floor.
- E. Round and rectangular ducts shall have closure plates (not chrome plated) made to fit accurately at all floor, wall and ceiling penetrations.

2.4 ROOF PENETRATIONS AND FLASHING

- A. Pipe, conduit and duct sleeves, pitch pockets and flashings compatible with the roofing installation shall be provided and installed for all roof penetrations by a contractor qualified in such work. Installation shall comply with the contract documents.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Cooperate with trades of adjacent, related or affected materials or operations, and with trades performing continuations of this work in order to effect timely and accurate placing of work and to coordinate, in proper and correct sequence, the work of such trades.

- B. The size of equipment indicated on the drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the contractor to determine that the equipment proposed will fit in the space. Fabrication drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.
- C. All equipment shall be installed in a manner to permit access to all surfaces. All valves, motors, drives, filters, and other accessory items shall be installed in a position to allow removal for service without disassembly of another part.
- D. Space Requirements:
 - 1. Consider space limitations imposed by contiguous work in location of equipment and material. Do not provide equipment or material which is not suitable in this respect.
 - 2. Make changes in material and equipment locations of up to five (5) feet, to allow for field conditions prior to actual installation, and as directed by the Architect/Engineer at no additional cost to the owner.
- E. Contractor shall note that the electrical design and drawings are based on the equipment scheduled and indicated on the drawings. Should any equipment be provided requiring changes to the electrical design, the required electrical changes shall be made at no cost to the owner.
- F. Connections for equipment other than Divisions 22 & 23:
 - 1. Rough-in and provide all gas, air, water, steam, sewer, etc. connections to all fixtures, equipment, machinery, etc., furnished by the owner and/or other trades in accordance with detailed rough-in drawings provided by the equipment suppliers, by actual measurements of the equipment connections, or as detailed.
 - 2. After the equipment is set in place, make all final connections and provide all required pipe, fittings, valves, traps, etc.
 - 3. Provide all backflow preventers and air gap fittings required, using approved devices. In each service line connected to an item of equipment or piece of machinery, provide a shutoff valve. On each drain not provided with a trap, provide a suitable trap.
 - 4. Provide all ductwork, transition pieces, etc., required for a complete installation of vent hoods, fume hoods, etc.

3.2 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. Piping may be run exposed in rooms typically without ceilings such as mechanical rooms, janitor's closets, tight against pan soffits in exposed "tee" structures, or storage spaces, but only where necessary. Shutoff and isolation valves shall be easily accessible.
- D. All pipe, conduits, etc., shall be cut accurately to measurements established at the building and shall be worked into place without springing or forcing. All ducts, pipes and conduits run exposed in machinery and equipment rooms shall be installed parallel to the building lines, except that piping shall be sloped to obtain the proper pitch. Piping and ducts run in furred ceilings, etc., shall be similarly installed, except as otherwise shown. All pipe openings shall be kept closed until the systems are closed with final connections.
- E. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the contractor shall notify owner's project manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The contractor shall provide written notification to the owner at least five (5) calendar days prior to the inspection.
- F. Precedence of Materials:
 - 1. The specifications determine the nature and setting of materials and equipment. The drawings establish quantities, dimensions and details.
 - 2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right-of-Way":
 - a. Building lines
 - b. Structural members
 - c. Structural support frames supporting ceiling equipment
 - d. Soil and drain piping
 - e. Supply, return and outside air ductwork
 - f. Vent piping
 - g. Exhaust ductwork
 - h. HVAC water and steam piping
 - i. Condensate piping
 - j. Natural gas piping
 - k. Domestic water (cold and hot, softened, treated)

1. Refrigerant piping
- m. Electrical conduit
3. Coordinate plumbing and HVAC systems with transport systems as required to maintain transport system right-of-way.

3.3 TESTING

- A. When any piece of mechanical equipment is operable and it is to the advantage of the contractor to operate the equipment, contractor may do so, provided that contractor properly supervises the operation, and has the owner's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the owner, or date of Substantial Completion, whichever occurs first.
- B. Regardless of whether or not the equipment has or has not been operated, the contractor shall properly clean the equipment, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the owner. The date of acceptance and performance certification will be the same date.
- C. Check inspections shall include piping, equipment, heating, air conditioning, insulation, ventilating equipment, controls, mechanical equipment and such other items hereinafter specified or specifically designated by the Architect/Engineer.
- D. The contractor shall execute, at no additional cost to the owner, any tests required by the owner or ASTM, etc. Standards listed. The contractor shall provide all equipment, materials and labor for making such tests. The owner will pay reasonable amounts of fuel and electrical energy costs for system tests. Fuel and electrical energy costs for system adjustment and tests, which follow Substantial Completion by the owner, will be borne by the owner.
- E. Notify the owner's project manager and the Architect/Engineer in writing at least seven (7) calendar days prior to each test and prior to other specification requirements requiring owner and Architect/Engineer to observe and/or approve tests.
- F. All tests shall have pertinent data logged by the contractor at the time of testing. Data shall include date, time, personnel performing, observing and inspecting, description of the test and extent of system tested, test conditions, test results, specified results and other pertinent data. Data shall be delivered to the Architect/Engineer as specified under "Requirements for Final Acceptance." The contractor or contractor's authorized job superintendent shall legibly sign all test log entries.
- G. Refer to commissioning specification sections for additional start-up, pre-functional and operational checkout, and for functional performance test procedures.

3.4 TRAINING

- A. Operating and Maintenance Manuals and instruction shall be provided as specified under the Division 01 Section entitled "Project Closeout Procedures."
- B. Specific training and operating instructions for individual equipment components shall be as specified in the individual Specification Sections.

END OF SECTION 20 01 00

SECTION 20 05 13

MOTORS

GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. Perform all work required to provide and install high efficiency single- and three-phase electric motors required for equipment supplied under this division of work as indicated by the contract documents, with supplementary items necessary for proper installation. Refer to electrical drawings for motor starter sizes. Disconnect switches to be furnished in Division 26.
- B. The Plumbing and HVAC Subcontractor shall furnish starters for Plumbing and HVAC Work. Motor starters shall be provided in accordance with Division 26 Specifications.
- C. Motors rated at less than 190 Watts and intended for intermittent operation need not conform to these specifications.
- D. ECM (Electronically Commutated Motor) motors on terminal units, fan-coil units, and computer room air conditioning units are exempt from specification requirements that cannot apply due to different electrical design characteristics.

1.3 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:
 - 1. AFBMA 9 – Load Ratings and Fatigue Life for Ball Bearings.
 - 2. AFBMA 11 – Load Ratings and Fatigue Life for Roller Bearings.
 - 3. EISA - The Energy Independence & Securities Act 2007.

4. ANSI/IEEE 112 – Test Procedure for Polyphase Induction Motors and Generators.
5. ANSI/NEMA/ MG 1 – Motors and Generators Part 31.
6. NFPA 70 – National Electrical Code.
7. ANSI C19 – Industrial Control Apparatus.
8. NEMA ICS – Industrial Control and Systems.
9. NEMA RV 3 - Application and Installation Guidelines for Flexible and Liquidtight Flexible Metal and Nonmetallic Conduits
10. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable
11. NEMA FB 2.20 - Selection and Installation Guidelines For Fittings for Use With Flexible Electrical Conduit and Cable
12. NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports
13. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports
14. NEMA OS 3 - Selection and Installation Guidelines for Electrical Outlet Boxes
15. UL 508 – Industrial Control Equipment.
16. ANSI/IEEE 117 – Standard Test Procedure for Evaluation of Systems of Insulating Materials for Random Wound AC Electric Machinery.
17. ANSI/NEMA MG 2 – Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors.
18. ANSI/UL 674 – Electric Motors and Generators for Use in Hazardous (Classified) Locations.
19. ANSI/UL 1004 – Electric Motors.

1.4 QUALITY ASSURANCE

- A. Motors associated with variable frequency drives (VFD) shall be inverter-duty rated, and provided with grounded shaft or ceramic bearings to insulate shaft, and Class F 105 degrees C rise insulation. Ref. NEMA MG1 Part 31.
- B. Conform to NFPA 70.

1.5 SUBMITTALS

- A. All motors provided by the Contractor shall be of the same manufacturer unless they are an integral part of the piece of equipment to which they are attached.
- B. Product Data: Provide the following information for each motor:
 - 1. Manufacturer.
 - 2. Rated full load horsepower.
 - 3. Rated volts.
 - 4. Number of Phases.
 - 5. Insulation Class.
 - 6. Frequency in Hertz.
 - 7. Full load amperes (FLA).
 - 8. Locked rotor amperes (LRA) at rated voltage or NEMA code letter.
 - 9. Nominal speed at full load (rpm).
 - 10. Service factor.
 - 11. NEMA design letter.
 - 12. NEMA machine type (ODP, WP-I, TEFC, etc.).
- C. For motors one horsepower and larger, include the following additional information:
 - 1. NEMA frame size.
 - 2. NEMA insulation system classification. For motors required to be installed outdoors, include information showing compliance for outdoor application.
 - 3. Maximum ambient temperature for which motor is designed.
 - 4. Time rating.
 - 5. Bearing size and type data.
 - 6. Guaranteed efficiency and power factor at full load, 75% load, 50% load, 25% load and 0% load.

- D. For motors 20 horsepower and larger, include the following additional information:
1. No load amperes.
 2. Safe stall time.
 3. Guaranteed efficiency and power factor at full load, 75% load, 50% load, 25% load and 0% load.
 4. Motor manufacturer's recommended maximum power factor correction capacitor (kvar) that can safely be switched with the motor.
 5. Expected value of corrected power factor at no load, 50 percent, 75 percent and full load.
 6. Full load amperes with corrected power factor.
 7. Maximum guaranteed slip at full load.
- E. Operation and Maintenance Data:
1. Submit operation and maintenance data including assembly Drawings, bearing data including replacement sizes, and lubrication instructions.
- F. Alternate Motors:
1. If a motor horsepower rating larger than indicated is offered as a substitute and accepted, provide required changes in size of conductors, conduits, motor controllers, overload relays, fuses, circuit breakers, switches and other related items at no change in the Contract price.

1.6 WARRANTY

- A. Provide minimum one-year manufacturer's warranty including coverage for motors one horsepower and larger.

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. Electrical Service: Refer to Drawing schedules for required electrical characteristics.

- C. Design for continuous operation in 40 degrees C environment and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor and motor enclosure type.
 - 1. Totally Enclosed Motors: Design for a service factor of 1.00 and an 80 degrees C maximum temperature rise in the same conditions.
 - 2. Explosion-Proof Motors: UL approved and labeled for hazard classification, with over temperature protection.
- D. Visible Stainless-Steel Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.
- E. Electrical Connection: Provide adequately sized metal electrical connection box for conduit connection. For fractional horsepower motors where connection is made directly, provide metal electrical box for conduit connection.
- F. Motors shall be built in accordance with the latest ANSI, IEEE and NEMA Standards and shall be fully coordinated with the equipment served, shall be of sizes and electrical characteristics scheduled and of approved manufacturer as listed below or of the same manufacturer as the equipment which they serve. Nameplate rating of motors shall match the characteristics scheduled.
- G. All motors shall be designed for normal starting torque unless the driven machine requires high starting torque and shall be selected for quiet operation, free from magnetic hum.
- H. All motors shall be provided with adequately sized electrical connection box for attachment of flexible conduit. Paragraph 1.03 of this specification refers to the NEMA standards and publications relevant to applications and use of both metal and liquid tight flexible conduit. When motors are connected to driven equipment by the use of a V-belt drive, they shall be furnished with adjustable rails.
- I. All air handling unit motor(s) with single and fan array arrangements, exhaust fan motors, chilled and hot water pump motors shall be compatible with variable frequency drive controllers. Equipment manufacturer shall coordinate with VFD manufacturer to ensure compatibility. Characteristics of motors furnished on equipment shall be furnished to VFD manufacturer for review, prior to installing motor on equipment. VFD's shall be furnished with driven equipment and shall be run tested as an equipment unit at factory prior to shipment. Submit run test report prior to shipping. F.O.B. of motors to factory shall be by the equipment manufacturer.
- J. Motors shall be open drip-proof type, except where specified or noted otherwise on the construction drawing.

- K. Motors $\frac{1}{4}$ to $\frac{3}{4}$ hp shall be Subtype II and meet the minimum requirements of EPA92 for minimum NEMA nominal efficiency motors.
- L. Motors 1 to 200 hp shall be Subtype I and meet the minimum requirements of NEMA Table 12-12 for NEMA premium efficiency motors.

2.2 MANUFACTURERS

- A. Manufacturer: Company specializing in the manufacture of electric motors for HVAC and plumbing equipment use, and their accessories, with minimum three (3) years documented product development, testing and manufacturing experience.
 - 1. Baldor - Super E – NEMA Premium Efficiency.
 - 2. Marathon - NEMA Premium Efficiency.
 - 3. Siemens – NEMA Premium Efficiency U.S. Electrical – NEMA Premium Efficiency.

2.3 SINGLE PHASE POWER - SPLIT PHASE MOTORS

- A. Starting Torque: Less than 150 percent of full load torque.
- B. Starting Current: Up to seven times full load current.
- C. Breakdown Torque: Approximately 200 percent of full load torque.
- D. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- E. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- F. Single phase motors, shall be less than $\frac{3}{4}$ horsepower and shall be permanent split phase, capacitor start, induction run, 120-volt, 60 hertz motors with dripproof enclosures except as hereinafter specified. These motors shall have built-in thermal overload protection and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.4 SINGLE PHASE POWER - PERMANENT-SPLIT CAPACITOR MOTORS

- A. Starting Torque: Exceeding one fourth of full load torque.
- B. Starting Current: Up to six times full load current.
- C. Multiple Speed: Through tapped windings.

- D. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum Service Factor as specified herein, prelubricated sleeve or ball bearings, automatic reset overload protector.
- E. Single phase motors shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection with automatic reset and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.5 SINGLE PHASE POWER - CAPACITOR START MOTORS

- A. Starting Torque: Three times full load torque.
- B. Starting Current: Less than five times full load current.
- C. Pull-up Torque: Up to 350 percent of full load torque.
- D. Breakdown Torque: Approximately 250 percent of full load torque.
- E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Enclosures shall be of the open dripproof type with a service factor as specified herein and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- H. Single phase motors, in general, shall be less than 3/4 horsepower and shall be permanent split phase, capacitor start, induction run, 120 volt, 60 hertz motors. These motors shall have built-in thermal overload protection and shall be rated for temperature rise as hereinbefore specified for 3-phase motors.

2.6 THREE PHASE POWER - SQUIRREL CAGE MOTORS

- A. Enclosures shall be of the open drip proof type with a service factor as specified herein and Class B insulation rated at 90 degrees C temperature rise measured above 40 degrees C room ambient condition at full load, unless otherwise noted.
- B. All motors 3/4 horsepower and larger, unless smaller motors are indicated to be supplied as 3-phase, shall be 3-phase and shall be squirrel cage high efficiency induction type with standard NEMA frame sizes.
- C. Three phase motors not connected to variable frequency drives are to be protected for phase loss and phase unbalance protection.

- D. Motors 1 HP and larger shall have integral frames.
- E. Starting Torque: Between one and one and one-half times full load torque.
- F. Starting Current: Six times full load current.
- G. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.
- H. Design, Construction, Testing and Performance: Conform to ANSI/NEMA MG 1 for Design B motors.
- I. Insulation System: NEMA Class B or better.
- J. Testing Procedure: In accordance with ANSI/IEEE 112, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.
- K. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- L. Bearings:
 - 1. Ball or roller type, double shielded with continuous grease relief to accommodate excessive pressure caused by thermal expansion or over lubrication.
 - 2. All motor bearings shall be factory prepacked with a nondetergent lubricant and shall be provided with lubrication fitting arranged to provide easy access when installed on the driven apparatus except as noted hereinafter.
 - 3. Permanently lubricated factory-sealed motors may be provided in fractional horsepower sizes only where they are an integral part of a piece of approved apparatus.
 - 4. All bearings shall be designed for L-10, 40,000 hour minimum life hours of continuous service. Calculate bearing load with NEMA minimum V-belt pulley with belt centerline at end of NEMA standard shaft extension. Direct driven fans may require specific bearings other than ball type, verify equipment specification where motor may be used where bearing life requirement may exceed L-10 rating. Stamp bearing sizes on nameplate.
- M. Sound Power Levels: Refer to ANSI/NEMA MG 1.
- N. Part Winding Start (Where Indicated): Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel. Bearings shall be double shielded with waterproof non-washing grease.

- O. Nominal Efficiency and Power Factor: Meet or exceed values as scheduled at load and rated voltage when tested in accordance with ANSI/IEEE 112.
- P. Motors one horsepower and larger shall be provided with a copper frame grounding lug of hydraulic compression design, for installation by the electrical subcontractor.

2.7 STARTING EQUIPMENT

- A. Each motor shall be provided with proper starting equipment. Starting equipment shall be furnished by this respective Division and installed by Division 26 Contractor.
- B. Relays and equipment supplied by this Contractor shall be integral with electrical equipment supplied.

2.8 RATING

- A. Speed and Size: Speed and approximate horsepower ratings are specified in equipment Specification Sections or are indicated on the Drawings. Furnish motors sufficiently sized for the particular application and with full-load rating not less than required by the driven equipment at specified capacity. Size motors so as not to overload at any point throughout the normal operating range.
- B. Voltage:
 - 1. Single phase: 115 volts for 120-volt nominal system voltage.
 - 2. Three phase: 200 volts for 208-volt nominal system voltage.
 - 3. Three phase: 230 volts for 240-volt nominal system voltage.
 - 4. Three phase: 230/460 volts for 240/480-volt nominal system voltage.
 - 5. Three phase: 460 volts for 480-volt nominal system voltage.
- C. Frequency: 60 Hertz.
- D. Efficiency: Provide energy-efficient motors meeting the requirements of NEMA MG1-12.55A, Table 12Y and MG 1.41.3. Efficiency to be determined by testing in accordance with NEMA MG 112.53 using IEEE 112A – Method B.
- E. Service Factor: According to NEMA MG 1-12.47 but not less than those indicated per the Table below.

F. Table: NEMA Open Motor Service Factors:

<u>Horsepower</u>	<u>3600 RPM</u>	<u>1800 RPM</u>	<u>1200 RPM</u>	<u>900 RPM</u>
1/6 – 1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15
1.5-150 and above	1.15	1.15	1.15	1.15

EXECUTION

3.1 APPLICATION

- A. Single-phase motors for shaft mounted fans shall be split phase type.
- B. Single-phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.
- C. Single-phase motors for fans shall be capacitor start, capacitor run type.
- D. Motors located in exterior locations and in direct drive axial fans, roll filters, humidifiers and draw-through air units shall be totally enclosed weatherproof epoxy-sealed type.

3.2 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. Properly install and align motors after installation on the driven equipment.
- D. Motor feeders shall be free of splices. In special cases when splice-free feeders are impractical, splices may be allowed given prior written approval from the Owner.
- E. Use crimp-on, solderless copper terminals on the branch circuit conductors. For motors 20 horsepower and larger, use 5300 Series 3M motor lead splicing kit or approved equal.
- F. When the motor and equipment are installed, the motor's nameplate must be in full view.

3.3 TESTING

- A. General: Provide all necessary instruments, labor and personnel required to perform motor inspection and testing.
- B. Inspection: Inspect all motors for damage, moisture absorption, alignment, freedom of rotation, proper lubrication, oil leaks, phase and rotation and cleanliness, and report any abnormalities to Owner before energizing.
- C. Tests: Motor full load current and full load voltage shall be measured. Motor phase loss and phase unbalance protection shall be tested. Motor Test Report forms included at the end of this Section shall be completed and submitted prior to Substantial Completion.
- D. Energizing: After installation has been thoroughly checked and found to be in proper condition, with thermal overloads in motor controllers properly sized and all controls in place, energize the equipment at system voltage for operational testing.
- E. Motor Test Report Form:

DATE: _____

SHEET: _____ OF _____

PROJECT NAME: _____

PROJECT NO.: _____

MOTOR DESIGNATION: _____ LOCATION:

HP: _____ FLA: _____ LOCATION :

PHASE LOSS AND PHASE UNBALANCE PROTECTION:

INSULATION CLASS:

SERVED FROM PANEL/MCC:

MEASURED CONDITIONS

TEMPERATURE: _____ degrees F

RELATIVE HUMIDITY: _____ %

CURRENT (AMPS): ØA _____, ØB _____, ØC _____

VOLTAGE (VOLTS): ØBA _____, ØBC _____, ØCA _____

ØAN _____, ØBN _____, ØCN _____

END OF SECTION 20 05 13

SECTION 20 05 29
SUPPORTS AND SLEEVES

GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. Perform all work required to provide and install supports, hangers, anchors, sleeves and bases for all pipe, duct, equipment, system components and accessories, indicated by the contract documents with all supplementary items necessary for complete, code compliant and approved installation

1.3 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:
 - 1. International Mechanical Code.
 - 2. International Plumbing Code.
 - 3. International Fuel Gas Code.
 - 4. ASME B31.2 - Fuel Gas Piping.
 - 5. ASME B31.9 - Building Services Piping.
 - 6. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
 - 7. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
 - 8. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
 - 9. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

10. MSS SP-90 - Guidelines on Terminology for Pipe Hangers and Supports.
11. NFPA 13 - Installation of Sprinkler Systems.
12. NFPA 14 - Installation of Standpipe and Hose Systems.
13. NFPA 99 - Standard for Health Care Facilities.
14. UL 203 - Pipe Hanger Equipment for Fire Protection Service.
15. SMACNA - HVAC Duct Construction Standards.
16. Underwriters Laboratories Standards and Listings.

1.4 QUALITY ASSURANCE

- A. Materials and application of pipe hangers and supports shall be in accordance with MSS-SP-58 and SP-69 unless noted otherwise.
- B. Support and sleeve materials and installation shall not interfere with the proper functioning of equipment.
- C. Contractor shall be responsible for structural integrity of all hangers, supports, anchors, guides, inserts and sleeves. All structural hanging materials shall have a minimum safety factor of five.
- D. Installer Qualifications: Utilize an installer experienced in performing work of this section who is experienced in installation of work similar to that required for this project and per the minimum requirements of MSS SP-89. Field welding of supports shall be by certified welders qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX using welding procedures per the minimum requirements of MSS SP-58.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturer's catalog data including code compliance, load capacity, and intended application.
- B. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.
- C. Shop Drawings: Submit detailed drawings of all shop or field fabricated supports, anchors and sleeves, signed and sealed by a qualified State of Texas registered professional engineer. Indicate size and characteristics of components and fabrication details and all loads exceeding 250 pounds imposed on the base building structure.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- B. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact. Maintain in place until installation.
- C. Store materials protected from exposure to harmful weather conditions.

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.

2.2 MANUFACTURERS

- A. Hangers and Supports:
 - 1. Anvil International.
 - 2. Kinder.
 - 3. Cooper B-Line.
 - 4. C & S Mfg. Corp.
 - 5. Hubbard Enterprises/Holdrite
 - 6. National Pipe Hanger Corporation.
 - 7. Power Strut.

2.3 HANGERS AND SUPPORTS

- A. General:
 - 1. Refer to individual system and equipment specification sections for additional support requirements. Comply with MSS SP-69 for support selections and applications that are not addressed within these specifications.
 - 2. Utilize hangers and supports to support systems under all conditions of operation, allowing free expansion and contraction, and to prevent excessive stresses from being introduced into the structure, piping or connected equipment.

3. All pipe supports shall be of the type and arrangement to prevent excessive deflection, to avoid excessive bending stresses between supports, and to eliminate transmission of vibration.
4. Design hangers to impede disengagement by movement of supported pipe.
5. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping.
6. Wire or perforated strap iron will not be acceptable as hanger material.
7. Hanger rods shall be threaded on both ends, threaded one end, or continuous threaded, complete with adjusting and lock nuts.
8. Fasteners requiring explosive powder (shooting) or pneumatic-driven actuation will not be acceptable under any circumstances.
9. Plastic anchors or plastic expansion shields will not be permitted under any circumstances.
10. Hangers and clamps supporting and contacting individual non-insulated brass or copper lines shall be copper or copper plated. Support individual non-insulated brass or copper lines 4 inches and smaller with adjustable swivel ring hangers. Where non-insulated brass or copper lines are supported on trapeze hangers or channels, the pipes shall be isolated from these supports with approved flexible elastomeric/thermoplastic isolation cushion material to completely encircle the piping and avoid contact with the channel or clamp. Plastic tape is not acceptable.
11. Hangers and clamps supporting and contacting glass piping shall be in accordance with the piping manufacturer's published recommendations and shall be fully lined with minimum 1/4 inch neoprene padding. The padding material and the configuration of its installation shall be submitted for approval.
12. Hangers and clamps supporting and contacting plastic piping shall be in accordance with the piping manufacturer's published recommendations and shall be factory coated or padded to prevent damage to piping.
13. Field fabricated supports shall be constructed from ASTM A36/A36M, steel shapes selected for loads being supported. Weld steel according to AWS D-1.1.

- B. Finishes: All ferrous hangers, rods, inserts, clamps, stanchions, and brackets on piping within interior non-corrosive environments, shall be dipped in Zinc Chromate Primer before installation. Rods may be galvanized or cadmium plated after threading, in lieu of dipping zinc chromate. All hangers and supports exposed to the weather, including roofs and building crawl space areas, shall be galvanized or manufactured from materials that will not rust or corrode due to moisture. All hangers and supports located within corrosive environments shall be constructed from or coated with materials manufactured for installation within the particular environment.
- C. Vertical Piping:
1. Supports for vertical riser piping in concealed areas shall utilize double bolt riser clamps, with each end having equal bearing on the building structure at each floor level.
 2. Supports for vertical riser piping at floor levels in exposed areas (such as fire protection standpipe in stairwells) shall be attached to the underside of the penetrated structure utilizing drilled anchors, two hanger rods (sized as specified), and socket clamp with washers.
 3. Two-hole rigid pipe clamps or four-hole socket clamps with washers may be used to support pipe directly from adequate structural members where floor-to-floor distance exceeds required vertical support spacing and lines are not subject to expansion and contraction.
- D. Trapezes: Where multiple lines are run horizontally at the same elevation and grade, they may be supported on manufactured channel, suspended on rods or pipes. Trapeze members including suspension rods shall be properly sized for the quantity, diameters, and loaded weight of the lines they are to support.
- E. Ductwork: All ductwork shall be supported in accordance with SMACNA recommendations for the service involved. Horizontal ducts supported using galvanized steel bands shall extend up both sides and onto the construction above, where they shall turn over and be secured with bolts and nuts fitted in inserts set in the concrete, bolted to angles secured to the construction above, or secured in another approved manner.
- F. Terminal Units:
1. Terminal units weighing up to 150 pounds shall be supported by four (4) 1-inch wide sheet metal straps with ends turned under bottom of unit at corners.
 2. Each band shall be secured by not over 3/4 inch in length, 1/4 inch diameter sheet metal screws – two (2) on bottom of unit and one (1) on each side.
 3. The other strap end shall be attached to the structure by 1/4 inch diameter threaded bolt into the concrete insert or into drilled-hole threaded concrete expansion anchor.

4. Where interference occurs, overhead of the box, not allowing direct vertical support by straps, provide trapeze channels suspended by 1/4 inch diameter galvanized threaded rods providing such channels do not block access panels of units.
5. Terminal units weighing more than 150 pounds shall be supported per the terminal unit manufacturer's installation instructions using threaded rod and hanger brackets located per manufacturer's drawing.

G. Fixture and Equipment Service Piping:

1. Piping at local connections to plumbing fixtures and equipment shall be supported to prevent the weight of the piping from being transmitted to fixtures and equipment.
2. Makeshift, field-devised methods of plumbing pipe support, such as with the use of scrap framing materials, are not allowed. Support and positioning of piping shall be by means of engineered methods that comply with IAPMO PS 42-96. These shall be Hubbard Enterprises/Holdrite support systems, C & S Mfg. Corp. or Owner-approved equivalent.
3. Supports within chases and partitions shall be corrosion resistant metal plate, clamps, angles or channels, and aligned with structure in the vertical or horizontal position. Plastic supports are not allowed unless approved by Owner.
4. Horizontal supports within chases and partitions that are attached to studs shall be attached at both ends. Drywall shall not be relied upon to support the piping.
5. Supports for plumbing fixture water service piping within chases and partitions may be attached to cast iron drain and vent pipe with approved brackets and pipe clamps.
6. Piping exposed on the face of drywall shall be supported with corrosion resistant metal channels that are attached to wall studs. Drywall shall not be relied upon to support the piping.
7. Piping supported from the floor shall utilize corrosion resistant metal channels or brackets that are anchored to the floor slab.
8. All water piping shall be isolated from building components to prevent the transmission of sound.
9. All copper or brass lines shall be isolated from ferrous metals with dielectric materials to prevent electrolytic action. Plastic tape is not an acceptable isolation material.

H. Fire Protection Piping: All hangers and supports for fire standpipe systems and fire sprinkler systems shall be Factory Mutual and Underwriters' Laboratories, Inc. listed and labeled.

I. Inserts:

1. Cast-in-place concrete inserts shall comply with MSS-SP-69, U.L. and F.M. approved, and sized to suit threaded hanger rods.
2. Inserts shall have malleable iron case with galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods. Suitable concrete inserts for pipe and equipment hangers shall be set and properly located for all pipe and equipment to be suspended from concrete construction. If the inserts are later found not to be in the proper location for the placement of hangers, then drilled anchors shall be installed. Drilled anchors in concrete or masonry shall be submitted for the approval.
3. Manufactured inserts for metal deck construction shall have legs custom fit to rest in form valleys.
4. Shop fabricated inserts shall be submitted and approved by Owner prior to installation.
5. Inserts shall be of a type that will not interfere with structural reinforcing and that will not displace excessive amounts of structural concrete.

J. Pipe Shields: Provide pipe shields in accordance with insulation manufacturer's published recommendations. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier.

K. Housekeeping Pads:

1. Provide minimum 4 inch reinforced concrete pads with chamfered corners and equipment bases for all outdoor equipment on grade, floor mounted equipment in main central plant area, mechanical rooms, areas with floors below grade, penthouse equipment rooms, floor mounted air handling units, and where shown on Drawings.
2. Housekeeping pads shall extend minimum of 6 inch on all sides beyond the limits of the mounted equipment unless otherwise noted.
3. Provide galvanized anchor bolts for all equipment placed on concrete pads or on concrete slabs of the size and number recommended by the equipment manufacturer.

2.4 PIPE AND DUCT PENETRATIONS

A. General:

1. Seal penetrations through all rated partitions, walls and floors with U.L. tested assemblies to provide and maintain a rating equal to or greater than the partition, wall or floor.

2. Inside diameter of all sleeves or cored holes shall provide sufficient annular space between outside diameter of pipe, duct or insulation to allow proper installation of required fire and water proofing materials and allow for movement due to expansion and contraction.
3. Exposed ceiling, floor and wall pipe penetrations within finished areas (including exterior wall faces) shall be provided with chrome plated, brass or stamped steel, hinged, split-ring escutcheon with set screw or snap-on type. Inside diameter shall closely fit pipe outside diameter or outside of pipe insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings. In exterior, damp, or corrosive environments, use Type 302 stainless steel escutcheons.

B. Floor Pipe Penetrations:

1. Seal penetrations through all floors to provide and maintain a watertight installation.
2. Sleeves cast in the slab for pipe penetrations shall be Schedule 40 steel, ASTM A53, with 2 inch wide annular fin water-stop continuously welded at midpoint of slab. Entire assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
3. Cored holes in the slab for pipe penetrations shall be provided with a Schedule 40 steel, ASTM A53 sleeve, with 2 inch wide annular fin water-stop continuously welded at point on sleeve to allow countersinking into slab and waterproofing. Entire sleeve assembly shall be hot-dipped galvanized after fabrication. Water-stop shall be same thickness as sleeve.
4. All sleeves shall extend a minimum of two inches above finished floor.
5. Where job conditions prevent the use of a sleeve that extends two inches above the slab, Link-Seal mechanical casing seals manufactured by Thunderline Corporation may be installed to provide a watertight penetration. Mechanical casing seals can be used only for relatively small diameter pipe penetrations. Verify that slab thickness allows proper installation of the link-seal assembly and the required fire stopping prior to applying this exception.

C. Wall Penetrations:

1. Where piping or ductwork passes through non-rated partition, close off space between pipe or duct and construction with gypsum wallboard and repair plaster smoothed and finished to match adjacent wall area.
2. Pipe penetrations through interior rated partitions shall be provided with adjustable prefabricated U.L. listed fire rated galvanized sheet metal sleeves having gauge thickness as required by wall fire rating, 20 gauge minimum. EXCEPTION: When U.L. Listed assembly does not require a sleeve,

3. Pipe penetrations through exterior walls and walls below grade shall be provided with “Link-Seal” mechanical casing seal manufactured by Thunderline Corporation.
4. Ductwork penetrations through rated partitions, walls and floors shall be provided with sleeves that are manufactured integral with the damper assembly installed.

D. Flashing:

1. Coordinate flashing material and installation required for pipe and duct roof penetrations with Owner and roofing Contractor.
2. Provide flexible flashing and metal counter-flashing where ductwork penetrates exterior walls. Seal penetration water and air tight.
3. Provide acoustical flashing around ducts and pipes penetrating equipment rooms, with materials and installation in accordance with manufacturer's instructions for sound control.

E. Roof Curbs: Coordinate roof curb material and installation with owner and roofing contractor.

A.

EXECUTION

3.1 PREPARATION

- A. Conduct a pre-installation meeting prior to commencing Work of this Section to verify Project requirements, coordinate with other trades, establish condition and completeness of substrate, review manufacturer’s installation instructions and manufacturer’s warranty requirements.

3.2 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. Application, sizing and installation of piping, supports, anchors and sleeves shall be in accordance with manufacturer's printed installation instructions.
- C. Provide for vertical adjustments after erection and during commissioning, where feasible, to ensure pipe is at design elevation and slope.
- D. Install hangers and supports to allow controlled thermal movement of piping systems, permitting freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- E. Install hanger so that rod is vertical under operating conditions.
- F. Supports, hangers, anchors, and guides shall be fastened to the structure only at such points where the structure is capable of restraining the forces in the piping system.

- G. The load and spacing on each hanger and/or insert shall not exceed the safe allowable load for any component of the support system, including the concrete that holds the inserts. Reinforcement at inserts shall be provided as required to develop the strength required. Contractor shall be responsible for engaging a structural engineer as required for design and review at support systems.
- H. Do not hang pipe, duct or any mechanical/plumbing item directly from a metal deck or locate on the bottom chord of any truss or joist unless approved by the Structural Engineer of Record.
- I. All supports shall be designed and installed to avoid interference with other piping, hangers, ducts, electrical conduit, supports, building structures, equipment, etc.
- J. Piping supports shall be independent from ductwork supports. Combining supports is not permitted.
- K. Provide all supporting steel required for the installation of mechanical equipment and materials, including angles, channels, beams, etc. to suspended or floor supported tanks and equipment. All of this steel may not be specifically indicated on the Drawings.
- L. All piping and ductwork support shall be designed and installed to allow the insulation to be continuous through the hangers.
- M. Adjustable clevis hangers shall be supported at rods with a nut above and below the hanger.
- N. All hanger rods shall be trimmed neatly so that 1 inch of excess hanger rod protrudes beyond the hanger nut. In the event a rod is intentionally but temporarily left excessively long (for sloped or insulated lines for example), the Contractor shall take appropriate measures to protect the pipe or other materials from damage.
- O. Install hangers to provide minimum ½ inch space between finished covering and adjacent structures, materials, etc.
- P. Horizontal and vertical piping in chases and partitions shall be supported to prevent movement and isolated from the supports to prevent transmission of sound.
- Q. Locate hangers within 12 inches of each horizontal elbow.
- R. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- S. Support riser piping independently of connected horizontal piping. Riser piping is defined as vertical piping extending through more than one floor level.
- T. Support riser piping at each floor level and provide additional supports where floor-to-floor distance exceeds required vertical support spacing. Installation of riser clamps and welded steel riser supports shall not allow weight of piping to be transmitted to floor sleeves.

- U. Steel Bar Joists: Hanger rods shall be secured to angle irons of adequate size; each angle shall span across two or more joists as required to distribute the weight properly and shall be welded or otherwise permanently fixed to the top of joists.
- V. Steel Beams: Where pipes and loads are supported under steel beams, approved type beam clamps shall be used.
- W. Pre-Cast Tee Structural Concrete: Hanger supports, anchors, etc. attached to the precast, double tee, structural concrete system shall be installed in accordance with approved Shop Drawings only. Holes required for hanger rods shall be core drilled in the "flange" of the double tee only; impact type tools are not allowed under any circumstances. Core drilling in the "stem" portions of the double tee is not allowed. Holes core drilled through the "flange" for hanger rods shall be no greater than 1/4 inch larger than the diameter of the hanger rod. Hanger rods shall be supported by means of bearing plates of size and shape acceptable to the Architect/Engineer, with welded double nuts on the hanger rod above the bearing plate. Cinch anchors, lead shields, expansion bolts, and studs driven by explosion charges are not allowed under any circumstances in the lower 15 inches of each stem and in the "shadow" of the stem on the top side of the "double tees".
- X. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Y. Inserts:
1. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 2. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 3. Install anchors in concrete after concrete is placed and completely cured. Install anchors according to manufacturer's written instructions.
- Z. Flashing:
1. Coordinate all roof flashing with requirements of Division 07.
- AA. Pipe Shields:
1. Provide shields at each hanger supporting insulated pipe.
 2. Provide shields of the proper length to distribute weight evenly and to prevent compression of insulation at hanger.

3. Install shield so that hanger is located at the center of the shield.
4. Attach shield to insulation with adhesive to prevent slippage or movement.

BB. Equipment Anchor Bolts:

1. Foundation bolts shall be placed in the forms when the concrete is poured, the bolts being correctly located by means of templates. Each bolt shall be set in a sleeve of sufficient size to provide ½ inch clearance around bolt.

END OF SECTION 20 05 29

SECTION 20 05 48
VIBRATION ISOLATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. Perform all work required to provide and install inertia bases and vibration isolation indicated by the contract documents with supplementary items necessary for their proper installation.

1.3 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:
 - 1. ASHRAE - Guide to Average Noise Criteria Curves.

1.4 QUALITY ASSURANCE

- A. Provide for vibration isolation supports for all equipment, piping and ductwork indicated herein. The transmission of perceptible vibration, structural borne noise or objectionable air borne noise to occupied areas by equipment installed under this contract will not be permitted. Install vibration isolators as specified herein or shown on the drawings or otherwise required to prevent the transmission of vibration which would create objectionable noise levels in occupied areas.
- B. The vibration isolation supplier must be a firm capable of dealing effectively with vibration and noise characteristics effects and criteria; and one that can provide facilities and capabilities for measuring and evaluating the aforementioned disturbances.

- C. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.
- D. Provide vibration isolation devices, from a single manufacturer or supplier who will be responsible for complete coordination of all phases of this Work.

1.5 SUBMITTALS

A. Product Data:

1. Submit Shop Drawings, installation instructions, and product data.
2. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.
3. Contractor shall furnish complete submittal data, including shop drawings, which shall indicate the size, type and deflection of each isolator; and the supported weight, disturbing frequency and efficiency of each isolator proposed; and any calculations and other information as may be required for the Architect/Engineer to check the isolator selection for compliance with the specification.

B. Record Documents:

1. Indicate inertia bases on shop drawings, including dimensions.
2. All steel bases and concrete inertia bases shall be completely detailed, and shall show completely any reinforcing steel that may be required to provide a rigid base for the isolated equipment. Further, the submittal data shall clearly indicate outlined procedures for installing and adjusting the isolators and bases mentioned above.
3. Submittals on riser isolation system shall show initial and final loads on the structure at each support point, initial and final deflection of each isolator, amount and direction of each deflection change, total expansion and contraction of each riser and operating temperature of 180 degrees F in the riser.
4. Riser diagrams shall be prepared by the vibration isolation manufacturer and submitted for approval. These diagrams shall show initial and final spring deflections, amount and direction of deflection changes, overall expansion and contraction of the riser, and operating temperature of the medium.
5. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the design proposed when installed in accordance with submittal and these Specifications.

C. Operation and Maintenance Data:

1. Provide manufacturer's recommended maintenance procedures.

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. All vibration isolators and bases shall be designed for and treated for resistance to corrosion.
- C. Steel components shall be PVC coated or phosphated and painted with industrial grade enamel. All nuts, bolts and washers shall be zinc-electroplated or cadmium plated.
- D. All isolators exposed to the weather shall have steel parts hot-dip galvanized or zinc-electroplated plus coating of Neoprene or Bitumastic paint. Aluminum components for outdoor installation shall be etched and painted with industrial grade enamel.
- E. Required spring deflections for isolators supporting various items of equipment are shown on the Drawings or tabulated elsewhere in these Specifications, but in no case shall be less than one inch. Springs shall be capable of 30 percent over-travel before becoming solid.
- F. Where height-saving brackets for side mounting of isolators are required, the height-saving brackets shall be designed to provide for an operating clearance of 2 inches under the isolated structure and designed so that the isolators can be installed and removed when the operating clearance is 2 inches or less. When used with spring isolators having a deflection of 2-1/2 inches or more, the height-saving brackets shall be of the pre-compression type to limit exposed bolt length between the top of the isolator and the underneath side of the bracket.
- G. All isolators supporting a given piece of equipment shall limit the length of the exposed adjustment bolt between the top and base to a maximum range of 1 inch to 2 inches.
- H. All isolators supporting a given piece of equipment shall be selected for approximately equal spring deflection.
- I. Isolators for equipment installed outdoors shall be designed to provide adequate restraint due to normal wind conditions and to withstand wind load of 55 pounds per square foot applied to any exposed surface of the equipment without failure.

2.2 MANUFACTURERS

- A. Amber Booth.
- B. Korfund Dynamics.
- C. Consolidated Kinetics.
- D. Mason Industries.

2.3 ISOLATION BASES

- A. Type SFB: A structural steel fan and motor base with NEMA standard motor side rails and holes drilled to receive the fan and motor. The steel members shall be adequately sized to prevent distortion and misalignment of the drive.
- B. Type CPF: Concrete inertia base, consisting of full depth perimeter steel pouring form, 3000 psi concrete reinforcing bars welded in place, bolting templates with anchor bolts and height-saving brackets for side mounting of the isolators. The base shall be sized with a minimum overlap of 4 inches around the base of the equipment. Fan bases are to be supplied with NEMA standard motor slide rails.
- C. The bases for pumps shall be sized to support the suction elbow of end suction pumps and both the suction and discharge elbows of horizontal split-case pumps. The bases shall be T-shaped where necessary to conserve space.
- D. Structural bases shall be thoroughly cleaned of welding slag and primed with zinc-chromate or metal etching primer. A finish coat of industrial grade enamel shall be applied over the primer.

2.4 ISOLATOR TYPES

- A. Isolator types and required deflections are specified under "Application." Isolator type designations are Amber Booth designators. The isolators shall comply with the following descriptions for each type required on the Project:
 - 1. Type XL: Aluminum-housed, adjustable, spring mounting having telescoping top and bottom sections separated by resilient inserts of Neoprene or other suitable material to limit horizontal motion. The inserts shall be permanently lubricated to minimize vertical friction. Steel or cast iron housings may be used if they are hot-dip galvanized after fabrication. A Neoprene pad having a minimum thickness of ¼ inch shall be bonded to the baseplate.
 - 2. Type SW: Adjustable, freestanding, open-spring mounting with combination leveling bolt and equipment fastening bolt. The spring mounting to baseplate and compression plate must be rigid. The neoprene pad with a minimum thickness of ¼ inch is bonded to the baseplate. A minimum horizontal-to-vertical spring rate of 1.0 is required.
 - 3. Type BS: Spring hanger consisting of a rectangular steel box, coil spring, spring retainers, neoprene-impregnated fabric washer and steel washer.
 - 4. Type BSA: Spring hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, coil spring, spring retainers, neoprene impregnated fabric washer and steel washer. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.

5. Type BSR: Combination spring and rubber hanger consisting of a rectangular steel box, coil spring, spring retainers and elastomeric mounting designed for ½ inch deflection.
6. Type BSRA: Combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, coil spring, spring retainers and elastomeric element. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.
7. Type RSW: Adjustable spring isolator as describe for Type SW with the addition of fabricated steel housing suitable for recessing into a concrete inertia block. The housing has a side access.
8. Type PBS: Spring hanger as described for Type BS with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation.
9. Type PBSA: Spring hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation, and to permit transferring the load to the spring after installation, a coil spring, spring retainers, neoprene impregnated fabric washer and steel washer. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.
10. PBSR: Combination spring and elastomeric hanger as described for Type BSR with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation and to permit transferring the load to the spring after installation.
11. Type PBSRA: Combination spring and elastomeric hanger consisting of a rectangular steel box capable of 200 percent minimum overload without visible deformation, with the addition of a load transfer plate to hold the equipment or piping at a fixed elevation during installation, a coil spring, spring retainers and elastomeric element. Incorporate a 30 degree angularity feature that will permit up to a 15 degree misalignment of the hanger rod from the vertical without shorting out to the hanger box.
12. Type CT: Adjustable, open-spring isolator having one or more coil springs attached to a top compression plate and a base plate. A neoprene pad with a minimum thickness of ¼ inch is bonded to the base plate. The spring assembly must fit within a welded steel enclosure consisting of a top plate and rigid lower housing, which serves as a blocking device during installation. The isolator includes restraining bolts for connecting the top plate and lower housing to prevent the isolated equipment from rising when drained of water.

13. Type SP-NRE: Pad-type mounting consisting of two layers of 3/8 inch thick ribbed or waffled neoprene pads bonded to a 16 gauge galvanized steel separator plate. Size pads for approximately 20 to 40 psi load and a deflection of 0.12 to 0.16 inch.
14. Type BRD: Elastomeric hanger consisting of a rectangular steel box and an elastomeric isolation element of neoprene. A high-quality synthetic rubber may be used if it contains anti-ozone and antioxidant additives. The elements are designed for approximately 1/2 inch deflection and loaded so that the deflection does not exceed 15 percent of the free height of the element.
15. Type TRK: For static pressure of 3 inch water or greater, provide a set of spring-loaded thrust resistors (two or more) installed across the flexible duct connection on the fan discharge, designed to limit the movement of the fan. Coil spring static deflection capabilities of thrust resistors shall equal those of the isolators supporting the equipment up to a maximum of 2 inches.
16. Type RVD: An elastomeric mounting having a steel baseplate with mounting holes and a threaded insert at top of the mounting for attaching equipment. All metal parts shall be completely embedded in the elastomeric material. Mountings shall be designed for approximately 1/2 inch deflection.

PART 3 - EXECUTION

3.1 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. Install motor driven equipment with vibration isolators.
- D. Set steel bases for one-inch clearance between housekeeping pad and base. Set concrete inertia bases for 2-inch clearance. Adjust equipment level.
- E. Isolate pumped water-piping systems with spring-type vibration isolators to produce a floating mechanical system. Provide spring isolators on piping connected to isolated equipment as follows: Static deflection for the two supports closest to equipment on each pipe connected to the equipment shall be equal to the deflection of isolated equipment. All other supports for horizontal piping shall have a minimum operating deflection of 3/4 inch with a capability of an additional 50 percent travel to solid.
- F. All open-type spring isolators shall be restrained as recommended by the manufacturer.

G. Pumps:

1. Each centrifugal pump and its driving motor shall be mounted on a common inertia base and the base, in turn, shall be mounted on the scheduled vibration isolator type to prevent transmission of vibration and noise to the building structure.
2. In general, all inertia bases shall be formed and poured in place onto a hard, flat surface from which the base can be separated when cured. The base shall be shimmed, using flat material, to the intended final height prior to equipment mounting and piping connection.
3. After piping connections are made and the system filled with water and ready to put into service, the isolator adjustment bolts shall be extended until the shim blocks can be removed. Isolators may then be backed down slightly to restore the intended height. The locknuts should then be tightened on the isolators. Jack bolts shall be trimmed to a length that will allow no more than 1 inch of additional height adjustment. After final adjustment, the inertia base shall not support any piping load. All springs supporting piping that is connected to a piece of isolated equipment shall be sized for static deflection equal to that of the isolated equipment.

H. Piping (Including Generator Piping):

1. Floor mounted supports shall have the same type of isolator or media as is used for the nearest isolated equipment connected to the piping.
2. The pipe hanger system shall have provisions for all piping to be shimmed or blocked in place until all connections are made and the system filled with water; then, the isolators adjusted to support the weights and the shim blocks removed.
3. The first three support points from a piece of isolated equipment shall be of the positioning type and provide not less than the static deflection of the equipment isolators.
4. All springs supporting piping shall be capable of an additional ½ inch deflection prior to complete compression and springs supporting vertical risers shall have provisions for limit stops.
5. Support risers up through 16 inches at every third floor, and risers 18 inches and over at every second floor. All supports for risers must have a deflection capability at least four times the anticipated expansion and contraction. Install temporary anchors as required to permit preadjustment of springs in the risers. Furnish permanent limit stops to prevent excessive vertical motion of risers in the event risers are drained. Wall sleeves for takeoffs from risers shall be sized for insulation outside diameter plus two times the calculated thermal movement to prevent binding.

6. System operating temperatures (degrees F) are as follows:

Service	Supply	Return
Chilled Water	42-45	56-59
Heating Water	180	160
25-pound Steam and Condensate	318	318
70-pound Steam and Condensate	318	318

- I. Resilient Sleeves: Resilient sleeves shall be provided at all points where equipment room walls, floors or ceilings are penetrated by ducts, piping or refrigerant line, etc.
- J. Fans and Air Handling Units: Such units shall have electrical flexible connections not less than 36 inches long and the flexible duct connections with a free length of not less than 8 inches.
- K. Ductwork: Isolate all high pressure ductwork within each equipment room and to a minimum of 50 feet from fan with Type BS hangers or Type SW floor supports, sized for ¾ inch deflection.
- L. To prevent excessive transfer of piping load from floor to floor, all water riser support springs shall have a deflection capability of four times the expansion or contraction to be accommodated by the support with the additional runout capability to absorb the movement. Isolators supporting steam and diesel engine exhaust risers shall be selected for deflections equal to two times the anticipated thermal movement at the support point. Riser isolation system shall be designed such that it supports the riser in tension, eliminating the need for guides; requires no anchors; and has a zero movement point at or near the center to divide thermal movement approximately in half, thus reducing vertical movement of horizontal pipe takeoffs.

3.2 APPLICATION

- A. The following is a schedule of equipment on a typical project that requires vibration isolation and base isolators of the types specified. Refer to Drawings for equipment scheduled for the Project. Any equipment, system or condition that may be altered, added, or changed; or that is not specifically described in the Contract Documents shall be isolated in a manner specified for similar equipment, system or condition in order to comply with these Specifications.

Equipment Type	Isolator Type/ Minimum Deflection (Inches)	Base Type
Air Handling Units Floor Mounted – Up to 15 HP	SW 2”	N/A
Floor Mounted – 15 HP and Over	SW2.4”	N/A
Suspended – Up to 15 HP	PBSRA 2”	SFB
Suspended – 15 HP and Over	PBSRA 3.5”	SFB
High pressure Fan Sections	SW 2” with TRK 3.5	CPF
Fan Coil Units – Suspended	PBSRA 1”	N/A
Fan Powered Terminal Units Not Internally Isolated	PBSRA 1”	N/A
Centrifugal Fans Class I and II – Up to 54-¼ inch Diameter Up to 15 HP	SW 2”	SFB (If required)
Class I and II – 60-inch Diameter and Over, 15 HP and Over	SW 4.5”	SFB (If required)
Class III – All sizes	SW 3.5” with TRK 2”	CPF
Arrangement # 3 Fans	SW 4.5”	SFB
Vane Axial Fans	SW 4.5” with TRK 2”	SFB
Vent Sets:		
Floor Mounted – Up to 15 HP	SW 1.5”	SFB (If required)
Suspended – Up to 15 HP	PBSRA 1.5”	SFB (If required)
Unit Substations	RVD 0.5”	N/A
Compressors	CT 1.5”	N/A
Engine Driven Generators: Skid Mounted	CT 3”	N/A
Exhaust Pipe	PBSRA 3”	N/A
Pumps: Up to 5 HP	RSW 0.5”	CPF
5 HP to 10 HP	RSW 1”	CPF
10 HP and Over	RSW 2”	CPF

Equipment Type	Isolator Type/ Minimum Deflection (Inches)	Base Type
Vacuum Pumps	RSW 1"	CPF

B. Piping Application:

1. Type PBSRA for hangers in all horizontal piping at equipment; except at connections to risers use BS.
2. Type SW for all floor supports of floor supported piping at equipment or stanchion.

END OF SECTION 20 05 48

SECTION 20 07 19
PIPING INSULATION

GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 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.

1.3 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:
 - 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 C610 - Molded Expanded Perlite Block and Pipe Thermal Insulation.
15. ASTM C921 - Jackets for Thermal Insulation.
16. ASTM C1126 - Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation.
17. ASTM D1056 - Flexible Cellular Materials - Sponge or Expanded Rubber.
18. ASTM D1667 - Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).
19. ASTM D2842 - Water Absorption of Rigid Cellular Plastics.
20. ASTM C795 - Insulation For Use Over Austenitic Steel.
21. ASTM E84 - Surface Burning Characteristics of Building Materials.
22. ASTM E96 - Water Vapor Transmission of Materials.
23. NFPA 255 - Surface Burning Characteristics of Building Materials.
24. UL 723 - Surface Burning Characteristics of Building Materials.
25. 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

1.4 DEFINITIONS

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

1.5 QUALITY ASSURANCE

- A. 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.
- 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.
 - 1. Certificates to this effect shall be submitted along with Contractor's submittal data for this Section of the Specifications.
 - 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.
- C. Application Company Qualifications: Company performing the Work of this Section shall have minimum 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 factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable.

1.6 SUBMITTALS

- A. Product Data:
 - 1. Provide product description, list of materials, "k" value, "R" value, mean temperature range, and thickness for each service and location.
 - 2. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type
- B. Operation and Maintenance Data:
 - 1. Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to the Project Site in original factory packaging, labeled with manufacturer's identification including product thermal ratings and thickness.

- B. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.
- C. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

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.

2.2 MANUFACTURERS

A. Insulation:

1. Owens-Corning (Type P1).
2. Certainteed Corporation (Type P1).
3. Johns Manville Corporation (Type P1).
4. Knauf Corporation (Type P1).
5. Dow Chemical Company (Type P2).
6. Armstrong/Armacell (Armaflex) (Type P3).
7. RBX Industries/Rubatex (Type P3).
8. Industrial Insulation Group, LLC (Type P4).
9. Resolco International by (Insul-Phen) (Type P5).
10. FOAMGLAS (Cellular Glass) by Pittsburgh Corning (Type P6).

B. Jackets:

1. Childers Products Company
2. PABCO
3. RPR Products, Inc.
4. Venture Clad Corporation
5. Foamglas

C. Coatings, Sealants, and Adhesives:

1. Foster
2. Childers

2.3 INSULATION

- A. Type P1: Fiberglass preformed insulation; ASTM C 547; minimum 3.0 lb/cu ft density, ASTM C335, 'k' value of 0.23 at 75 degrees F; noncombustible.
- B. Type P2: Molded closed cell polyisocyanurate insulation; ASTM E96, maximum water vapor transmission rating of 0.005 Perm-In; ASTM C518, 'k' value of 0.20 at 75 degrees F; ASTM D2842, water absorption value of 0.05 lb/ft².
- C. Type P3: Closed cell elastomeric, flexible, insulation; ASTM E96; maximum vapor transmission rating of 0.20 perms; ASTM C 518; 'k' value of 0.27 at 75 degrees F.
- D. Type P4: Mineral Wool; ASTM C 547; preformed, high temperature insulation; 'k' value of 0.35 at 300 degrees F.
- E. Type P5: Phenolic closed cell, ASTM C1126 rigid foam, 2.2 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.13 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).
- F. Type P5A: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.02 Perm-In; ASTM C1126 rigid foam, 3.75 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.16 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).
- G. Type P5B: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.02 Perm-In; ASTM C1126 rigid foam, 5.0 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.21 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).
- H. Type P6: Cellular Glass, ASTM C552, 7.5 lbs./cu.ft, density, ASTM E96 (Wet Cup Method) 0.00 water vapor perm , ASTM C518 'k' value of 0.29 at 75 degrees F.

2.4 JACKETS

A. Factory Applied Jackets:

1. White kraft bonded to reinforced foil vapor barrier with self-sealing adhesive joints.
2. ASJ White, triple-ply laminate polypropylene, mold resistant, metalized polyester vapor barrier film backing: Venture 1555U or Insulrap 30 Vapor Barrier I-30.

B. Field Applied Jackets:

1. PVC Jackets: UL listed 25/50 rated per ASTM E 84, UV resistant, minimum insulation thickness 0.020 inches for pipe outside diameters up to 18 inches and 0.030 inches for pipe outside diameters 18 inches and above. Standard manufactured PVC cover fittings cover system consisting of one-piece, pre-molded, PVC covers with fiberglass inserts manufactured from 20-mils thick, high-impact, ultraviolet-resistant. Use ultraviolet resistant adhesive as recommended by the manufacturer.
2. Reinforcing Mesh: Glass Fiber Childers Chil-Glas #10 or synthetic 9X8 mesh with minimum weight of 0.9 ounces per square yard.
3. Aluminum Jackets: ASTM B 209; 0.020 inch thick; smooth finish with factory applied moisture barrier.
4. Stainless Steel Jackets: Type 304 stainless steel; 0.010 inch thick; smooth finish.
5. VentureClad 1577CW, zero permeability and mold resistant jacket material, 5-ply laminate with 6 mil film with adhesive on one side. Product shall be used with phenolic closed cell insulation where Type 5A and 5B insulation is installed on existing chilled water piping being repaired or being modified.

2.5 COATINGS, SEALANTS, AND ADHESIVES

- A. Insulating Cement: ASTM C 195; hydraulic setting mineral wool; Ryder One-Coat.
- B. Sealants: Childers CP-70 or CP-76
 1. Apply at valves, fittings and where insulation is terminated. Brush-apply sealant to end of insulation and continue along pipe surface.
 2. Below-ambient closed cell pipe insulation (Type P5, P5A, P5B): apply sealant on all longitudinal and butt insulation joints to prevent moisture transmission.
- C. Adhesives: Use to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP-82 or Foster 85-25 as general purpose adhesive. Use Childers CP-97 or Foster 81-27 fibrous adhesive when adhering pipe saddles and shields to the insulation.
- D. Primers: For proper bonding with lagging adhesive/canvas provide light coat of Childers CP-50 AMV1 or Foster 82-27 diluted 50 percent with water over insulation or Pittcoat 300 primer thinned with mineral spirits to cover insulating cements prior to finish coating.

E. Coatings and Mastics:

1. Vapor barrier coating for indoor, below-ambient applications: Foster 30-80 or Childers CP-38 on all elbows, fittings, and valves. Coating shall adhere to MIL-C-19565C, Type II and shall be QPL listed.
2. Weather barrier/breather mastics for above-ambient piping applications: Childers CP-10/CP-11 or Foster 46-50.
3. High humidity applications: Foster 30-80 AF or Childers CP-137 AF fungus/mold resistant coating that meets ASTM D 5590 with zero growth rating.
4. Exterior applications: Childers CP 30LO (low odor), Childers CP-45 Encacel V, or Foster 60-95 for insulated elbows/fittings, longitudinal seams, and butt joints of vapor barrier jackets or glass cloth jackets.
5. Finish coat over closed cell elastomeric: Foster 30-64 or Armstrong "Finish" acrylic finish.
6. Canvas Finishes:
 - a. Apply lagging adhesive to prevent mildew for securing canvas. Apply anti-fungal lagging adhesive that adheres to ASTM D 5590 with zero growth rating. (Foster 30-36AF, Childers CP-137AF) Do not use wheat paste.
 - b. Exterior Applications: cover all canvas insulation with a fire-retardant weather barrier mastic. On canvas jacketed systems where seam joints at fittings are rough, cover with an application of insulating cement and smooth with a trowel before the canvas is applied with adhesive. Canvas shall be free of wrinkles and have a smooth, neat appearance.

F. Reinforcing Mesh: Childers Chil-Glas #10 or Foster Mast-a-Fab 9x8 reinforcing mesh with coatings and mastics.

G. Lagging Adhesives/Coatings: Childers CP-50A HV2 or Foster 30-36 for adhering canvas and glass cloths over thermal insulation installed indoors. Adhesive shall adhere to MIL-A-3316C Class I, Grade A.

1. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating that meets ASTM D 5590 with zero growth rating. Coating shall adhere to MIL-C-19565C, Type II and must be QPL listed.

2.6 APPLICATIONS

A. Interior Concealed Applications (Plenums, Chases):

1. Type P1 Insulation: Provide factory applied ASJ white kraft foil vapor barrier.
 - a. Below-ambient piping: Coat all ASJ seams with Foster 30-80 or Childers CP-38 vapor barrier coating. Coat all elbows, fittings, and valves with same vapor barrier coating and Foster Mast-a-Fab or Childers Chil-Glas #10 reinforcing mesh.
 - b. High humidity applications: Foster 30-36 AF.
2. Type P3 Insulation: Finish coat is not required.
3. Type P4 Insulation: Lightly coat insulation with lagging adhesive diluted 50% with water for proper bonding with canvas/lagging adhesive. Cover with a canvas jacket and non-diluted Childers CP-50A HV2 or Foster 30-36 lagging adhesive.
 - a. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating.
4. Type P5 and P5A, 5B Insulation: VentureClad jacket on piping where condensation can occur or where installed on existing chilled water piping, chilled water condensate drain piping, and roof storm drain piping that transports cold rain water from the building roof.
5. Type P5 Jacket not required when insulation is used on hot water piping.
6. Type P6 Insulation:
 - a. Above-ambient piping: Pittcoat 404, Foster 46-50, or Childers CP-10/11 pre-molded PVC covers per manufacturer's recommendations. Jacket is not required when this type of piping insulation is concealed within a piping chase.
 - b. Below-ambient piping: Coat all ASJ seams with Foster 30-80 or Childers CP-38 vapor barrier coating. Coat all elbows, fittings, and valves with same vapor barrier coating and Foster Mast-a-Fab or Childers Chil-Glas #10 reinforcing mesh.
 - c. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating.

B. Interior Exposed Applications (Equipment Rooms):

1. Type P1 and P2 Insulation: Factory applied ASJ white kraft foil vapor barrier. Finish with canvas jacket or Childers Chil-Glas #10 glass membrane with Childers CP-50A HV2 or Foster 30-36. Verify jacket is suitable for applications.

- a. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating. Finish coat is not required.
2. Type P3 Insulation: Finish coat is not required.
3. Type P4 Insulation: Lightly coat insulation with lagging adhesive diluted 50% with water for proper bonding with canvas/lagging adhesive. Cover with a canvas jacket and non-diluted Childers CP-50A HV2 or Foster 30-60 lagging adhesive.
 - a. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating. Finish coat is not required.
4. Type P5 Insulation: Factory applied ASJ white kraft foil vapor barrier.
5. Type P5 and P5A Insulation: VentureClad jacket on piping where condensation can occur or where installed on existing chilled water piping, chilled water condensate drain piping, and roof storm drain piping that transports cold rain water from the building roof.
6. Type P6 Insulation: Provide triple-ply laminate polypropylene, mold resistant with a metal foil and polyester vapor barrier film backing.
 - a. Below-ambient piping: Coat all ASJ seams with Foster 30-80 or Childers CP-38 vapor barrier coating. Coat all elbows, fittings, and valves with same vapor barrier coating and Foster Mast-a-Fab or Childers Chil-Glas #10 reinforcing mesh.
 - b. Above-ambient piping: Provide Pittcoat 404, Foster 46-50, or Childers CP-10/11 or pre-molded PVC covers per manufacturer's recommendations.
 - c. High humidity applications (unconditioned space): Foster 30-36 AF or Childers CP-137 AF fungus/mold resistant coating.
7. All exposed insulated piping within six (6) feet of the floor shall be protected with aluminum or stainless-steel jacket to protect insulation from being torn or punctured.

C. Exterior Applications / Crawl Spaces:

1. Insulate piping system as indicated under Interior Exposed Applications, prior to final jacket installation.
2. Provide electric heat tracing for all exterior small bore piping 2 inches and smaller where water may be susceptible to freezing due to intermittent flow conditions.
3. Final jacket cover shall be aluminum or stainless steel having integral moisture barrier with seams located at 2 or 10 o'clock position of horizontal piping. All laps shall be minimum 2 inches. Apply Foster 95-44 or Childers CP-76 metal jacketing sealant on all laps to prevent water transmission.

4. Type P1 Insulation: For above-ambient piping, finish with Childers Chil-Glas #10 or 9X8 reinforcing mesh and Childers CP-10/CP-11, or Foster 46-50 weather barrier/breather mastic, prior to final jacket installation.
5. P6 Insulation Above-ground: Provide (50 mil thickness) self-sealing non-metallic, bituminous compound reinforced with glass fiber membrane with 1 mil aluminum top film jacketing for both chilled water and hot water piping (PITTWRAP CW Plus). Provide metal jacket where material is exposed to ultraviolet rays.
6. P6 Insulation Underground: Provide factory applied (50 mil thicknesses) self-sealing membrane bituminous compound reinforced with glass fiber for chilled water piping (PITTWRAP IW 50 or Foster C.I. Wrap 50mil). Metal jacket not required for buried pipe.

2.7 INSERTS, SUPPORTS AND SHIELDS

- A. Application: Piping ½ inch diameter or larger for all systems except direct buried.
- B. Shields shall be made of galvanized steel or made of black iron painted on both sides with a minimum two coats of aluminum paint. Required metal shield sizes are as follows:

Nominal IPS (inches)	Metal Thickness (gage)	Minimum Lengths of Shield (inches)
½ to 1½	18	12
2	14	12
2-½ to 6	12	16
8 and above	10	20

- C. Inserts for shields shall be manufactured of 7.5 lb/cu. ft. density cellular glass or 5.0 lb/cu. ft. density cellular, phenolic insulating material suitable for the planned temperature range. Provide factory fabricated inserts with integral galvanized pipe saddles. Inserts shall be the same thickness as the adjacent insulation.
- D. Depending on the type of pipe support design, stainless steel bands or aluminum bands may be required to keep shield material next to the jacketing material.
 1. Insulation Bands: ¾ inch wide; 0.007 inch thick galvanized steel when exposed to interior environment, 0.010 inch thick stainless steel or 0.015 inch thick aluminum when exposed to humid interior environment or outside environment.
 2. Metal Jacket Bands: ⅜ inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.

EXECUTION

3.1 PREPARATION

- A. Verify that piping has been inspected at the welds and pressure tested before applying paint and insulation materials.
- B. 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 of primer paint. Painting on piping where condensation is occurring on the pipe surface is strictly prohibited.
- C. Provide primer coat on all steel piping field welds. Painting shall be completed and approved prior to installation of insulation. Paint shall be applied in accordance with the paint manufacturer's instructions, environment, and pipe surface temperatures.

3.2 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. Installation of insulation and jacket materials shall be in accordance with manufacturer's published instructions.
- C. Handle and install materials in accordance with manufacturer's instructions in the absence of specific instructions herein.
- D. On exposed piping, locate insulation cover seams with the ridge of the lap joint is directed down.
- E. Exposed Insulated piping within six feet of the floor shall be protected with an aluminum or stainless jacket material to protect the insulation.
- F. Insulate fittings, joints and valves with molded insulation of the same material and thickness as adjoining pipe. Open voids and cracks insulation shall be kept at a minimum when placing insulation on abnormal or irregular shapes. Use closed cell or recommended fill material as instructed by the insulation manufacturer to close openings. Fiberglass insulation shall not be used as a fill material on chilled water piping or fittings. Vapor seal all cold piping ASJ seams and elbows/fittings with vapor barrier coating and reinforcing mesh.
- G. Continue insulation through walls, sleeves, pipe hangers, floors, and other pipe penetrations.
- 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. Insulate entire system including fittings, valves, flanges and strainers. Use closed cell insulation on cold piping system flexible connections, expansion joints and unions, bevel and seal ends of insulation and continue sealant or coating a minimum of 4 inches along the piping, unless stated otherwise. On all closed-cell insulation, cold piping, use insulation joint sealant on all longitudinal and butt joints.
- J. For hot piping conveying fluids 180 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation. Continue sealant or coating a minimum of 4 inches along the piping.
- K. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3 inches). Where insulation terminates, it shall be neatly beveled and finished. All materials used shall be fire retardant or nonflammable.
- L. 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 be sealed with vapor barrier coating. Where insulation with a vapor barrier terminates, seal off with vapor barrier continuous to the surface being insulated. Ends shall not be left raw.
- M. Where pipe chases are tight, adequate provision shall be made at the rough-in stage using offset fittings or other means (except springing the pipe) to ensure that insulation can be applied throughout the length of the pipe.
- N. When installing phenolic insulation provide a 5 lb. density insert of same thickness and contour as adjoining 3.75 lb. density insulation, between the support shield and piping, and under the finish jacket, on piping 1½ inch diameter or larger, to prevent insulation from sagging at support points. Provide inserts for 180-degree arc and not less than 2 inches more than the length of the pipe support shield or minimum 12 inches long (whichever is greater). Pipe support shield shall be adhered to insulation with a UL approved adhesive that meets E-84 requirements.
- O. Seal all insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.
- P. Shields:
 - 1. Install between pipe hangers or pipe hanger rolls and inserts. Curved metal shields shall be used between the hangers or support points and at the bottom of insulated pipe.
 - 2. Hangers shall support the load of the insulated pipe section on the outside of the insulation and shall not be in direct contact with the pipe.
 - 3. Manufacturer shall be responsible to size the length of shield required to prevent insulation from breaking.

4. Provide rigid insulation at each support point, a minimum of 2 inches longer than shield length.
5. Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe.

3.3 PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE

- A. In no case shall installed piping insulation have insulation thicknesses that are less than what is required by local energy codes and ASHRAE 90.1 (whichever is more stringent), based on comparable insulation conductivity values at the specified mean rating temperature.
- B. Type 5A and 5B insulation is only used where it is being replaced on existing pipe and thickness of the replacement insulation shall match the existing insulation thickness.

Piping Systems	Location	Type	Pipe Size	Insulation Thickness
Domestic Cold Water, Soft Water, Make-Up Water	Interior Concealed	P1	1-1/2" & Smaller	1/2"
			2" to 4"	1/2"
			6" & Larger	1/2"
	Interior Exposed	P5	1-1/2" & Smaller	3/4"
			2" to 4"	3/4"
			6" & Larger	1"
	Interior Exposed	P6	1-1/2" & Smaller	1"
			2" to 4"	1"
			6" & Larger	1-1/2"
	Exterior	P5	All Sizes	1"
P6		4" & Smaller	1"	
			6" & Larger	1-1/2"
Domestic Hot Water, Tempered Water (Maximum 180 Degrees F)	Interior Concealed	P1	2" & Smaller	1"
			2-1/2" & Larger	1-1/2"
	Interior Exposed	P5	1-1/2" & Smaller	3/4"
			2" to 4"	1"
		P6	6" & Larger	1-1/2"
			4" & Smaller	1"
			6" & Larger	1-1/2"

Piping Systems	Location	Type	Pipe Size	Insulation Thickness
	Exterior	P5	All Sizes	1-1/2"
		P6	All Sizes	1-1/2"
Fire Protection Water (40 Degrees F – Nominal)	Exterior	P5	4" and Smaller	3/4"
			6" and Larger	1"
		P6	4" and Smaller	1-1/2"
			6" and Larger	3
Underside of all Roof / Overflow Drain Bodies and related horizontal roof drain lines to vertical leader	Interior Exposed	P5	2" to 4"	3/4"
			6" and Larger	1"
		P6	2" to 4"	1"
			6" and Larger	1-1/2"
	Interior Concealed	P1	2" to 4"	1/2"
			6" and Larger	1/2"
Floor Drain Bodies and related horizontal Sanitary Drain Lines above floor that receive cold condensate drainage.	Interior Exposed	P5	2" to 4"	3/4"
			6" and Larger	1"
		P6	2" to 4"	1"
			6" and Larger	1-1/2"
	Interior Concealed	P1	2" to 4"	1/2"
			6" and Larger	1/2"
Cold Condensate Drain Lines	Interior	P5	All Sizes	3/4"
			P6	4" and Smaller
		P6		6" & Larger
			Interior Concealed	P3
	P6	All Sizes		1"
	Refrigerant Suction Piping (35 Degrees F – Nominal)	All	P3	2-1/2" and Smaller

END OF SECTION 20 07 19

SECTION 22 00 00

BASIC PLUMBING SPECIFICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. The Contractor shall familiarize himself with all drawings and specifications and properly use information found on the Architectural, Civil, Utility, Structural, Mechanical, Fire Protection and Electrical drawings and specifications affecting his work.
- C. Verify all standard practices of the City Utility Departments for water, sewer, and fire water services. Coordinate metering requirements, connection requirements; furnish necessary labor to install all equipment supplied by the local utility office, and furnish and install other materials and equipment as required.

1.2 SUMMARY

- A. Work Included: Provide complete plumbing systems as shown on drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to the following summary of work:
 1. Furnish and install **Plumbing Fixtures and Equipment** as shown on drawings and described herein.
 2. Furnish and install a complete **Sanitary Drain, Waste, and Vent System** as shown on drawings and described herein.
 3. Furnish and install a complete **Domestic Cold and Hot Water Piping System** to all plumbing fixtures and equipment.
 4. Other items and services required to complete the plumbing systems.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. If additional work is required for Work indicated or specified, it shall be the responsibility of the Contractor to provide same, as well as to provide material and equipment usually furnished with such systems or as required to complete the installation.

1.3 PLUMBING CODES, STANDARDS, AND SYMBOLS

- A. All work shall be in accordance with the latest edition of the following codes:
 1. International Building Code
 2. International Plumbing Code
 3. International Fire Code
 4. International Fuel Gas Code
 5. National Fire Protection Association (NFPA 54)

6. International Energy Conservation Code
 7. National Electrical Code (NEC)
 8. American with Disabilities Act (ADA)
 9. Texas Accessibility Standards (TAS)
 10. Texas Administration Code
- B. Local governing codes and authorities, trade association standards and publications are an extension of the contract documents, and are hereby imposed as applicable to the work in each instance.
- C. Where local codes, ordinances, rules or authority conflicts with associations and standards listed hereinafter, the local ordinances, codes, rules or authorities take precedence.
- D. Standards: Specifications and Standards of the following organizations are by reference made part of these Specifications. Unless otherwise indicated, shall comply with requirements and recommendations wherever applicable:
1. National Sanitation Foundation (NSF)
 2. American Water Works Association (AWWA)
 3. American Gas Association (AGA).
 4. American Nation Standards Institute (ANSI).
 5. American Society for Testing and Materials (ASTM).
 6. American Society of Mechanical Engineers (ASME).
 7. American Society of Plumbing Engineers (ASPE).
 8. Cast Iron Soil Pipe Institute (CISPI)
 9. International Association of Plumbing and Mechanical Officials (IAPMO)
 10. National Fire Protection Association (NFPA).
 11. Underwriters Laboratories, Inc. (UL).
- E. The listing of (or key to) specific graphic symbols used to show the plumbing work on the contract documents is shown on the drawings.

1.4 QUALITY ASSURANCE:

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Provide only materials that are new, of the type and quality specified.
- C. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61.

- D. All brass and bronze piping materials within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.
- E. Solder for copper piping shall be lead-free Tin/Copper/Silver/Nickle (optional) solder conforming to ASTM B32, Wolverine Silvabrite 100 Lead-Free Solder or Harris Nick Lead-Free Solder. Use water soluble flux recommended by solder manufacturer and conforming to ASTM B813 and NSF 61, Wolverine Silvabrite 100 Soluable Flux or Bridgit Water Soluble Paste Flux.
- F. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation. The contractor must support all pipe, equipment, and other items furnished and installed under this scope from steel joists or structural steel frames. It is prohibited to support pipe, equipment, and other items furnished under this scope from the metal deck.
- G. Where installation instructions are not included in the contract documents, the manufacturer's instructions shall be followed.
- H. Copies of each welder's certification documents shall be furnished to the Engineer prior to them performing work.

1.5 SUBMITTALS

- A. Comply with pertinent provisions of submittals in specifications.
- B. Provide manufacturer's specifications and other data needed to prove compliance with specified requirements. Term "Compliance" is understood to mean that contractor certifies that submitted equipment meets or exceed contract document requirements. Items that do not clearly meet this definition should be identified and explained as required in following paragraph.
- C. Identify difference between specified item and proposed item. Explain with enough detail so that it can easily be determined that item complies with functional intent. List disadvantages or advantages of proposed item versus specified item. Submit technical data sheets and/or pictures and diagrams to support and clarify. Organize in clear and concise format. Substitutions shall be approved in writing by Engineer. Engineer's decision shall be final.
- D. Allow a minimum of 10 working days for review of each submittal and re-submittal.
- E. Items of equipment that are not accepted in writing as approved equal shall be replaced or revised to comply with Contract Documents at Contractor's expense.
- F. The manufacturers recommended installation procedures shall become basis for accepting or rejecting actual installation procedures used on Work.
- G. Shop drawing shall consist of detailed drawings with dimensions, schedules, weights, capacities, installation details, and pertinent information needed to describe the material or equipment.

H. Submittals required of materials and equipment under this Division include following listed items not supplied by Owner. These submittal requirements are intended to be complimentary to requirements that may be listed in individual sections. In event of conflict more stringent requirements shall apply.

1. Fixtures, Carriers and Accessories.
2. Plumbing Equipment.
3. Water hammer arresters.
4. Backflow preventers.
5. Trap primers.
6. Tempering valves.
7. Insulation
8. Piping accessories.
9. Vibration Isolation and Sound Control materials.

1.6 SUBSTITUTIONS

- A. The use of manufacturers' names and catalog numbers followed by the phrase "or equal" is generally used to establish a standard of quality and utility for the specified items and to provide a dimensional reference for construction documents that are drawn to scale.
- B. Submittals for "equal" items shall, where applicable, include the following data that are not necessarily required for specified items:
1. Performance characteristics.
 2. Materials
 3. Finish
 4. Certification of conformance with specified codes and standards.
- C. Submittals of "equal" components or systems may be rejected if:
1. The material or equipment would necessitate the alteration of any portion of the mechanical, electrical, architectural or structural design.
 2. Dimensions vary from the specified material or equipment in such a manner that accessibility or clearances are impaired or the work of other trades is adversely affected.

1.7 COMPATIBILITY OF EQUIPMENT

- A. Assume full responsibility for satisfactory operation of component parts of plumbing systems. Assure compatibility of equipment and performance of integrated systems in accordance with requirements of the construction documents. Notify the Engineer before submitting a bid should specifications or drawings make acceptance of responsibility impossible, prohibitive, or restrictive. The bid shall be accompanied by a written statement listing any objections or exceptions to the applicable specification section and/or drawing.

1.8 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

- A. Procure all permits and licenses necessary for completion of this project and pay all lawful fees required and necessary pursuant in obtaining said permits and licenses. All required certificates of approvals and inspections by local governing and regulating authorities shall be obtained and paid for by the contractor.
- B. Pay all fees for the connection of sewer, water and gas to utility mains, and any meter fees if required.

1.9 EXISTING UTILITIES AND TEMPORARY SERVICES FOR CONSTRUCTION

- A. Verify location and capacity of all existing utility services before starting Work.
- B. Relocated existing utilities unearthed by excavation as directed by the utility service companies affected.
- C. Provide temporary services for construction.
- D. Provide temporary services in strict accordance with the provisions of these specifications.
- E. The locations and sizes of plumbing utility lines are shown in accordance with data secured from Owner's survey, site visits, or record drawings. The data shown is offered as an estimating guide without guarantee of accuracy.

1.10 COORDINATION

- A. The Contractor shall not hinder and/or delay any work being accomplished by other Divisions at or near the general construction site; nor shall the Contractor impede normal operation of the Owner at any time except as coordinated and scheduled in writing.
- B. The Contractor shall make plumbing connections to equipment installed by other Divisions.
- C. The Contractor shall lay out the plumbing system in careful coordination with the Drawing, determining proper elevations for all components of the system and using only the minimum number of bends to produce a satisfactorily functioning system.
- D. Layout pipes to fall within partition, wall or roof cavities, and to not require furring other than as shown on the Drawings.
- E. Coordinate as necessary with other trades to assure proper and adequate interface with all work.
- F. Where pipes and other plumbing items are shown in conflict with locations of structural members and other equipment, include labor and materials required for extensions, offsets and supports to clear the encroachment.
- G. Furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation.
- H. Coordinate accepted equipment changes from those scheduled or specified with other Divisions affected.

- I. Plumbing Contractor shall furnish and Electrical Contractor shall install magnetic starter with each motor furnished under Plumbing Section of the documents. (Starters indicated furnished in motor control centers on electrical drawings shall be by Electrical Contractor). Electrical Contractor shall provide all power and wiring for plumbing work. If power required for the equipment furnished by Plumbing Contractor differs from that submitted or shown on the electrical drawings, Plumbing Contractor shall be responsible for cost of any required changes in breakers, starters, wiring, etc., required to serve the particular equipment.

PART 2 – MATERIALS

2.1 PLUMBING FIXTURES

- A. Acceptable Manufacturers
 1. Vitreous China Toilets: Kohler, American Standard, Crane, Zurn
 2. Vitreous China Urinals: Kohler, American Standard, Crane, Zurn
 3. Vitreous China Lavatories: Kohler, American Standard, Crane, Zurn
 4. Wash Fountains: Bradley, Wiloughby
 5. Stainless Steel Sinks: Elkay, Just
 6. Drinking Fountains / Electric Water Coolers: Elkay, Acorn, Halsey Taylor
 7. Vitreous China Mop Sinks: Kohler, Americans Standard, Crane, Zurn
 8. Carriers: Wade, J.R. Smith, Josam, or Zurn
 9. Flush Valves: Sloan Valve or equal by Zurn
 10. Faucets: Kohler, Bradley, Elkay, T&S Brass, Zurn
 11. Mixing Valves: Bradley, Leonard, Lawler, Symmons
 12. Circulating Pumps: Taco, Grundfos, Armstrong
- B. Furnish and install all plumbing fixtures as indicated and scheduled on the Contract Drawings and as specified herein.
- C. Fixtures, trim, and accessories of any one type shall be by the same manufacturer.
- D. Plumbing fixtures and accessories shall be furnished and installed complete with trim and all other appurtenances required for connecting to rough-in piping at floor and/or wall.
- E. Carriers shall be furnished with all wall-mounted fixtures.
- F. Coordinate mounting heights of plumbing fixtures with Architectural Drawings details / elevations.

- G. The maximum flow rates for plumbing fixtures are to be no greater than those scheduled on the Contract Drawings or following quantities as listed herein:
 - 1. Toilets: 1.28 gallons per flush (GPF).
 - 2. Urinals: 0.5 gallons per flush (GPF).
 - 3. Lavatory (hand sink): 0.5 gallons per minute (GPM).
- H. Provide all adapters, flanges, gaskets, etc. as required for proper installation of fixtures.
- I. Insulate all exposed p-traps and water connections for handicapped lavatories with White "Truebro Lav-Guard2" Insulation Kit complete with P-trap cover, angle valve and supply covers, offset tail piece cover, and etc. for compliance with ADA / TAS code requirements.

2.2 SANITARY WASTE AND VENT PIPING

- A. Sanitary Sewer Piping: Buried beyond 5 feet of Building
 - 1. PVC Pipe: ASTM D1785/D2729 SCH40; installed per ASTM D2321
 - a. Fittings: PVC, ASTM D3311/D2665 drainage pattern, with bell and spigot ends. Furnished by the same manufacturer as pipe or approved equal.
 - b. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- B. Sanitary Drain, Waste, and Vent Piping: Buried within 5 feet of Building
 - 1. PVC Pipe: ASTM D1785/D2665 SCH40 PVC-DWV.
 - a. Fittings: PVC, ASTM D3311/D2665 drainage pattern, with bell and spigot ends. Furnished by the same manufacturer as pipe or approved equal.
 - b. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- C. Sanitary Drain, Waste and Vent Piping: Above Grade
 - 1. Cast Iron Pipe: ASTM A 888, hubless, service weight.
 - a. Fittings: Cast iron, ASTM A 888 drainage pattern.
 - b. Joints: No hub, ASTM C564 neoprene gaskets and standard stainless steel clamp and solid shield assemblies constructed of type 300 series stainless steel. Clamp assemblies shall conform to FM 1680 where required by the authority having jurisdiction.

IN AREAS NOT USED AS A RETURN AIR PLENUM CONTRACTOR MAY USE

- 2. PVC Pipe: ASTM D1785/D2665 SCH40 PVC-DWV.
 - a. Fittings: PVC, ASTM D3311/D2665 drainage pattern, with bell and spigot ends. Furnished by the same manufacturer as pipe or approved equal.
 - b. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.3 CONDENSATE PIPING FOR HVAC SYSTEMS

A. Type “M” hard drawn copper.

1. Route insulated copper condensate drain line from each unit to nearest floor drain, deep seal traps, sink p-traps, janitor sink, dry well (exterior units), or roof drain if piped to storm sewer. Condensate shall not drain on to roof. Mechanical Contractor and Plumbing Contractor shall coordinate locations, slope all piping to drain at minimum 1/8” per foot. Drains shall be sized in accordance with equipment capacities as follows:

Equipment Capacity	Minimum Pipe Size
0-7.5 Tons	3/4”
8-20 Tons	1”
21-40 Tons	1-1/4”

- B. Coordinate mounting heights of units to allow adequate slope for condensate piping to disposal point.
- C. Provide cleanout plug at end of each main run.

2.4 DOMESTIC WATER PIPING (INCLUDING COLD, HOT, & SOFTENED WATER)

A. Domestic Water Piping: Under-Building-Slab to 5 Feet Beyond Building

1. Copper pipe (2-1/2 inch and above): ASTM A 88, Type K, hard drawn.
 - a. Fittings: ASME B 16.18, cast bronze, or ASTM B16.22 wrought copper alloy.
 - b. Joints: Brazed

B. Domestic Water Piping: Buried within 5 feet of Building and Trap Primers

1. Copper tubing (2 inch and below): ASTM A 88, Type K, soft annealed.
 - a. Fittings: ASME B 16.18, cast bronze, or ASTM B16.22 wrought copper alloy.
 - b. Joints: ASTM B 32, lead free solder Grade 95TA
 - c. No joint connections allowed below slab. All such piping must be brought up above finished floor line a minimum of 12” before joining.
 - d. Trap-Primers: All piping below slab or installed in concrete or masonry floors and walls shall be encased in polyethylene sleeve, “Polysleeve” or equal.

C. Domestic Water Piping: Above Grade (Including Cold, Hot & Softened)

1. Copper Tubing: All sizes, ASTM B88, Type L, hard drawn.
 - a. Fittings: ASME B16.18, cast bronze or ASME B16.22, wrought alloy.
 - b. Joints: ASTM B32, lead free solder Grade 95TA.

SYSTEMS MAY UTILIZE COPPER PRESS FITTINGS WHEN THE FOLLOWING CONDITIONS ARE MET.

- c. Written approval from the owner shall be obtained prior to bidding.
- d. Fittings shall be installed in portions of systems having an operating pressure that will not exceed 200 p.s.i.g
- e. Fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22.
- f. O-rings for copper press fittings shall be EPDM. Copper press fittings shall be rated at 200 psi working pressure and 250 degree working temperature.
- g. All copper press fittings, couplings, and specialties shall be manufactured by "Viega".
- h. Installation tools shall be as recommended by the fittings manufacturer.

D. Domestic Water Valves:

- 1. All materials within domestic water distribution systems that may come in contact with the potable water delivered shall comply with ANSI/NSF Standard 61.
- 2. All brass and bronze valve materials within domestic water distribution systems that may come in contact with the potable water delivered shall have no more than 15% zinc content.
- 3. Similar types of valves shall be the product of one manufacturer; i.e., all butterfly valves shall be of the same manufacturer, all ball valves shall be of the same manufacturer, etc. EXCEPTION: 2-1/2" & 3" ball valves may be by a different manufacturer than 2" and smaller ball valves.
- 4. Line Shut-Off Valves up to and including 2" shall be two-piece bronze body of ASTM B584 Alloy 844, ASTM B61, or ASTM B62, full port ball type rated at 600 WOG with threaded connections, blow-out proof stem, plastic coated lockable lever handle, Teflon packing, 316 stainless steel ball and stem. Acceptable valves are NIBCO Model T-585-70-66-LL, or approved equivalent model by Crane, Milwaukee or Apollo.
- 5. Line Shut-Off Valves sizes 2-1/2" and 3" shall be full port ball type rated at 400 WOG with threaded connections, two-piece bronze body ASTM B584 with 316 stainless steel ball and stem, plastic coated lockable lever handle, blow out proof stem and reinforced Teflon seats. Acceptable valves are Kitz Model 68PM, or approved equivalent model by Crane, NIBCO, Milwaukee or Apollo.
- 6. Line Shut-Off Valves 4" and larger where system operating pressure will not exceed 160 p.s.i.g. shall be 200 WOG threaded lug type ductile iron body butterfly valve with extended neck, lockable lever handle, 416 stainless steel stem, aluminum bronze disc, EPDM liner and seal, suitable for bi-directional flow and dead-end service with downstream flange removed. Acceptable valves are NIBCO Model LD-2000, or approved equivalent model by Keystone, Jamesbury, Milwaukee, Crane or Apollo.

7. Line Shut-Off Valves 4" and larger installed within systems having design operating pressures between 160 and 250 p.s.i.g. shall be threaded lug type ductile iron body butterfly valve with extended neck, lockable lever handle, 316 stainless steel stem and disc, EPDM liner and seal, suitable for bi-directional flow and dead-end service with downstream flange removed. Acceptable valves are NIBCO Model LD-3022, or approved equivalent model by Keystone, Jamesbury, Dezurik, Milwaukee, Crane or Apollo.
8. Line Shut-Off Valves 4" and larger installed in roll grooved copper systems may be 300 psi roll grooved end type bronze body butterfly valve with lockable lever handle, bronze trim, EPDM coated disc, suitable for bi-directional flow and dead-end service. Manufactured by Victaulic Model V-size-3-6-2-2-11.
9. Provide stem extensions of a non-thermal conducting material for valves in insulated lines to allow unobstructed operation.
10. Provide memory stops on all ball valves installed in domestic hot water return lines. Memory stops shall be adjustable after pipe insulation is applied.
11. Provide line shut-off valves that have the same inside diameter of the upstream pipe in which they are installed.
12. Domestic Hot Water Return Circuit Balancing Valves 1/2" through 2" shall be 'Y or T' pattern with threaded inlet and outlet connections, equal percentage globe-style and provide precise flow measurement, precision flow balancing and positive drip-tight shut-off. Valves shall provide multi-turn, 360° adjustment with micrometer type indicators located on the valve handwheel. Valves shall have a minimum of five full 360° handwheel turns. 90° 'circuit-setter' style ball valves are not acceptable. Valve handle shall have hidden memory feature to provide a means for locking the valve position after the system is balanced. Valves shall be furnished with precision machined venturi built into the valve body to provide highly accurate flow measurement and flow balancing. The venturi shall have two, 1/4" threaded brass metering ports with check valves and gasketed caps located on the inlet side of the valve. Valves shall be furnished with flow smoothing fins downstream of the valve seat and integral to the forged valve body to make the flow more laminar. The valve body, stem and plug shall be brass. The handwheel shall be high-strength resin. Provide valves as manufactured by Armstrong Model CBV-VT or NIBCO T-1710 and F737-A. Furnish each valve complete with optional pre-formed 25/50 fire/smoke rated insulation.
13. Swing Check Valves, 2" and smaller - "Y" or "T" pattern bronze, Class 150, with threaded connections and screw-in cap. Manufactured by NIBCO Model T-433-Y or approved equivalent model by Milwaukee or Crane.
14. Spring Loaded Check Valves, 2" and smaller - Silent closing, bronze, Class 125, with threaded connections, Buna disc, bronze or stainless steel spring. Manufactured by NIBCO Model T-480 or approved equivalent model by Milwaukee or Crane.

15. Swing Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-918-B or approved equivalent model by Milwaukee or Crane.
16. Swing Check Valves, 2-1/2" and larger - 285 pound CWP, Iron body, with stainless steel trim. Manufactured by NIBCO Model F-938-33 or approved equivalent model by Milwaukee or Crane.
17. Spring Loaded Check Valves, 2-1/2" and larger - 200 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-910 or approved equivalent model by Milwaukee or Crane.
18. Spring Loaded Check Valves, 2-1/2" and larger - 400 pound CWP, Iron body, with bronze or stainless steel trim. Manufactured by NIBCO Model F-960 or approved equivalent model by Milwaukee or Crane.

2.5 PLUMBING SPECIALTIES

A. Acceptable Manufacturers

1. Floor Drains: Wade, Zurn, Smith, Josam.
2. Floor Sinks: Wade, Zurn, Smith, Josam.
3. Roof Drains: Wade, Zurn, Smith, Josam.
4. Wall/Floor Cleanouts: Wade, Zurn, Smith, Josam.
5. Backflow Preventers and Vacuum Breakers: Watts Regulator, Febco, Conbraco.
6. Water Pressure Regulating Valves: Wilkins, Watts Regulator, Cla-Val.
7. Water Hammer Arrestors: Wade, Zurn, Smith
8. Wall Hydrants: Woodford, Wade, Zurn, Smith, Josam.
9. Hose Bibbs: Woodford, Chicago.
10. Trap Primer Units: Wade, Zurn, Smith
11. Stainers: Conbraco, Wilkins, Watts
12. Temperature Gauges: Ashcroft, Terice, Weksler
13. Pressure Gauges: Ashcroft, Terice, Weksler

B. Floor drains (FD):

1. All floor drains shall be furnished and installed with all options and accessories required for a waterproof installation within the particular construction in which they are to be mounted.
2. Each floor drain shall be provided with a deep-seal p-trap unless noted otherwise.

3. Floor drains installed for general floor area drainage within toilet rooms and other finished spaces shall have cast iron body with flange, adjustable top and sediment bucket, integral reversible clamping collar, seepage openings, 1/2" plugged primer tap, and 6" diameter nickel bronze or stainless steel strainer with vandal proof screws.
4. Floor drains installed for general floor area drainage and light to medium flow indirect equipment discharge within mechanical rooms shall have cast iron body with plugged 1/2" primer tap, integral clamping collar, seepage openings, adjustable top and 11-1/2" diameter ductile iron loose set tractor grate.
5. Floor drains installed for non-monolithic shower stall floors shall have cast iron body with flange, adjustable top, integral reversible clamping collar, seepage openings and 5" diameter nickel bronze or stainless steel strainer with vandal proof screws.
6. All floor drains shall be as sized and scheduled on contract drawings.

C. Cleanouts:

1. All cleanouts shall be located to be easily accessible for service and in locations approved by the Engineer. Cleanouts shall be the same nominal size as the pipe they serve up to four inches. All covers shall be set flush with the finish floor or wall in which they are installed.
2. Cleanouts in chases or walls shall have access doors or nickel-bronze wall plates in easily accessible locations for servicing.
3. Cleanouts shall be provided in waste piping at each change in direction as required by local code, at the end of each continuous waste line and at 50 foot intervals in long horizontal runs located within the building. In long horizontal runs exterior of the building, cleanouts shall be located at spacing required by governing codes but not greater than 100 feet apart.
4. Cleanouts shall have cast iron body with tapered cast brass or bronze plug providing gas and watertight seal.
5. Interior floor cleanouts shall have stainless steel or nickel bronze scoriated top. Provide carpet marker when installed in areas to be covered by carpet.
6. Wall cleanouts shall be provided with stainless steel access covers of adequate size to allow rodding of drainage system. Wall cleanouts incorporating cover screws that extend completely through the access plug are not acceptable.
7. Exterior cleanouts at grade shall have scoriated cast iron top.

D. Backflow Preventers (includes backpressure and backsiphonage):

1. Reduced Pressure Zone Type (Not For Use In Fire Protection Water Supply):
 - a. The assembly shall meet the requirements of ASSE 1013, AWWA C511.

- b. The assembly shall consist of a pressure differential relief valve located in a zone between two positive seating check valves and captured springs. Backsiphonage protection shall include provision to admit air directly into the reduced pressure zone via a separate channel from the water discharge channel. The assembly shall include two tightly closing shutoff valves before and after the valve and test cocks.
- c. Test cocks
- d. Seats: Bronze, removable and replaceable without removing valve from the line.
- e. Checks: Independently operating.
- f. Relief Valve: Independently operating, located between the two check valves.
- g. Rated 175 psi maximum working pressure with continuous temperature range of 33 to 140°F.
- h. Unit to be complete with vent-port funnel to maintain the air gap and to provide a drain connection point.
- i. Sizes 1/4" and 1/2" - Bronze body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 009.
- j. Sizes 3/4" through 2" - Bronze body, bronze strainer, upstream and downstream quarter-turn ball valves, union connections: Watts Regulator Company Series 919.
- k. Sizes 2-1/2" through 10" - FDA epoxy coated cast iron body, FDA epoxy coated strainer, upstream and downstream OSY – UL/FM outside stem and yoke resilient seated gate valves, flange connections: Watts Regulator Company Series 909.

E. Water Pressure Regulating Valves:

- 1. Low to Moderate Flow Systems (Less Than 70 GPM) and Individual Equipment
 - a. Sizes 1/2" through 2"
 - b. All bronze body
 - c. 0.25% maximum weighted average lead content
 - d. Integral stainless steel strainer screen
 - e. Built-in bypass check valve
 - f. FDA approved elastomers
 - g. Renewable seat
 - h. Union end connection
 - i. Rated for water temperature up to 180°F and minimum 300 psi inlet pressure. Provide model with inlet pressure rating, reduced pressure range and factory preset outlet pressure as scheduled on Contract Drawings.
 - j. Manufactured by Wilkins Series 600XL or approved equal by Watts.

2. Large Demand Systems
 - a. Sizes 1-1/4" through 2 - ASTM B62 bronze body
 - b. Sizes 2-1/2" and larger - ASTM A536 ductile iron body
 - c. Pressure reducing pilot control
 - d. Stainless steel disc guide, seat and bearing cover
 - e. Stainless steel stem, nut and spring
 - f. FDA approved Nylon reinforced Buna-N rubber diaphragm
 - g. Provide model(s) with size, temperature range, inlet pressure rating, reduced pressure range, outlet pressure and options as scheduled on Contract Drawings.
 - h. Cla-Val Company Series 90 or approved equal by Watts.
- F. Water Hammer Arrestors (Shock Absorbers):
 1. Provide water hammer arrestors on hot water lines and cold water lines.
 - a. Install in upright position at all quick closing valves, solenoids, isolated plumbing fixtures, and supply headers at plumbing fixture groups.
 - b. Locate and Nesting type bellows operated water hammer arrestor with male N.P.T. connection. Bellows and body casing made of Type 304 stainless steel. Water hammer arrestors shall be certified to the PDI WH-201 Standard and ASSE Standard 1010.
 - c. Arrestors shall be designed and manufactured for a maximum working temperature of 250F and maximum operating pressure of 125 P.S.I.G.
 - d. Provide access panels for all concealed arrestors.
 - e. Water hammer arrestors shall be sized according to water hammer arresters standard PDI-WH-201.
- G. Wall Hydrants (WH):
 1. Provide antisiphon, non-freeze wall hydrant with brass casing, integral backflow preventer, vandalproof box with loose-key handle and finish as scheduled on Drawings.
- H. Water Supplied Trap Primer Units (TP):
 1. Trap Priming devices that rely upon line pressure differential for activation are not allowed.
 2. Vacuum Breaker Trap Primer for use with exposed Flushometers:
 - a. This type of device shall not serve more than one trap.
 - b. One Piece, Chrome Plated Flush Connection.
 - c. Water Deflector to control the amount of water diverted from the flush.
 - d. 3/8" Elbow and Flex-bend Tube connection from Vacuum Breaker to wall.

- e. Diverter Wall Flange and Fittings
 - f. Chrome Plated Wall Flange and Fitting to connect ½" NPT pipe.
 - g. High Back Pressure Vacuum Breaker.
 - h. One-piece Bottom Hex Coupling Nut.
 - i. Sloan Model VBF-72-A1 or approved equal of a referenced acceptable manufacture.
3. Trap Primer for use with Lavatory or Sink Drain Tailpiece:
- a. This type of device shall not serve more than one trap.
 - b. Polished Chrome Plated Cast Bronze P-trap with Ground Joint Outlet.
 - c. Threaded Wall Tube, Slip Joint Nuts, Washers and Escutcheons.
 - d. 1/2" Polished Chrome Plated Bronze Primer Tube with Compression Fitting Connection at Wall.
 - e. Jay R. Smith Model 2698 or approved equal of a referenced acceptable manufacture.

I. Strainers:

- 1. Strainers, 2" and smaller, bronze body, screwed ends, No. 20 mesh type 304 stainless steel screen, screwed cap with bronze blow-off valve (size to be determined by standard tap size in cap).
- 2. Strainers, 2-1/2" and larger, Cast iron body, isolating type flanged ends where installed in copper lines, .125" perforated type 304 stainless steel screen, flanged cap with bronze ball blow-off valve (size of blow-off valve shall be determined by standard tap size in cap). Special Note: All strainers 6" and larger shall have studs mounted in the body flange in lieu of bolts for removal of cap. Baskets for strainers 6" and larger shall have stainless steel reinforcing bands at ends to prevent collapsing.

J. Valves:

- 1. Provide valves in water systems. Locate valves for easy accessibility and maintenance. Locate and arrange so as to give complete regulation of apparatus, equipment, and fixtures.
- 2. Valves 2" and smaller shall be ball valves for all services. Valves 2 ½" and larger shall be gate valves for shut-off duty and plug valves for throttling duty. DO NOT USE Butterfly Valves.
- 3. Provide valves in at least the following locations:
 - a. In branches and/or headers of water piping serving a group of fixtures.
 - b. On both sides of apparatus and equipment.
 - c. For shutoff of risers and branch mains.
 - d. For flushing and sterilizing the system.
 - e. Where shown on the Drawings.

K. Temperature Gauges:

1. Thermometers shall be vapor or liquid actuated, direct-mounted, universal adjustable angle dial type with stainless steel or cured polyester powder coated cast aluminum case, stainless steel friction ring and glass window. Dial face shall be white with black figures; pointer shall be friction adjustable type. Movement shall be brass with bronze bushings. Bourdon tube shall be phosphor bronze with a brass socket.
2. Thermometer range shall be 30 - 240° Fahrenheit and have an accuracy of ± 1 scale division.
3. Dial face shall be 4½" diameter where installed within eight feet of floor level and 6" diameter where installed higher than six feet above floor level. Provide remote read-out gauges for isolated or hard to access monitoring points.
4. Provide a brass or stainless steel separable thermowell for each thermometer.
5. Thermometers shall have a sensing bulb with an insertion length of roughly half of the pipe diameter; minimum insertion length shall be 2". Thermometers installed on tanks shall have a minimum insertion length of 5".
6. Where insulation thickness exceeds 2", provide proper bulb length and an extension neck separable thermowell. The extension neck shall be at least 2" long.

L. Pressure Gauges:

1. Gauges shall comply with ASME B40.1, Grade 2A, and have ± 0.5 percent of full scale accuracy, with type 304 stainless steel or aluminum case, bronze wetted parts and brass socket. Dial face shall be 3½" diameter where installed within six feet of floor level and 6" diameter where installed higher than eight feet above floor level. Dial face shall be aluminum with white background, black graduations and black markings. Pointer shall be adjustable with black finish. Provide remote read-out gauges for isolated or hard to access monitoring points.
2. Units of measure shall be in pounds per square inch (psi). The proper range shall be selected so that the average operating pressure falls approximately in the middle of the scale selected.
3. All pressure gauges shall be equipped with brass or stainless steel needle valves and pressure snubbers.

PART 3 – EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 DELIVERY, STORAGE, AND PRODUCT HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

- B. Deliver products to the project at such time as the project is ready to receive the equipment or pipe, properly protected from incidental damage and weather damage.
- C. Damaged equipment or pipe shall be promptly removed from the site and new, undamaged equipment or pipe shall be installed in its place promptly with no additional charge to the Owner.

3.3 TRENCHING AND BACKFILLING

- A. All safety systems shall meet Occupational Safety and Health Administration Standards.
- B. Prior to any ditching and/or excavation contractor shall notify the appropriate authorities in compliance with the Texas Utilities Code, Chapter 251. This notification shall be at least two working days before ditching and/or excavation begins. Contractor shall maintain records of the required notification.
- C. Trenching shall be in accordance with Occupational Safety and Health Document, Part 1926 - Safety and Health Regulations for Construction; 1926-652 - General Trenching Requirements.
 - 1. Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Refer to drawings for standard trenching details.
 - 2. The Contractor may also have supporting systems, pilings, cribbing, shoring, etc., designed by a Registered Professional Structural Engineer and submitted to the Architect/Engineer as a shop drawing submittal before trenching work is done. Submittal drawings shall be sealed by the Engineer.
- D. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room.
- E. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.
- F. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
- G. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

3.4 COMPACTION

- A. General: Control soil compacting during construction providing minimum percentage of density specified for each area classification.

- B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D 1557.
 - 1. Structures, Building Slabs: Compact top 12" of subgrade and each layer of backfill or fill material at 95% maximum dry density per ASTM D698-78 at or near optimum moisture content.
 - 2. Lawn or Unpaved Areas: Compact top 6" of subgrade and each layer of backfill or fill material at 90% maximum dry density per ASTM D698-78 at or near optimum moisture content.
 - 3. Walkways: Compact top 6" of subgrade and each layer of backfill or fill material at 95% maximum dry density per ASTM D698-78 at or near optimum moisture content.
- C. Pavements: Compact top 12" of subgrade and each layer of backfill or fill material at 95% maximum dry density per ASTM D698-78 at or near optimum moisture content.
- D. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
- E. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 - 1. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.5 BACKFILL AND FILL

- A. General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
 - 1. In excavations, Select fill.
 - 2. Under grassed areas, Site top soil.
 - 3. Under walks, Select fill.
 - 4. Under steps and ramps, Select fill.
 - 5. Under building slabs, Select fill.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 - 2. Inspection, testing, approval and recording locations of underground utilities.
 - 3. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.

4. Removal of trash and debris.
 5. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
- C. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
 - D. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.
 - E. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth for materials compacted by heavy compaction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers.
 - F. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - G. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.
 - H. Cut bottom of trenches to grade. Make trenches 12" wider than the greatest dimension of the pipe(s).
 - I. Trenches shall not be backfilled until all required tests are performed, installation has been approved, and systems conform to the requirements of the specifications.

3.6 FLASHINGS, SLEEVES, AND INSERTS

- A. Furnish and install flashings where pipes pass through outside walls. Flashings shall be properly formed to fit around pipes and shall be caulked, with 790 Silicone Building Sealant by Dow Corning Corporation, so as to make watertight seal between pipe and building.
- B. Unless otherwise specified, install sleeves for each pipe where it may pass through interior walls or floors. Galvanized 22-gauge sheet iron sleeves shall be used. Finish flush with each finished wall surface. In pipe chases, the sleeve shall extend 1-1/2" inches above floor slab and shall be watertight.
- C. Raceways that pass through concrete beams or walls and masonry exterior walls shall be provided with galvanized wrought iron pipe sleeve, unless shown otherwise on drawings. Inside diameter of these sleeves shall be at least 1/2" greater than outside diameter of service pipes. After pipes are installed in these sleeves, fill annular space between pipes and sleeves with 790 Silicone Building Sealant by Dow Corning Corporation. Completed installation shall be watertight.

3.7 ROOF PENETRATIONS

- A. Pipe penetrating the roof shall be installed as directed by roofing supplier/installer and shall be compatible with roofing system.

3.8 CUTTING AND PATCHING

- A. The Contractor shall coordinate work to eliminate cutting of the construction except as specified. Where it becomes necessary to cut through the construction to permit the installation of work or the repair of defective work, it shall be performed by trades specializing in the type of work involved.
- B. Request for Engineer's consent:
 - 1. Prior to cutting which affects structural safety, submit a written request to Engineer for written permission to proceed with cutting.
 - 2. When conditions of Work or schedule require a change of materials or methods for cutting and patching, notify Engineer and secure written permission to proceed with work.
- C. Perform, Architect-approved, cutting and patching by methods which will prevent damage to other portions of the work and provide proper surfaces to receive installation of new work and/or repair.
 - 1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect. Impact-type equipment will not be used except where specifically acceptable to the Architect.
 - 2. Openings in precast concrete slabs or walls for pipes, etc., shall be core drilled to exact size. Oversize the hole to allow for link seals, and to deter pipe corrosion condensation from forming.
 - 3. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect.
 - 4. Openings cut through plaster or drywall shall be cut prior to plaster finish coat or texture coat on drywall. Cutting of the finish coat of plaster or texture coat of drywall will not be permitted unless written approval of the Architect is obtained.
 - 5. Openings shall be restored and/or repaired as required to replace the cut surface to an "as-new" and/or "as original" condition. Refer to the appropriate section of the specifications for the material involved.
- D. Perform fitting and adjusting of products to provide finished installation complying with the specified tolerances and finishes.

3.9 INSTALLATION OF PIPING AND EQUIPMENT

- A. Thoroughly clean items before installation. Cap pipe openings to exclude dirt until fixtures are installed and final connections have been made.
- B. Cut pipe accurately, and work into place without springing or forcing, properly clearing windows, doors, and other openings. Excessive cutting or other weakening of the building will not be permitted.
- C. Show no tool marks or threads on exposed plated, polished, or enameled connections from fixtures. Tape all finished surfaces to prevent damage during construction.
- D. Make changes in directions with fittings; make changes in main sizes with eccentric reducing fittings. Unless otherwise noted, install water supply and return piping with straight side of eccentric fittings at top of the pipe.
- E. Building sewers shall be run in practical alignment at a uniform slope of not less than one-fourth (1/4) of an inch per foot toward the point of disposal or termination as indicated on drawings; provided that where it is impractical, due to the depth of the street sewer or to the structural features or to the arrangement of any building or structure, to obtain a slope of one-fourth (1/4) of an inch per foot any such pipe or piping four (4) inches or larger may have a slope of not less than one-eighth (1/8) of an inch per foot when approved by the Administration Authority (unless otherwise noted). Run horizontal water piping with an adequate pitch upwards in direction of flow to allow complete drainage.
- F. Provide sufficient swing joint, ball joints, expansion loops, and devices necessary for a flexible piping system, whether or not shown on the Drawings.
- G. Support piping independently at pumps, coils, tanks, and similar locations, so that weight of pipe will not be supported by the equipment.
- H. Pipe the drains from pump glands, drip pans, relief valves, air vents, and similar locations, to spill over an open sight drain, floor drain, or other acceptable discharge point, and terminate with a plain end unthreaded pipe 6" above the drain.
- I. Securely bolt all equipment, isolators, hangers, and similar items in place.
- J. Support each item independently from other pipes. Do not use wire for hanging or strapping pipes.
- K. Provide complete dielectric isolation between ferrous and non-ferrous metals.
- L. Provide union and shut off valves suitably located to facilitate maintenance and removal of equipment and apparatus.

3.10 EQUIPMENT ACCESS

- A. Install piping, equipment, and accessories to permit access for maintenance. Relocate items as necessary to provide such access, and without additional cost to the Owner.
- B. Provide access doors where valves, motors, or equipment requiring access for maintenance are located in walls or above ceilings. Coordinate location of access doors with other trades as required.

3.11 TESTING PLUMBING SYSTEMS

- A. The Plumbing Contractor shall test and adjust the plumbing systems for performances as required by governing codes, specifications and drawings. All testing to be done before piping is covered or enclosed. Any leaks or defects shall be repaired and test repeated until requirements are complied with. Caulking or patching material is prohibited.
- B. After completion of water and sewer systems testing, inspection and acceptance, a written test report for each system shall be submitted by the Contractor to the Owner.

3.12 WATER SUPPLY SYSTEM TEST

- A. Upon completion of the water system, or section thereof, it shall be pressure tested and proved tight. Water from a potable supply must be used in this test. Test water system according to procedures of authorities having jurisdiction or, in absence of published procedures as follows:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 4. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.13 STERILIZATION OF DOMESTIC WATER SYSTEMS

- A. Sterilize each unit of completed supply line and distribution system with chlorine solution before acceptance for domestic operation.
- B. Accomplish sterilization as described below or by the system prescribed by the American Water Works Association Standard C-601. Apply the amount of chlorine to provide a dosage of no less than 50 parts per million. Provide chlorine manufactured in conformance to the following standards:
 - 1. Liquid Chlorine: Federal Specification BB-C-120.
 - 2. Hypochlorite: Federal Specification 0-C-114a, Type 11, Grade B or Federal Specification 0-X-602.

- C. Introduce the chlorinating material to the supply stream at a rate sufficient to provide a uniform concentration throughout the system. All outlets shall be opened and closed several times during chlorination. When the specified level of chlorine is detected at every outlet in the system, close all valves to prevent release of water from the system for 24 hours. At the completion of the 24 hour disinfection period, test every outlet for a minimum chlorine residual of 50 parts per million. This minimum residual must be present to proceed with flushing. Flush the system with clean water at a sufficient velocity until the residual chlorine detected at every outlet is within 0.2 parts per million of the normal water supply's level.
- D. Open and close all valves in the lines being sterilized several times during above chlorination.
- E. The sterilization process shall be done by persons whose major business is water treatment and sterilization. The Plumbing Contractor shall pay all costs and charges associated to this test and certification.
- F. Contractor shall obtain written certification from the independent testing agency stating that the water samples meet Federal and State guidelines for safe drinking water. Upon satisfactory completion of all procedures, and receipt of acceptable laboratory test results, obtain written approval by Owner's representative. Failure to fully comply with the above procedures will result in a requirement to repeat the procedure until acceptable results are achieved, at no additional cost to the Owner.
- G. Isolate or bypass equipment that would be detrimentally affected by disinfection solution. Isolate all other sections of the domestic water system no being disinfected to prevent migration of chlorine.
- H. Prior to injection of chlorine into the piping system, strategically place signs stating "heavily Chlorinated Water – Do Not Drink", and protect all outlets to prevent use during disinfection and flushing procedures.

3.14 SEWER SYSTEM TEST

- A. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-

stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

- 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
- 6. Prepare reports for tests and required corrective action.

3.15 OPERATION AND MAINTENANCE DATA

- A. Submit two copies of preliminary draft of proposed manual or manuals to Engineer for review and comments. Allow minimum of 10 working days for review.
- B. Submit approved manual to Engineer prior to indoctrination of operation and maintenance personnel.
- C. Where instruction manuals are required for submittal, they shall be prepared in accordance with the following:

Format:

Size: 8-1/2" x 11"

Paper: White Bond, at least 20 lb.

Text: weight Neatly written or printed.

Drawings: 11" in height preferable; bind in with text; foldout

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

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

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

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

OPERATING AND MAINTENANCE INSTRUCTIONS

Name and Address of Work

Name of Contractor

General subject of this manual

Space for approval signature of Engineer and approval date[s]

- E. Contents: Include at least following:
1. Neatly typewritten index near front of Manual, giving immediate information as to location within manual of emergency information regarding installation.
 2. Complete instructions regarding operation and maintenance of equipment involved including lubrication, disassembly, and reassembly.
 3. Complete nomenclature of parts of equipment.
 4. Complete nomenclature and part number of replaceable parts, name and address of nearest vendor and other data pertinent to procurement procedures.
 5. Copy of guarantees and warranties issued.
 6. Manufacturer's bulletins, cuts, and descriptive data, where pertinent, clearly indicating precise items included in this installation and deleting, or otherwise clearly indicating, manufacturers' data with which this installation is not concerned.
 7. Other data as required in pertinent Sections of these Specifications.

3.16 WARRANTY

- A. Warrant equipment and workmanship for period of one year after date of substantial completion and replace or repair faulty equipment or installation at no cost to Owner for service during this period.
- B. Warranty shall not void specific warranties issued by manufacturers for greater periods of time or void rights guaranteed to Owner by law.
- C. Warranties shall be in writing in form satisfactory to Owner, and shall be delivered to Owner before final payment is made.

3.17 PROJECT COMPLETION

- A. Upon completion of Work of this Division, thoroughly clean exposed portions of plumbing installation, removing traces of soil, labels, grease, oil, and other foreign material, and using only type cleaner recommended by manufacturer of item being cleaned.

- B. Thoroughly indoctrinate Owner's operation and maintenance personnel in contents of operations and maintenance manual required to be submitted as part of this Division of these Specifications.
- C. Date of final acceptance shall be the date documented in writing and signed by Architect / Engineer.

END OF SECTION 22 00 00

SECTION 22 11 16
PEX DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Domestic potable hot and cold water plumbing system shall be crosslinked polyethylene pipe, and shall include the following:
 - 1. Crosslinked polyethylene (PEX-A) piping.
 - 2. Distribution manifold(s) with copper flow control valves, Sioux Chief or equal.
 - 3. Pipe fasteners, support, strapping, connection rings, & polymer couplings as approved by the manufacturer of the PEX-A piping.
 - 4. Supervision and field engineering required for the complete and proper function of the system.
 - 5. Contractor shall use Uponor PEX-A piping for all hot and cold water domestic plumbing, or approved equal.

1.2 REFERENCES

- A. Publications listed here are part of this specification to the extent they are referenced. Where no specific edition of the standard or publication is identified, the current edition shall apply.
- B. ASTM - American Society for Testing and Materials
 - 1. ASTM D 2765 - Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.
 - 2. ASTM D 6394 - Specification for Sulfone Plastics (SP).
 - 3. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
 - 4. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
 - 5. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
 - 6. ASTM F 876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.

7. ASTM F 877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot-and Cold-Water Distribution Systems.
 8. ASTM F 1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubing.
- C. American Water Works Association:
1. AWWA C904 Standard for Crosslinked Polyethylene (PEX) Pressure Pipe, 1/2 in. Through 3 in., for Water Service.
- D. American National Standards Institute (ANSI)/National Sanitation Foundation (NSF)
1. ANSI/NSF Standard 14 Plastics Piping System Components and Related Materials.
 2. ANSI/NSF Standard 61 Drinking Water System Components - Health Effects.
 3. ANSI/NSF Standard 359 Valves for Crosslinked Polyethylene (PEX) Water Distribution Tubing Systems.
- E. American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL)
1. ANSI/UL 263 Standard for Safety for Fire Tests of Building Construction and Materials.
 2. ANSI/UL 2846 Standard for Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.
- F. American Society of Mechanical Engineers (ASME):
1. ASME B 16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
 2. ASME B16.51 Copper and Copper Alloy Press-Connect Pressure Fittings.
- G. International Code Council (ICC)
1. International Plumbing Code (IPC)
- H. International Association of Plumbing Officials (IAPMO)
1. Uniform Plumbing Code (UPC)

- I. National Association of Plumbing, Heating and Cooling Contractors (NAPHCC)
 - 1. National Standard Plumbing Code (NSPC)
- J. Plastics Pipe Institute (PPI)
 - 1. PPI Technical Report TR-4/06
- K. Underwriters Laboratories (UL):
 - 1. UL 2846 Standard for Fire Tests of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.
- L. Uponor, Inc.
 - 1. Uponor Plumbing Design Assistance Manual (PDAM), 2017.
 - 2. Uponor Piping Pocket Guide, 2017.

1.3 THIS SPECIFICATION REQUIRES PEX TO BE DESIGNATED AS PEX-A AND BE MANUFACTURED BY THE ENGEL OR PEROXIDE METHOD.

1.4 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Water shall enter building main, shut-off valve, then be distributed as per the drawings.
 - 2. Tubing Standard: High-Density Cross-linked polyethylene tubing shall be manufactured to the requirements of ASTM F876 and meet the standard grade hydrostatic pressure ratings from Plastic Pipe Institute in accordance with TR-4/03. The following three standard grade ratings are required.
 - a. 200 degrees F at 80 psig
 - b. 180 degrees F at 100 psig
 - c. 73.4 degrees F at 160 psig
 - 3. Chlorine testing: According to ASTM F876 shall meet or exceed the following end use condition.
 - a. End use conditions of: 100% @ 140°F Per PEX 5306 (CL5)
 - 4. UV testing: According to ASTM F876 PEX tubing products shall meet or exceed the following exposure limits: 6 months

1.5 SUBMITTALS

- A. Comply with Section 01 33 00, Submittal Procedures. Approval and/or acceptance of all submittals are required prior to installation or fabrication.
- B. Product Data: Submit manufacturer's Technical Manual, submittal forms, catalog cuts, brochures, specifications, and installation instructions. Submit data in sufficient detail to indicate compliance with the contract documents.
 - 1. Submit manufacturer's instructions for installation.
 - 2. Submit data for equipment, fittings, fasteners and associated items necessary for the installation of the piping and manifolds.
- C. Certification:
 - 1. Submit independent certification results for the piping systems from an accredited independent testing laboratory.
 - 2. The design shall be approved by a professional appropriately licensed in the jurisdiction where the installation will take place, as being complete and accurate.
 - 3. Fittings shall be third-party as approved by the manufacturer's PEX piping system with applicable plumbing and mechanical code certifications.
 - 4. Fittings encased behind walls or ceilings shall be certified to ASTM F2080.
- D. Maintenance Instructions: Submit instructions for any maintenance required or recommended by manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer: Must be a company specializing in the Work of this Section with a minimum of 5 years documented experience.
- B. All components shall be supplied by one manufacturer.
- C. Pipe shall be manufactured in a facility whose quality management system is ISO 9001 certified.
 - 1. Crosslinked polyethylene (**PEX-A**) pipe shall conform and be certified to ASTM F876, F877 and CSA B137.5. Fittings shall conform and be certified to ASTM F877 or F2080, and CSA B137.5

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and equipment in shipping containers with labeling in place.
 - 1. Pipe shall be kept in original shipping boxes until required for installation.
- B. Store piping and equipment in a safe place, dry, enclosed, under cover, in a well-ventilated area.
 - 1. Do not expose pipe to ultraviolet light.
 - 2. Protect piping and manifolds from entry of contaminating materials. Install suitable plugs in open pipe ends until installation.
 - 3. Where possible, connect pipes to assembled manifolds to eliminate possibility of contaminants and cross-connections.
 - 4. Piping shall not be dragged across the ground or other surfaces, and shall be stored on a flat surface with no sharp edges.
- C. Protect materials from damage by other trades.
- D. Pipe shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

1.8 WARRANTY

- A. Provide manufacturer's standard written warranty in O&M Submittal.
 - 1. The warranty shall include as a minimum, provisions to repair defects from faulty materials or workmanship developed during the guarantee period, or provide for replacement with new materials, at no expense to the Government.
 - 2. The pipe manufacturer shall warrant the crosslinked polyethylene piping to be free from defects in material and workmanship for a period of twenty-five (25) years starting at building project acceptance date.
 - 3. Cold-expansion compression-sleeve pipe repair couplings shall be warranted to be free from defects in material and workmanship for a period of twenty-five (25) years starting at building project acceptance date.
 - 4. All manifolds and distribution headers shall be warranted to be free from defects in material and workmanship for a period of two (2) years starting at building project acceptance date.
- B. Provide installer's guarantee in O&M Submittal.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURER

- A. Acceptable Manufacturer: Uponor , which is located at: 5925 148th St. W.; Apple Valley, MN 55124; Toll Free Tel: 800-321-4739; Tel: 952-891-2000; Fax: 952-891-2008; Email:request info (daniel.worm@uponor.com); <http://www.uponorengineering.com>
- B. Any substitution requests shall be submitted by Contractor with full comparison documents to Uponor for all products to be reviewed for possible approval by CO.

2.2 PEX PIPE AND FITTINGS

- A. PEX-A (Engel-Method Crosslinked Polyethylene) Piping: ASTM F 876 and F877 (CAN/CSA-B137.5) by Uponor.
- B. PEX-A Fittings: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
 - 1. UNS No. C69300 Lead-free (LF) Brass.
 - 2. UNS No. C27453 Lead-free (LF) Brass.
 - 3. 20% glass-filled polysulfone as specified in ASTM D 6394.
 - 4. Unreinforced polysulfone (group 01, class 1, grade 2) as specified in ASTM D 6394.
 - 5. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D 6394.
 - 6. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D 6394.
 - 7. Reinforcing cold-expansion rings shall be manufactured from the same source as PEX-A piping manufacturer and marked "F1960".
- C. Pre-Sleeved Piping (1/2 inch (16mm) through 3/4 inch (20mm) nominal pipe size): PEX-A piping, with a high-density polyethylene (HDPE) corrugated sleeve.
- D. Pre-Insulated Piping (1/2 inch (16mm) through 2 inch (50mm) nominal pipe size): PEX-A piping, with a closed-cell polyethylene foam insulation.

E. Manifolds: Multiple-outlet assembly complying with ASTM F 877 (CAN/CSA B137.5); with ASTM F 1960 outlets.

1. Lead-free copper valved manifold.

2.3 TRANSITION FITTINGS

A. PEX-to-Metal Transition Fittings:

1. Manufacturers: Provide fittings from the same manufacturer of the piping.
2. PEX-A to Thread Transition: One-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-A reinforcing cold-expansion ring.
3. PEX-A to Copper Sweat Transition: One-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-A reinforcing cold-expansion ring.
4. PEX-A to Copper Press Transition: One-piece lead free (LF) brass fitting with one ASME B16.51 copper press end and one ASTM F1960 cold-expansion end, with PEX-A reinforcing cold-expansion ring.
5. PEX-A to Flange Transition: Two-piece fitting with one steel flange conforming to ASME B 16.5 and one lead free (LF) brass adapter conforming to ASTM F 1960.
6. PEX-A to Groove Transition: One-piece lead free (LF) brass fitting with one CSA B24205 groove end in either iron pipe size (IPS) or copper tube size (CTS) and one ASTM F1960 cold-expansion end, with PEX-A reinforcing cold-expansion ring.
7. PEX-A to Water Meter Transition: Two-piece fitting with one NPSM union thread and one ASTM F 1960 cold-expansion end, with PEX-A reinforcing cold-expansion ring.

B. PEX-to-Thermoplastic Transition Fittings:

1. PEX-A to CPVC Transition: Thermoplastic fitting with one spigot or socket end and one ASTM F 1960 cold-expansion end, with PEX-A reinforcing cold-expansion ring.

2.4 VALVES

- A. PEX-to-PEX, Lead Free (LF) Brass Ball Valves (1/2 inch (16 mm) through 2 inch (50 mm) nominal pipe size)
 - 1. Manufacturers: Provide ball valve(s) from the same manufacturer as the piping system.
 - 2. Full-port ball valve: two-piece, ASTM F1960 cold-expansion ends, with PEX-A reinforcing cold-expansion ring.
 - 3. LF brass valve with a positive stop shoulder manufactured from C69300 brass.
 - 4. In compliance with: 250 CWP, ANSI/NSF 359, ANSI/NSF 14/61, cNSF-us-pw_G lead free 0.25% Lead max., ASTM F1960, ASTM F 877 (CAN/CSA B137.5).

2.5 MARKINGS

- A. Pipe shall carry the following markings every three (3) feet (0.9 meters):
 - 1. Manufacturer's name or trademark, nominal size, PEX-A 3006 (material designation) SDR9 (standard dimension ratio), ASTM F876/ F877 / F2080, CSA B137.5, NSF-pw, UPC Shield, 160 psi @ 73.4°F / 100 psi @ 180°F / 80 psi @ 200°F, POTABLE TUBING, manufacturing date and footage mark.

2.6 PACKAGING

- A. Coiled pipe shall be shipped in protective cardboard boxes marked with product name and size.
- B. Straight lengths shall be packed in plastic bags.

PART 3 - EXECUTION

3.1 ACCEPTABLE INSTALLERS

- A. As a minimum, installation shall be performed by qualified laborers trained by the manufacturer in the procedures of PEX systems and they shall be appropriately licensed for the jurisdiction where the installation will take place.

3.2 EXAMINATION

- A. Examine areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of work. Do not proceed until unsatisfactory conditions are corrected.
- B. Beginning of installation means acceptance of existing conditions.

3.3 PREPARATION

- A. Coordinate with related trades and manufacturer's recommendations with regard to installation in conjunction with:
- B. Prepare a suitable cavity for the manifold, with a secure mounting plate that will secure the manifold at least 30 inches above floor level. Manifold must be installed in an area that will allow easy access for piping as well as future access for maintenance.

3.4 INSTALLATION

- A. Install in accordance with manufacturer's published installation manual and/or published guidelines and final shop drawings.
- B. Manifolds shall be mounted as level as possible.
- C. Route piping in an orderly manner, according to layout and spacing shown in final shop drawings. All installation notes shown on the drawings shall be followed.
- D. At connections and fittings, use a plastic pipe cutter to ensure square (90°) and clean cuts, and join pipes immediately or cap ends of pipe to seal from contaminants.
- E. Pipe shall be dispensed using a suitable uncoiling device. Remove twists prior to securing pipe. Pipe shall lie flat on an even plane.
- F. Piping that passes through expansion joints or walls shall be covered in protective polyethylene convoluted sleeving (flexible conduit) extending 15 inches on each side of the joint. Sleeving shall be secured on pipe to prevent movement during installation.
- G. Where piping enters or exits a wall a protective conduit shall be placed around the pipe, with the conduit extending a minimum of 6 inches into the floor and exiting by a minimum of 6 inches. For penetrations at manifolds, use rigid PVC bend guides secured in place to prevent movement.

3.5 FIELD QUALITY CONTROL

- A. Filling, Testing & Balancing: Tests of domestic plumbing systems shall comply with authorities having jurisdiction, and, where required, shall be witnessed by the building official.
- B. Pressure gauges used in testing and balancing shall show pressure increments of 1 psig and shall be located at or near the lowest points in the distribution system.
- C. Air Test
 - 1. Charge the completed, yet unconcealed pipes with air at a minimum of 40 psig.
 - 2. Do not exceed 150 psig.
 - 3. Use soap solution to check for leakage at manifold connections
- D. Water Test
 - 1. Purge air from pipes.
 - 2. Charge the completed, yet unconcealed pipes with water.
 - 3. Take necessary precautions to prevent water from freezing.
 - 4. Check the system for leakage, especially at all pipe joints.
- E. Perform a preliminary pressure test pressurizing the system to the greater of 1.5 times the maximum operating pressure or 100 psig for 30 minutes.
 - 1. As the piping expands, restore pressure, first at 10 minutes into the test and again at 20 minutes.
 - 2. At the end of the 30-minute preliminary test, pressure shall not fall by more than 8 psig from the maximum, and there shall be no leakage.
- F. After successfully performing the preliminary pressure test, perform the main pressure test immediately.
 - 1. The test pressure shall be restored and continued as the main test for 2 hours.
 - 2. The main test pressure shall not fall more than 3 psig after 2 hours.
 - 3. No leakage shall be detected.
- G. Complete inspection and furnish test reports supplied by the manufacturer of the system.

3.6 CLEANING

- A. Clean exposed surfaces upon completion of installation using clean, damp cloth. No cleaning agents are allowed.
- B. Comply with manufacturer's recommendations.

3.7 PROTECTION

- A. Protect installation throughout construction process until date of final completion.
- B. Replace components that cannot be repaired.

END OF SECTION

SECTION 22 20 23
NATURAL GAS PIPING

GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. This section covers the complete first-class 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.

1.3 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:
 - 1. International Fuel Gas Code.
 - 2. Latest Edition of NFPA 54, National Fuel Gas Code.
 - 3. Minimum Safety Standards for Natural Gas, 49 Code of Federal Regulations (CFR) Part 192, as Required by Title 16 of the Texas Administration Code § 8.70.

1.4 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.
- D. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three (3) years documented experience.
- E. Installer Qualifications: Company specializing in performing the Work of this Section with minimum three (3) years documented experience. Installation of natural gas systems shall be performed by individuals licensed by the Texas State Board of Plumbing Examiners as a Journeyman or Master Plumber. All installation shall be supervised by a licensed Master Plumber. All testing shall be performed by a licensed Journeyman or Master Plumber. Welders shall be certified in accordance with ASME Section 9.

1.5 SUBMITTALS

A. Product Data:

- 1. Provide code and standards compliance verification, manufacturer's product data and ratings on pipe materials, pipe fittings, regulators, valves and accessories.

B. Record Documents:

- 1. Submit test reports and inspection certification for all-natural gas systems installed under this Contract.
- 2. Submit manufacturer's data reports for all material used in coating and wrapping.
- 3. Submit welder's certifications prior to any shop or field fabrication. Welder's certifications shall be current within six (6) months of submission.
- 4. Record actual locations of valves, regulators, etc. and prepare valve charts.
- 5. Provide full written description of manufacturer's warranty.

C. Operation and Maintenance Data:

- 1. Include installation instructions, spare parts lists, exploded assembly views manufacturer's recommended maintenance.

1.6 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.

1.7 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.

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 customer 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 2-1/2 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 Exposed 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 2-1/2 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. EXCEPTIONS:
 - a. All exposed piping 2 inches and smaller located within areas utilized as return air plenums shall have welded joints with Schedule 40 socket welded forged steel fittings conforming to ASME B16.11.
 - b. All exposed piping 2 inches and smaller serving laboratories from main natural gas riser to each emergency shut-off valve shall have welded joints with Schedule 40 socket welded forged steel fittings conforming to ASME B16.11.

D. Above Ground Piping Concealed Inside of Building (Includes above all ceilings, within partitions, within chases, and all non-accessible locations):

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 2-1/2 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. EXCEPTIONS:
 - a. Threaded piping 2 inches and smaller may be installed 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 & TRACER WIRE

- 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.
 1. 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.
 2. Minimum tensile strength: 63 LBS per 3 IN width.
 3. Minimum elongation: 500 percent.
 4. 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").
 5. Manufactured by Reef Industries "Terra Tape" or approved equal.
- B. Buried plastic pipe that is not encased shall have a minimum of #12 PVC coated solid copper wire installed along entire length of the gas pipe. The trace wire may not be wrapped around pipe and contact with the pipe is to be minimized. Tape trace wire to top side of pipe the entire length. The wire must be wrapped around the riser beginning a few inches below grade and extended up to the building stop. Leave at least 6' of wire coiled up at the location of the proposed utility connection location.

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 or Nordstrom Model 142.
- 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-1431 or Nordstrom Model 143.
- 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 or Milwaukee Model BB2-100.
- 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 or Milwaukee Model BB2-100.
- 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. Complete test reports may be required for any fitting selected at random. Flanges which have been machined, remarked, painted or otherwise produced domestically from imported forges will not be acceptable. Flanges shall have the manufacturer's trademark permanently identified in accordance with MSS SP-25. Contractor shall submit data for firm certifying compliance with these Specifications. Bolts used shall be carbon steel bolts with semi-finished hexagon nuts of American Standard Heavy dimensions. All thread rods will not be an acceptable for flange bolts. 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 pumps, check valves, strainers, etc. Only one manufacturer of weld flanges will be approved for each project.
- 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, Klingersil C-4400, Manville Style 60 service sheet packing, or approved equal.

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, including equipment furnished under other Divisions of these Specifications and/or by the Owner.
- 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.
- 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. All excavation required for plumbing work is the responsibility of the Plumbing Contractor and shall be done in accordance with project Specifications.
- G. Do not install underground piping when bedding is wet or frozen.
- H. 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.
- I. 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.
- J. 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.
- K. Polyethylene piping shall not be installed above ground.
- L. Provide connection between buried plastic gas piping and metallic riser in accordance with the gas code.
- M. All above ground gas piping shall be electrically continuous and bonded to electrical system ground conductor in accordance with NFPA 70.
- N. 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.
- O. Provide dielectric isolation device where copper lines connect to ferrous lines or equipment, such as dielectric coupling or dielectric flange fitting.
- P. 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.
- Q. Route piping in orderly manner and maintain gradient. Install piping to conserve building space. Group piping whenever practical at common elevations.
- R. Install piping to allow for expansion and Contraction without stressing pipe, joints, or connected equipment.
- S. 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.
- T. Close nipples, bushing and cross type fittings shall not be installed in any gas piping system.

- U. 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.
- V. 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. Valves shall be installed as nearly as possible to the locations indicated in the Contract Drawings. Any change in valve location must be so indicated on the Record Drawings.
- W. Install line shut-off valve at each branch connection to riser. Branch line shut-off valves shall be automatic type where indicated on Drawings.
- X. Provide adequate clearance for access to and operation of all valves.
- Y. Install valves with stems upright or horizontal, not inverted unless required otherwise by the valve manufacturer.
- Z. 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.
- AA. 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.
- BB. 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.

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 Resident Construction Manager 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 37-½ 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.
- I. Weld Testing:
 - 1. All welds are subject to inspection, visual and/or x-ray, for compliance with Specifications. The Owner will at the Owner's option, provide employees or employ a testing laboratory for the purposes of performing said inspections and/or x-ray testing. Initial visual and x-ray inspections will be provided by the Owner. The Contractor shall be responsible for all labor, material and travel expenses involved in the re-inspection and retesting of any welds found to be unacceptable. In addition, the Contractor shall be

responsible for the costs involved in any and all additional testing required or recommended by ASME/ANSI Standards B31.1 and B31.3 due to the discovery of poor, unacceptable or rejected welds.

2. Welds lacking penetration, containing excessive porosity or cracks, or are found to be unacceptable for any reason, must be removed and replaced with an original quality weld as specified herein. All qualifying tests, welding and stress relieving procedures shall, moreover, be in accord with Standard Qualification for Welding Procedures, Welders and Welding Operators, Appendix A, Section 6 of the Code, current edition.

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 natural gas piping systems shall be very carefully inspected, tested, purged and placed into operation by a Licensed Plumber.
- C. All necessary apparatus for conducting tests shall be furnished by the Contractor and comply with the requirements of NFPA 54.
- D. 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.
 1. 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.
 2. 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.
 3. 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.
- E. 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.
- F. After successful results of pressure test and purging have been completed, a leakage test shall be performed in accordance with NFPA 54 Appendix D.

- G. Connect, inspect and purge gas utilization equipment, lab hook-ups, outlets, etc., and place into operation only after successful results of pressure test, leakage test and purging have been completed and accepted.
- H. In all instances in which leaks are then found, they shall be eliminated in the manner designated by the Owner's duly authorized representative. Testing operations shall be repeated until gas-piping systems are absolutely tight at the pneumatic test pressures indicated above.
- I. 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 22 20 23

SECTION 23 00 00

BASIC HEATING, VENTILATING, AND AIR CONDITIONING SPECIFICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. The Contractor shall familiarize himself with all drawings and specifications and properly use information found on the Architectural, Civil, Utility, Structural, Mechanical, and Electrical drawings and specifications affecting his work.

1.2 SUMMARY

- A. Work Included: Provide complete mechanical systems where shown on drawings, as specified herein, and as needed for a complete and proper installation including, but not necessarily limited to the following summary of work:
 - 1. Furnish and install a complete **Heating, Ventilating, and Air Conditioning (HVAC) System** to include: equipment, ducts, dampers, diffusers and registers, etc. as required for a complete and operating system.
 - 2. Other items and services required to complete the mechanical systems.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. If additional work is required for Work indicated or specified, it shall be the responsibility of the Contractor to provide same, as well as to provide material and equipment usually furnished with such systems or as required to complete the installation.

1.3 MECHANICAL CODES, STANDARDS, AND SYMBOLS

- A. All work shall be in accordance with the latest edition of the following codes:
 - 1. International Building Code.
 - 2. International Mechanical Code.
 - 3. International Plumbing Code.
 - 4. International Fire Code,
 - 5. International Fuel Gas Code.
 - 6. National Fire Protection Association, NFPA 54
 - 7. International Energy Conservation Code.
 - 8. National Electrical Code (NEC).
- B. Local governing codes and authorities, trade association standards and publications are an extension of the contract documents, and are hereby imposed as applicable to the work in each instance.

- C. Where local codes, ordinances, rules or authority conflicts with associations and standards listed hereinafter, the local ordinances, codes, rules or authorities take precedence.
- D. Standards: Specifications and Standards of the following organizations are by reference made part of these Specifications. Unless otherwise indicated, shall comply with requirements and recommendations wherever applicable:
 - 1. Air Moving & Conditioning Association (AMCA).
 - 2. American Standards Association (ASA).
 - 3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE)
 - 4. American Society of Mechanical Engineers (ASME).
 - 5. American Nation Standards Institute (ANSI).
 - 6. American Society for Testing and Materials (ASTM).
 - 7. American Society of Mechanical Engineers (ASME).
 - 8. Sheet Metal & Air Conditioning Contractor's National Association (SMACNA)
 - 9. National Fire Protection Association (NFPA).
 - 10. Underwriters Laboratories, Inc. (UL).
- E. The listing of (or key to) specific graphic symbols used to show the mechanical work on the contract documents is shown on the drawings.

1.4 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- B. Provide only materials that are new, of the type and quality specified.
- C. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrated satisfactory operating installation. The contractor must support all ductwork, pipe, equipment, and other items furnished and installed under this scope from steel joists or structural steel frames. It is prohibited to support pipe, equipment, and other items furnished under this scope from the metal deck.
- D. Where installation instructions are not included in the Contract Documents, the manufacturer's instructions shall be followed.
- E. Copies of each welder's certification documents shall be furnished to the Engineer prior to them performing work.

1.5 SUBMITTALS

- A. Comply with pertinent provisions of Submittals in Specifications.
- B. Provide Manufacturer's specifications and other data needed to prove compliance with specified requirements. Term "Compliance" is understood to mean that Contractor certifies that submitted equipment meets or exceed Contract Document requirements. Items that do not clearly meet this definition should be identified and explained as required in following paragraph.
- C. Identify difference between specified item and proposed item. Explain with enough detail so that it can easily be determined that item complies with functional intent. List disadvantages or advantages of proposed item versus specified item. Submit technical data sheets and/or pictures and diagrams to support and clarify. Organize in clear and concise format. Substitutions shall be approved in writing by Engineer. Engineer's decision shall be final.
- D. Allow a minimum of 15 working days for review of each submittal and re-submittal.
- E. Items of equipment that are not accepted in writing as approved equal shall be replaced or revised to comply with Contract Documents at Contractor's expense.
- F. The manufacturers recommended installation procedures shall become basis for accepting or rejecting actual installation procedures used on Work.
- G. Shop drawing shall consist of detailed drawings with dimensions, schedules, weights, capacities, installation details, and pertinent information needed to describe the material or equipment.
- H. Submittals required of materials and equipment under this Division include following listed items not supplied by Owner. These submittal requirements are intended to be complimentary to requirements that may be listed in individual sections. In event of conflict more stringent requirements shall apply.
 - 1. Basic Materials
 - 2. HVAC Equipment
 - 3. Duct Specialties
 - 4. Air Distribution Devices
 - 5. Filters
 - 6. HVAC Pipe and Duct Insulation
 - 7. Fire Dampers and Fire Smoke Dampers
 - 8. Temperature Controls and Control Sequences
 - 9. Test, Adjust, and Balance Reports
 - 10. Testing, Adjusting and Balancing Contractor Qualifications.
 - 11. Vibration Isolation and Sound Control materials.

1.6 SUBSTITUTIONS

- A. The use of manufacturers' names and catalog numbers followed by the phrase "or equal" is generally used to establish a standard of quality and utility for the specified items and to provide a dimensional reference for construction documents that are drawn to scale.
- B. Submittals for "equal" items shall, where applicable, include the following data that are not necessarily required for specified items:
 - 1. Performance characteristics.
 - 2. Materials
 - 3. Finish
 - 4. Certification of conformance with specified codes and standards.
- C. Submittals of "equal" components or systems may be rejected if:
- D. The material or equipment would necessitate the alteration of any portion of the mechanical, electrical, architectural or structural design.
- E. Dimensions vary from the specified material or equipment in such a manner that accessibility or clearances are impaired or the work of other trades is adversely affected.

1.7 COMPATIBILITY OF EQUIPMENT

- A. Assume full responsibility for satisfactory operation of component parts of mechanical systems. Assure compatibility of equipment and performance of integrated systems in accordance with requirements of the Construction Documents. Notify the Engineer before submitting a bid should Specifications or Drawings make acceptance of responsibility impossible, prohibitive, or restrictive. The bid shall be accompanied by a written statement listing any objections or exceptions to the applicable specification section and/or drawing.

1.8 PERMITS AND INSPECTIONS

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

1.9 TEMPORARY SERVICES FOR CONSTRUCTION

- A. When any piece of mechanical equipment is operable and it is to the advantage of the Contractor to operate the equipment, he may do so, providing that he properly supervises the operation, and has the Engineer's written permission to do so. The warranty period shall, however, not commence until such time as the equipment is operated for the beneficial use of the Owner, or date of substantial completion, whichever occurs first.
- B. If the system has been operated without scheduled filters or if the integrity of temporary closures has been compromised, Contractor shall have ductwork cleaned according to National Air Duct Cleaners Association (NADCA) Standards by a Certified Regular Member of the NADCA.

- C. Before turning the installation over to the Owner, Contractor shall certify that the air handling systems have only been operated with scheduled filters in place. Otherwise, Contractor shall present evidence that the ductwork, equipment, and related items were cleaned as required above, install clean filter media, properly adjust, and complete all deficiency list items before final acceptance by the Owner. The date of acceptance and performance certification will be the same date.

1.10 COORDINATION

- A. The Contractor shall not hinder and/or delay any work being accomplished by other Divisions at or near the general construction site; nor shall the Contractor impede normal operation of the Owner at any time except as coordinated and scheduled in writing.
- B. The Contractor shall lay out the mechanical system(s) in careful coordination with the Drawing, determining proper elevations for all components of the system and using only the minimum number of bends to produce a satisfactorily functioning system.
- C. Layout pipes to fall within partition, wall or roof cavities, and to not require furring other than as shown on the Drawings.
- D. Coordinate as necessary with other trades to assure proper and adequate interface with all work.
- E. Where ductwork, pipes and other mechanical items are shown in conflict with locations of structural members and other equipment, include labor and materials required for extensions, offsets and supports to clear the encroachment.
- F. Furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, and complete installation.
- G. Coordinate accepted equipment changes from those scheduled or specified with other Divisions affected.
- H. Mechanical Contractor shall furnish and Electrical Contractor shall install magnetic starter with each motor furnished under Mechanical Section of the documents. (Starters indicated furnished in motor control centers on electrical drawings shall be by Electrical Contractor). Electrical Contractor shall provide all power and wiring for mechanical work. If power required for the equipment furnished by Mechanical Contractor differs from that submitted or shown on the electrical drawings, Mechanical Contractor shall be responsible for cost of any required changes in breakers, starters, wiring, etc., required to serve the particular equipment.

PART 2 - MATERIALS

2.1 DUCTWORK MATERIAL AND CONSTRUCTION

- A. All ductwork indicated on the Drawings, specified or required for the air conditioning and ventilating systems shall be of materials as hereinafter specified unless indicated otherwise on Drawings. All air distribution ductwork shall be fabricated, erected, supported, etc., in accordance with all applicable standards of SMACNA where such standards do not conflict with NFPA 90A and where class of construction equals or exceeds that noted herein.

- B. Ductwork shall be constructed of G-90 coated galvanized steel of ASTM A653 and A924 Standards.
- C. Minimum gage of round, oval or rectangular ductwork shall be 26 gage per SMACNA Standards.
- D. All duct sizes shown on the Drawings are clear inside dimensions. Allowance shall be made for internal lining, where specified, to provide the required free area.
- E. All holes in ducts for damper rods and other necessary devices shall be either drilled or machine punched (not pin punched), and shall not be any larger than necessary. All duct openings shall be provided with sheet metal caps if the openings are to be left unconnected for future connections/phases, otherwise plastic covers are acceptable.
- F. Except for specific duct applications specified herein, all sheet metal shall be constructed from prime galvanized steel sheets and/or coils up to 60 inches in width. Each sheet shall be stenciled with manufacturer's name and gage.
- G. Sheet metal must conform to SMACNA sheet metal tolerances as outlined in SMACNA's "HVAC Duct Construction Standards."
- H. Where ducts are exposed to view (including equipment rooms) and where ducts pass through walls, floors or ceilings; furnish and install sheet metal collars around the duct.
- I. Duct Sealing: All ductwork, regardless of system pressure classification, shall be sealed in accordance with Seal Class A, as referenced in SMACNA Standards. All transverse joints, longitudinal seams, and duct wall penetrations shall be sealed.
 - 1. All seams and joints in shop and field fabricated ductwork shall be sealed by applying one layer of sealant, then immediately spanning the joint with a single layer of 3 inches wide open weave fiberglass scrim tape. Sufficient additional sealant shall then be applied to completely embed the cloth.
 - 2. Sealant shall be water based latex UL 181A-M sealant with flame spread of 0 and smoke developed of 0. Sealants shall be Hard Cast Iron Grip 601, Ductmate Pro Seal, Foster 32-19, Childers CP-146 or Design Polymeric DP 1010.
 - 3. Scrim tape shall be fiberglass open weave tape, 3 inches wide, with maximum 20/10 thread count, similar to Hardcast FS-150.
 - 4. Sealer shall be rated by the manufacturer and shall be suitable for use at the system pressure classification of applicable ductwork.
 - 5. Except as noted, oil or solvent-based sealants are specifically prohibited.
 - 6. For exterior applications, "Uni-Weather" (United McGill Corporation), solvent-based sealant, or Foster 32-19 shall be used.

2.2 RECTANGULAR AND ROUND DUCTWORK

- A. Metal gages listed in SMACNA HVAC Duct Construction Standards, Metal and Flexible Duct, are the minimum gages which shall be used. Select metal gage heavy enough to withstand the physical abuse of the installation. In no case shall ductwork be less than 26 gauge per SMACNA Standards.
- B. All longitudinal seams for rectangular duct shall be selected for the specified material and pressure classification. Seams shall be as referenced in SMACNA Standards.
- C. Longitudinal seams in laboratory hood exhaust ducts shall be welded.
- D. All transverse joints and intermediate reinforcement on rectangular duct shall be as shown in SMACNA Standards. Transverse joints shall be selected consistent with the specified pressure classification, material, and other provisions for proper assembly of ductwork.
- E. Spiral round duct and fittings shall be as manufactured by United McGill Sheet Metal Company or approved equivalent. All fittings shall be factory fabricated, machine formed and welded from galvanized sheet metal.
- F. Joints in spiral duct and fittings shall be assembled, suspended, sealed, and taped per manufacturer's published assembly and installation instructions.
- G. Contractor may use DUCTMATE or Ward Industries coupling system, as an option, on rectangular ductwork. The DUCTMATE or Ward Industries system shall be installed in strict accordance with manufacturer's recommendations.

2.3 ELBOWS RECTANGULAR DUCTS

- A. Construct elbows as follows in order of preference:
 - 1. Long radius, unvaned elbows.
 - 2. Short radius, single thickness vaned elbows.
 - 3. Rectangular, double thickness vaned elbows.
- B. Long radius elbows shall have a centerline radius of not less than one and one-half (1-1/2) times the duct width. Short radius elbows shall have a centerline radius of not less than one times the duct width.
- C. Contractor shall have the option to substitute short radius vaned elbows, but shall request the substitution at the time of submittal of Product Data.
- D. Provide turning vanes in all rectangular elbows and offsets.
- E. Job fabricated turning vanes, if used, shall be fabricated of the same gage and type of material as the duct in which they are installed. Vanes must be fabricated for same angle as duct offset. Submit Shop Drawings on factory fabricated and job fabricated turning vanes.
- F. All turning vanes shall be anchored to the cheeks of the elbow in such a way that the cheeks will not breathe at the surfaces where the vanes touch the cheeks. In most cases, this will necessitate the installation of an angle iron support on the outside of the cheek parallel to the line of the turning vanes.

- G. In 90-degree turns that are over 12 inches wide in the plane of the turn, provide and install double thickness vanes on integral side rails. For ducts under 12 inches in width, use single thickness vanes. The installation of the turning vanes shall be as described for single thickness vanes. On other types of turns or elbows, single thickness trailing edge vanes shall be used.

2.4 FLEXIBLE DUCT

- A. Flexible duct connections shall be used at the intake and discharge of all motor driven equipment.
- B. Acoustical Flexible Duct to Diffusers, Grilles, and Terminal Units:
 - 1. Maximum flex duct length 6'-0" (six feet), installed with no more than 90 degrees of bend to diffusers and grilles. Where longer duct runs or more bends are necessary, provide rigid round ductwork.
 - 2. Maximum flex duct length 2'-0" (two feet), installed as a straight run to the inlet of the terminal units.
 - 3. Acoustical flexible duct shall be manufactured with an acoustically rated CPE inner film as the core fabric, mechanically locked by a corrosion-resistant galvanized steel helix.
 - 4. Core shall be factory pre-insulated with a total thermal performance of R-3.5 or greater. Outer jacket shall be a fire retardant polyethylene vapor barrier jacket with a perm rating not greater than 0.10 per ASTM E 96, Procedure A.
 - 5. Duct shall be rated for a minimum positive working pressure of 6 inches w.g. and a negative working pressure of 4 inches w.g. minimum.
 - 6. Temperature range shall be -20 degrees F to 250 degrees F.
 - 7. Duct must comply with the latest NFPA Bulletin 90A and be listed and labeled by Underwriter's Laboratories, Inc., as Class I Air Duct, Standard 181, and meet GSA, FHA and other U. S. Government standards; flame spread less than 25; smoke developed less than 50.
 - 8. Acoustical flexible duct shall be similar to Flexmaster Type 8M for construction and acoustical performance standards.
 - 9. Flexible duct shall not be used above gypsum board ceilings that are inaccessible.

2.5 DUCT ACCESSORIES

- A. Acceptable Manufacturers
 - 1. Backdraft Dampers: Greenheck, Ruskin
 - 2. Volume Dampers: Metalaire, Nailor, Ruskin
 - 3. Motorized Control Dampers: Greenheck, Metalaire, Nailor, Ruskin
 - 4. Turning Vanes: Ductmate Industries, Metalaire,

5. Duct Mounted Access Doors: Ductmate Industries, Greenheck, Nailor,
6. Flexible Connectors: Ductmate Industries, Ventfabrics
7. Flexible Ducts: Flexmaster, Hart & Cooley, McGill
8. Fire Dampers: Greenheck, Nailor, Ruskin
9. Smoke Dampers: Greenheck, Nailor, Ruskin
10. Grilles, Registers, Diffusers: Krueger, Metalaire, Nailor, Titus

B. Air Flow Control Dampers

1. Furnish and install dampers where shown on the Drawings and wherever necessary for complete control of airflow, including all supply, return, outside air, and exhaust branches, "division" in main supply, return and exhaust ducts, and each individual air supply outlet. Where access to dampers through a permanent suspended ceiling (gypsum board) is necessary, the Contractor shall be responsible for the proper location of the access doors.
2. Dampers larger than three (3) square feet in area shall be controlled by a self-locking splitter damper assembly.
3. Volume damper blades shall not exceed 48 inches (48") in length or twelve inches (12") in width and shall be of the opposed interlocking type. The blades shall be of not less than No. 16 gage galvanized steel supported on one-half inch (1/2") diameter rust-proofed axles. Axle bearings shall be the self-lubricating ferrule type.
4. Volume dampers and other manual dampers shall be carefully fitted, and shall be manually controlled by damper regulators as follows:
 - a. On exposed uninsulated ductwork the locking quadrant shall be made with a base plate of 16-gage cold-rolled steel and a heavy die cast handle designed with a 3/8 inch bearing surface. A 1/4 inch-20 zinc plated wing nut shall firmly lock the handle in place.
 - b. On exposed externally insulated ductwork the regulator shall be 4-1/4 inch diameter, for 1/2 inch rod, designed for use on duct with insulation thickness specified for duct, and shall have four (4) 3/16 inch holes provided to rivet or screw regulator to the duct surface. The flange that covers the raw edge of the insulation shall be high enough so that it slightly compresses the insulation and holds insulation in place. The handle shall be 3/8 inch above the flange, and shall easily turn without roughing up the insulation.
 - c. On concealed ductwork above inaccessible ceilings, the regulator shall be 2-5/8 inch diameter chromium plated cover plate that telescopes into the base, for 1/2 inch rod. Regulator shall be cast into a box for mounting in ceilings. Base shall be 1-1/2 inch deep. The cover shall be secured by two screws that can be easily removed for damper adjustment.

- d. Furnish and install end bearings for the damper rods on the end opposite the quadrant.
5. Spin-in fittings may be used for duct taps to air devices and shall include dampers on all duct to air devices (diffusers and grilles) even though a volume damper is specified for the air device. Spin-in fittings shall be similar to Flexmaster FLD with BO3 including a 2 inch buildout, nylon bushings, locking quadrant similar to Duro Dyne KR-3, and a 3/8 inch square rod connected to the damper with U-bolts. Spin-in fittings shall be sealed at the duct tap with sealant as specified herein. Determine location of spin-in fittings after terminal units are hung or after location of light fixtures are confirmed to minimize flexible duct lengths and sharp bends.

C. Fire Dampers

1. Each fire damper shall be constructed and tested in accordance with Underwriters Laboratories Safety Standard 555, latest edition. Dampers shall possess a 1-1/2 hour or 3 hour (as appropriate for the construction shown in the architectural Drawings) protection rating, 160 or 165 degrees F fusible link, and shall bear a U.L. label in accordance with Underwriters' Laboratories labeling procedures. Construct fire dampers such that damper frame material and curtain material are galvanized.
2. Fire dampers shall be curtain blade type and damper shall be constructed so that the blades are out of the air stream to provide 100 percent free area of duct in which the damper is housed.
3. Equip fire dampers for vertical or horizontal installation as required by location shown on Drawings. Install fire dampers in wall and floor openings utilizing steel sleeves, angles and other material and practices as required to provide an installation equivalent to that utilized by the manufacturer when the respective dampers were tested by Underwriters Laboratories. Mounting angles shall be minimum 1-1/2 inch by 1-1/2 inch by 14 gage and bolted, tack welded or screwed to the sleeve at maximum spacing of 12 inches and with a minimum of two connections at all sides. Mounting angles shall overlap at least equal to the duct gage as defined by the appropriate SMACNA Duct Construction Standard, latest edition, and as described in NFPA 90A. The entire assembly, following installation, shall be capable of withstanding 6 inch water gauge static pressure.
4. All fire dampers shall be dynamic rated type.
5. Completely seal the damper assembly to the building components using manufacturer recommended material(s).

D. Combination Fire / Smoke Dampers

1. Provide one damper motor for each 12 square feet of damper area.
2. Each combination fire/smoke damper shall be 1-1/2 hour fire rated under UL Standard 555, Current Edition, and shall be further classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems under the latest version of UL555S, and bear a UL label attesting to same. Damper manufacturer shall have tested

and qualified with UL, a complete range of damper sizes covering all dampers required by this Specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be no higher than Leakage Class II (4 CFM per square foot at one-inch water gauge pressure and 8 CFM per square foot at 4 inches water gauge pressure). Maximum air pressure drop through each combination fire/smoke damper shall not exceed 0.10-inch water gauge at the design air quantity. (Note that this may require a larger damper than the connected duct size.) All ratings shall be dynamic.

3. Damper frame shall be minimum 20-gage galvanized steel formed into a structural hat channel shape with tabbed corners for reinforcement, as approved in testing by Underwriters Laboratories. Bearings shall be integral high surface area non electrolytic materials construction to incorporate a friction free frame blade lap seal, or molybdenum disulfide impregnated stainless steel or bronze oilite sleeve type turning in an extruded hole in the frame or an extruded frame raceway. Dampers may be either parallel or opposed blade type. Blades shall be constructed with a minimum of 14-gage equivalent thickness. Blade edge seal material shall be able to withstand 450 degrees F. Jamb seals shall be flexible stainless steel compression type or lap seal type.
4. In addition to the leakage ratings specified herein, combination fire/smoke dampers and their operators shall be qualified under UL555S to an elevated temperature of 350 degrees F. Electric operators shall be installed by the damper manufacturer at the time of damper fabrication. Damper and operator shall be supplied as a single entity that meets all applicable UL555 and UL555S qualifications for both dampers and operators. Manufacturer shall provide a factory-assembled sleeve. Sleeve shall be minimum 20-gage for dampers where neither width nor height exceeds 48 inches or 16-gage where either dimension equals or exceeds 48 inches.
5. As part of the UL qualification, dampers shall have demonstrated a capacity to operate (open and close) under HVAC system operation conditions, with pressures at least 4 inches water gauge in the closed position, and 2500 fpm air velocity in the open position.
6. Each combination fire/smoke damper, except as noted hereinafter, shall be equipped with a UL Classified firestat/releasing device. The firestat/releasing device shall electrically (24 or 120 VAC) and mechanically (pneumatically) lock the damper in a closed position when the duct temperatures exceed 165 degrees F and still allow the appropriate authority to operate the damper as may be required for smoke control functions. Damper must be operable while the temperature is above 350 degrees F. Actuator/operator package shall include two damper position indicator switches linked directly to damper blade to provide capability of remotely indicating damper position. One switch shall close when the damper is fully open, and the other switch shall close when the damper is fully closed. The firestat/releasing device and position indicator switches shall be capable of interfacing electrically with the smoke detectors, building fire alarm system, and remote indicating/control stations or building automation system (BAS).

7. Damper releasing device shall be mounted within the airstream. Device shall be activated and the damper shall close and lock when subjected to duct temperatures in excess of approximately 285 degrees F.
8. Motors for operation of smoke dampers shall be smoke system fail safe, spring return normally open supplies and normally closed returns, or as indicated on the Drawings, and shall be furnished and installed by the damper manufacturer as required by the U.L. rating mentioned above. Motors shall be electric or pneumatic to match the type of temperature control system specified elsewhere in this Specification. Furnish all required relays, EP switches, wiring piping and other labor and material necessary to completely interconnect the smoke detector system.
9. Furnish each damper in a square or rectangular configuration. Furnish and install sleeves manufactured by the approved damper manufacturer for each damper. Construct sleeves with square or rectangular to square, rectangular, round, or oval adapters as required. Dampers shall be installed in the sleeves in accordance with manufacturer's U.L. installation instructions. The entire assembly, following installation, shall operate smoothly and be capable of withstanding 6 inch water gauge static pressure.
10. Each combination fire/smoke damper shall be equipped with a Damper Test Switch. The damper test switch will have the ability to "cycle test" the fire/smoke damper by pushing and holding the test button until the damper has cycled.
11. All combination fire/smoke dampers shall be dynamic type.
12. Completely seal the damper assembly to the building components using manufacturer recommended material(s).

E. Smoke Dampers

1. Smoke Dampers meeting the following specifications shall be furnished and installed where shown on plans and/or as described in schedules. Dampers shall meet the requirements of NFPA 92A, 92B, 101 & 105 and further shall be tested, rated and labeled in accordance with the latest edition of UL Standards 555S. Dampers shall have a low leakage design qualified to UL555S Leakage Class I.
2. Each damper /actuator combination shall have a UL555S elevated temperature rating of 250°F (121°C) minimum and shall be operational at maximum design air flow at its installed location. Each damper shall be supplied with an appropriate actuator installed by the damper manufacturer at the time of damper fabrication. Damper actuator shall be electric type for 120 Volt operation.
3. Damper blades shall be 16 ga. (1.5mm) galvanized steel 3V type with three longitudinal grooves for reinforcement. Damper frame shall be galvanized steel formed into a structural hat channel shape with reinforced corners. Bearings shall be sintered bronze sleeve type rotating in extruded holes in the damper frame. Blade edge seals shall be silicone rubber designed to inflate and provide a tighter seal against leakage as pressure on either side of the damper increases. Jamb seals shall be stainless steel compression

type. Blades shall be completely symmetrical relative to their axle pivot point, presenting identical resistance to airflow in either direction or pressure on either side of the damper.

4. The Damper Manufacturer's submittal data shall certify all air performance pressure drop data is licensed in accordance with the AMCA Certified Ratings Program for Test Figures 5.2, 5.3, and 5.5. Damper air performance data shall be developed in accordance with the latest edition of AMCA Standard 500-D. Dampers shall be labeled with the AMCA Air Performance Seal.
5. Damper must be rated for mounting horizontally and be UL 555S rated for leakage and airflow in either direction through the damper.
6. Each smoke damper shall be equipped with a Damper Test Switch. The damper test switch will have the ability to "cycle test" the smoke damper by pushing and holding the test button until the damper has cycled.

F. Flexible Connections

1. Where ducts connect to, flexible connections shall be made using "Flexmaster TL-M" or "Ventglas" fabric that is temperature-resistant, fire-resistant, waterproof, mildew-resistant and practically airtight, weighing approximately thirty ounces (30 oz.) per square yard. Ventglas is good for connections for inside building environments where ultra-violet light is not present.
2. Material used outdoors shall be resistant to ultra-violet sunrays. There shall be a minimum of one-half inch (1/2-inch) slack in the connections, and a minimum of two and one-half inches (2-1/2-inch) distance between the edges of the. This does not apply to air handling units with internal isolation. A more rugged flexible material that is resistant to ultra violet rays needs to be used when connecting an exhaust fan or exhaust air plenum to ductwork. Mercer Rubber supplies a more durable flex connection for outdoor use.

G. Access Doors

1. Furnish and install in the ductwork, hinged rectangular, pressure relief, or round "spin-in" access doors to provide access to all fire dampers, mixed air plenums, steam reheat coils (install upstream), automatic dampers, etc.
2. Where ductwork is insulated, access doors shall be double skin doors with one inch (1") of insulation in the door.
3. Where duct size permits, doors shall be eighteen inches (18") by sixteen inches (16"), or eighteen inches in diameter, and shall be provided with Ventlok No. 260 latches (latches are not required in round doors).
4. Latches for rectangular doors smaller than 18 inch x 16 inch shall be Ventlok No. 100 or 140.

5. Doors for zone heating coils shall be Ventlok, stamped, insulated access doors, minimum 10 inch x 12 inch, complete with latch and two (2) hinges, or twelve inches (12") in diameter.
6. Round access doors shall be "Inspector Series" spin-in type door as manufactured by Flexmaster USA.
7. Doors for personnel access to ductwork shall be nominal twenty-four inches (24") in diameter. Doors may be fabricated in a local approved sheet metal shop in accordance with SMACNA Standards.
8. Where access doors are installed above a suspended ceiling, this Contractor shall be responsible for the proper location of ceiling access doors.

H. Screens

1. Furnish and install screens on all duct, fan, etc., openings furnished by this Contractor which lead to, or are located outdoors.
2. Screens shall be No. 16 gage, one-half inch (1/2") mesh in removable galvanized steel frame.
3. Provide safety screens meeting OSHA requirements for protection of maintenance personnel on all fan inlets and fan outlets to which no ductwork is connected.

I. Diffusers, Registers, & Grilles

1. Furnish and install diffusers, registers, and grilles as scheduled and shown on drawings. If a manufacture other than the one scheduled is used, the sizes shown on the drawings shall be checked for performance, noise level, face velocity, throw, pressure drop, etc. before the submittal is made. Selections shall meet the manufacturer's own published data for the above criteria. The throw shall be such that the velocity at the end of the throw in the (5) foot occupancy zone will not exceed 50 fpm nor be less than 25 fpm except where indicated otherwise. Noise levels shall not exceed those published in ASHRAE for the type of space being served (NC level). In the vicinity of lab hood terminal velocity at face of hood shall not exceed 20 fpm.
2. Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical.
3. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.
4. Provide all specialties and frames for air distribution devices as required for proper installation in ceiling type as indicated on Architectural Drawings. Provide all cutting and patching of T-bars, gypsum board, and other ceiling systems as required for installation of air devices.
5. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed before starting air balancing.

6. Coordinate color and finish of the devices with the Architect.
7. Paint ductwork visible behind air outlets and inlets matte black.

2.6 TEMPERATURE CONTROLS

- A. Provide a complete, low voltage (24 VAC) control system for each unit. The HVAC Contractor is responsible for all control work, including all wiring and conduit, which must be installed in accordance with Division 26. Condensing unit control wiring shall be routed parallel to the associate refrigerant tubing. Tie-Strap loose control wires to the refrigerant tubing.
- B. Furnish and install U.L. listed duct mounted firestat with factory setting of 135F, for units delivering 2000 cfm or more, to shut down the blowers when fire is detected.

2.7 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

2.8 DELIVERY, STORAGE, AND PRODUCT HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Deliver products to the project at such time as the project is ready to receive the equipment or pipe, properly protected from incidental damage and weather damage.
- C. Damaged equipment or pipe shall be promptly removed from the site and new, undamaged equipment or pipe shall be installed in its place promptly with no additional charge to the Owner.

2.9 FLASHINGS, SLEEVES, AND INSERTS

- A. Furnish and install flashings where ducts or pipes pass through outside walls. Flashings shall be properly formed to fit around ducts or pipes and shall be caulked, with 790 Silicone Building Sealant by Dow Corning Corporation, so as to make watertight seal between conduit and building.
- B. Unless otherwise specified, install sleeves for each conduit where it may pass through interior walls or flows. Galvanized 22-gauge sheet iron sleeves shall be used. Finish flush with each finished wall surface. In pipe chases, the sleeve shall extend 1-1/2" inches above floor slab and shall be watertight.
- C. Raceways that pass through concrete beams or walls and masonry exterior walls shall be provided with galvanized wrought iron pipe sleeve, unless shown otherwise on drawings. Inside diameter of these sleeves shall be at least 1/2" greater than outside diameter of service pipes. After pipes are installed in these sleeves, fill annular space between pipes and sleeves with 790 Silicone Building Sealant by Dow Corning Corporation. Completed installation shall be watertight.

2.10 CUTTING AND PATCHING

- A. The Contractor shall coordinate work to eliminate cutting of the construction except as specified. Where it becomes necessary to cut through the construction to permit the installation of work or the repair of defective work, it shall be performed by trades specializing in the type of work involved.
- B. Request for Engineer's consent:
 - 1. Prior to cutting which affects structural safety, submit a written request to Engineer for written permission to proceed with cutting.
 - 2. When conditions of Work or schedule require a change of materials or methods for cutting and patching, notify Engineer and secure written permission to proceed with work.
- C. Perform, Architect-approved, cutting and patching by methods which will prevent damage to other portions of the work and provide proper surfaces to receive installation of new work and/or repair.
 - 1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect. Impact-type equipment will not be used except where specifically acceptable to the Architect.
 - 2. Openings in precast concrete slabs or walls for pipes, etc., shall be core drilled to exact size. Oversize the hole to allow for link seals, and to deter pipe corrosion condensation from forming.
 - 3. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect.
 - 4. Openings cut through plaster or drywall shall be cut prior to plaster finish coat or texture coat on drywall. Cutting of the finish coat of plaster or texture coat of drywall will not be permitted unless written approval of the Architect is obtained.
 - 5. Openings shall be restored and/or repaired as required to replace the cut surface to an "as-new" and/or "as original" condition. Refer to the appropriate section of the specifications for the material involved.
- D. Perform fitting and adjusting of products to provide finished installation complying with the specified tolerances and finishes.

2.11 INSTALLATION OF DUCTWORK

- 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. Prior to the installation of any ceiling material, gypsum, plaster or acoustical board, the Contractor shall notify Owner's Project Manager so that arrangement can be made for an inspection of the above-ceiling area about to be "sealed" off. The Contractor shall provide written notification to the Owner at least five (5) calendar days prior to the inspection.
- D. Precedence of Materials:
1. The Specifications determine the nature and setting of materials and equipment. The Drawings establish quantities, dimensions and details.
 2. If interference is encountered, the following installation precedence of materials shall guide the Contractor to determine which trade shall be given the "Right of Way":
 - a. Building lines
 - b. Structural members
 - c. Structural support frames supporting ceiling equipment
 - d. Electric tracked vehicle system
 - e. Pneumatic trash and linen system
 - f. Pneumatic tube system
 - g. Soil and drain piping
 - h. Vent piping
 - i. Supply, return and outside air ductwork
 - j. Exhaust ductwork
 - k. HVAC water and steam piping
 - l. Condensate piping
 - m. Fire protection piping
 - n. Natural gas piping
 - o. Medical/Laboratory gases
 - p. Domestic water (cold and hot, softened, treated)
 - q. Refrigerant piping
 - r. Electrical conduit
 3. Cleanliness:
 - a. Before installing ductwork, wipe ductwork to a visibly clean condition.
 - b. During construction, provide temporary closures of metal or taped polyethylene on open ductwork and duct taps to prevent construction dust or contaminants from entering ductwork system. Seal ends of ductwork prior to installation to keep ductwork interior clean. Remove closures only for installation of the next duct section.

- c. During duration of construction, maintain the integrity of all temporary closures until air systems are activated.
- 4. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- 5. Support flexible ducts as per SMACNA standards to prevent sags, kinks and to have 90 degree turns.
- 6. Hangers and Supports:
 - a. All ductwork supports shall be in accordance with Table 4-1 (rectangular duct) and Table 4-2 (round duct) of the SMACNA Standards, with all supports directly anchored to the building structure.
 - b. Rectangular duct shall have at least one pair of supports on minimum 8'-0" (eight feet) centers. All horizontal round and flat oval ducts shall have ducts hangers spaced 10'-0" (ten feet) maximum.
- 7. Lower attachment of hanger to duct shall be in accordance with Table 4-4 of the SMACNA Standards.
- 8. Vertical ducts shall be supported where they pass through the floor lines with 1-1/2 inch x 1-1/2 inch x 1/4 inch angles for duct widths up to 60 inches. Above 60 inches in width, the angles must be increased in strength and sized on an individual basis considering space requirements.
- 9. Hanger straps on duct widths 60 inches and under shall lap under the duct a minimum of 1 inch and have minimum of one fastening screw on the bottom and two on the sides.
- 10. Hanger straps on duct widths over 60 inches shall be bolted to duct reinforcing with 3/8 inch bolts minimum.

2.12 INSTALLATION OF DUCTWORK ACCESSORIES

- 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 balancing dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing.
- D. Provide fire dampers, and combination fire and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Provide backdraft dampers on exhaust fans or exhausts ducts where indicated. Install dampers so that they will open freely.
- F. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment. Cover connections to medium and high pressure fans with leaded vinyl sheet, held in place with metal straps.

- G. Provide duct access doors for inspection and cleaning before and after duct mounted filters, coils, fans, automatic dampers, at fire dampers, and elsewhere as indicated on Drawings. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as indicated.
- H. Access doors as specified elsewhere shall be provided for access to all parts of the fire and combination fire and smoke dampers. Doors shall open not less than 90 degrees following installation and shall be insulated type where installed in insulated ducts.
- I. Install each fire and combination fire and smoke damper square and true to the building. The installation shall not place pressure on the damper frame, but shall enclose the damper as required by UL555 and UL555S.

2.13 EQUIPMENT ACCESS

- A. Install ductwork, equipment, and accessories to permit access for maintenance. Relocate items as necessary to provide such access, and without additional cost to the Owner.
- B. Provide access doors where valves, motors, or equipment requiring access for maintenance are located in walls or above ceilings. Coordinate location of access doors with other trades as required.

2.14 TESTING

- A. Provide Testing Adjusting & Balancing of HVAC Systems in accordance Section 230593 Testing Adjusting & Balancing and as follows.
- B. All medium and high pressure duct systems (positive or negative) shall be pressure tested according to SMACNA test procedures (HVAC Air Duct Leakage Test Manual). Notify Owner minimum seven (7) calendar days in advance of leakage testing.
 - 1. Design pressure for testing ductwork shall be determined from the maximum pressure generated by the fan at the nominal motor horsepower selected.
 - 2. Total allowable leakage shall not exceed 1 percent of the total system design airflow rate.
 - 3. When partial sections of the duct system are tested, the summation of the leakage for all sections shall not exceed the total allowable leakage.
 - 4. Leaks identified during leakage testing shall be repaired by:
 - a. Complete removal of the sealing materials.
 - b. Thorough cleaning of the joint surfaces.
 - c. Installation of multiple layers of sealing materials.
 - 5. The entire ductwork system shall be tested, excluding connections upstream of the terminal units (i.e. ductwork shall be capped immediately prior to the terminal units, and tested as described above).
 - 6. After testing has proven that ductwork is installed and performs as specified, the terminal units shall be connected to ductwork and connections sealed with extra care.

Contractor shall inform the Owner when joints may be visually inspected for voids, splits, or improper sealing of the joints. If any leakage exists in the terminal unit connections/joints after the systems have been put into service, leaks shall be repaired as specified for other leaks.

7. Fixed flow measurement devices (i.e. orifice tubes, nozzles, etc.) shall have current calibration documentation showing that the device was verified to a National Institute Of Standards and Technology (NIST) standard within the previous five years or as recommended by the manufacture and be accurate to at least +/- 2% of reading.
 8. Pressure measurement instrumentation (i.e. manometer) shall have current calibration documentation showing that the device was verified to a NIST standard within the previous year or as recommended by the manufacture. Instrumentation shall have an accuracy of at least +/- 2% of reading and have a resolution of 2:1 with respect to the measured pressure (i.e. resolution of 0.01 measured 0.1).
- C. All low-pressure duct systems (positive or negative) shall be inspected for visible and audible signs of leakage.
1. Leaks identified by inspection shall be repaired by:
 - a. Complete removal of the sealing materials.
 - b. Thorough cleaning of the joint surfaces.
 - c. Installation of multiple layers of sealing materials.
 2. Discrepancies found during testing and balancing between duct traverses and diffuser/grille readings shall result in re-inspection, repair and retest until discrepancies are eliminated.
- D. At the option of the Owner, if documented in writing, Contractor may be allowed to eliminate testing of terminal units by capping the supply ductwork prior to the terminal units, then inspecting the connection to the terminal units when complete. This option may only be exercised by the Owner, only if documented in writing prior to testing.]
- E. Ductwork leakage testing and/or inspection shall be performed prior to installation of external ductwork insulation.
- F. After each fire damper, smoke damper and combination fire and smoke damper has been installed and sealed in their prescribed openings and prior to installation of ceilings, Contractor shall, as directed by Owner, activate part or all dampers as required to verify “first-time” closure.
- G. Activation of damper shall be accomplished by manually operating the resettable link, disconnecting the linkage at the fire damper fusible link, and manually operating the fire/smoke damper through the pneumatic or electronic controls as appropriate.
- H. Failure of damper to close properly and smoothly on the first attempt will be cause to replace the entire damper assembly.
- I. Coordinate smoke damper system interlock requirements with the fire alarm system.

2.15 OPERATION AND MAINTENANCE DATA

- A. Submit two copies of preliminary draft of proposed manual or manuals to Engineer for review and comments. Allow minimum of 10 working days for review.
- B. Submit approved manual to Engineer prior to indoctrination of operation and maintenance personnel.
- C. Where instruction manuals are required for submittal, they shall be prepared in accordance with the following:

Format

Size: 8-1/2" x 11"

Paper: White Bond, at least 20 lb.

Text: weight Neatly written or printed.

Drawings: 11" in height preferable; bind in with text; foldout

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

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

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

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

OPERATING AND MAINTENANCE INSTRUCTIONS

Name and Address of Work

Name of Contractor

General subject of this manual

Space for approval signature of Engineer and approval date[s]

- E. Contents: Include at least following:
 - 1. Neatly typewritten index near front of Manual, giving immediate information as to location within manual of emergency information regarding installation.
 - 2. Complete instructions regarding operation and maintenance of equipment involved including lubrication, disassembly, and reassembly.
 - 3. Complete nomenclature of parts of equipment.

4. Complete nomenclature and part number of replaceable parts, name and address of nearest vendor and other data pertinent to procurement procedures.
5. Copy of guarantees and warranties issued.
6. Manufacturer's bulletins, cuts, and descriptive data, where pertinent, clearly indicating precise items included in this installation and deleting, or otherwise clearly indicating, manufacturers' data with which this installation is not concerned.
7. Other data as required in pertinent Sections of these Specifications.

2.16 WARRANTY

- A. Warrant equipment and workmanship for period of one year after date of substantial completion and replace or repair faulty equipment or installation at no cost to Owner for service during this period.
- B. Warranty shall not void specific warranties issued by manufacturers for greater periods of time or void rights guaranteed to Owner by law.
- C. Warranties shall be in writing in form satisfactory to Owner, and shall be delivered to Owner before final payment is made.

2.17 PROJECT COMPLETION

- A. Upon completion of Work of this Division, thoroughly clean exposed portions of mechanical installation, removing traces of soil, labels, grease, oil, and other foreign material, and using only type cleaner recommended by manufacturer of item being cleaned.
- B. Thoroughly indoctrinate owner's operation and maintenance personnel in contents of operations and maintenance manual required to be submitted as part of this division of these specifications, recommended by manufacturer of item being cleaned.
- C. Date of final acceptance shall be the date documented in writing and signed by Architect / Engineer.

END OF SECTION 23 00 00

SECTION 26 00 00

BASIC ELECTRICAL REQUIREMENTS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS:

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division-1 Specification sections, apply to work of this section.
- B. The Contractor shall familiarize himself with all drawings and specifications and properly use information found on the Architectural, Civil, Utility, Structural, Mechanical, and Electrical drawings and specifications affecting his work.
- C. Verify all standard practices of the electric utility company and requirements for electric metering and provide metering to conform to the requirements. Furnish necessary labor to install all equipment supplied by the electric utility company and furnish and install other materials and equipment as required.
- D. Verify all standard practices of the electric utility company and requirements for electric metering and provide metering to conform to the requirements. Furnish necessary labor to install all equipment supplied by the electric utility company and furnish and install other materials and equipment as required.
- E. Verify all standard practices of the Telecommunication's company.

1.2 SUMMARY

- A. Work Included: Provide complete electrical systems as shown on drawings, as specified herein, and as needed for complete and proper installation, including but not necessarily limited to the following summary of Work.
 - 1. Furnish and install a complete **Power and Lighting System** to include: main switchboard, panelboards, disconnects, wiring, conduits, pull and junction boxes, outlet boxes, receptacles, switches, light fixtures, lamps, and etc. as required for a complete and operating system.
 - 2. Furnish and install a **Data Network System** to include conduit, outlet boxes, pull cords, wiring and etc. as required for a complete raceway system.
- B. It is the intent of the Contract Documents to provide an installation complete in every respect. If additional work is required for Work indicated or specified, it shall be the responsibility of the Contractor to provide same, as well as to provide material and equipment usually furnished with such systems or as required to complete the installation.

1.3 ELECTRICAL CODES, STANDARDS, AND SYMBOLS

- A. All work shall be in accordance with the latest edition of the following codes:
 - 1. National Electrical Code
 - 2. International Building Code
 - 3. International Fire Code
 - 4. International Energy Code
 - 5. Texas Accessibility Standards (TAS).
- B. Local governing codes and authorities, trade association standards and publications are an extension of the contract documents, and are hereby imposed as applicable to the work in each instance.
- C. Where local codes, ordinances, rules or authority conflicts with associations and standards listed hereinafter, the local ordinances, codes, rules or authorities take precedence.
- D. Standards: Specifications and Standards of the following organizations are by reference made part of these Specifications. Unless otherwise indicated, shall comply with requirements and recommendations wherever applicable:
 - 1. Association of Edison Illuminating Companies (AEIC)
 - 2. American National Standards Institute (ANSI)
 - 3. American Society of Mechanical Engineers (ASME)
 - 4. American Society for Testing and Materials (ASTM)
 - 5. Certified Ballast Manufacturers (CBM)
 - 6. Electrical Testing Laboratories (ETL)
 - 7. Institute of Electrical and Electronic Engineers (IEEE).
 - 8. Insulated Power Cable Engineers Association (IPCEA)
 - 9. National Bureau of Standards (NBS)
 - 10. National Electrical Contractors Association (NECA)
 - 11. National Electrical Manufacturer's Association (NEMA)
 - 12. National Fire Protection Association (NFPA)
 - 13. Radio-Television Manufacturer's Association (RTMA)
 - 14. Reflector Luminaire Manufacturers (RLM)
 - 15. Underwriters' Laboratories, Inc. (UL)
- E. The listing (or legend) of specific graphic symbols used to show the electrical work on the contract documents is shown on the drawings.

1.4 QUALITY ASSURANCE

- A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section. Electrical Contractor shall have an Electrical Contractor License as issued by Texas Department of Licensing and Regulation.
- B. Provide only materials that are new, of the type and quality specified. Where Underwriters' Laboratories, Inc. has established standards for such materials, provide only materials bearing the UL label.
- C. The size of electrical equipment indicated on the Drawings is based on the dimensions of a particular manufacturer. While other manufacturers may be acceptable, it is the responsibility of the Contractor to determine if the equipment he proposes to furnish will fit in the space. Fabrication Drawings shall be prepared when required by the Architect/Engineer or Owner to indicate a suitable arrangement.
- D. The Contractor shall be responsible for fitting his material and apparatus into the building and shall carefully lay out his work at the site to conform to the structural conditions, to avoid all obstructions, to conform to the details of the installation and thereby to provide an integrate satisfactory operating installation. The contractor must support all duct, pipe, equipment, and all other items furnished and installed under this scope from steel joists or structural steel frames. It is prohibited to support duct, pipe, equipment, and any other items furnished under this scope from the metal deck.
- E. Where installation instructions are not included in the Contract Documents, the manufacturer's instructions shall be followed.

1.5 SUBMITTALS

- A. Comply with pertinent provisions of Submittals in Specifications.
- B. Provide Manufacturer's specifications and other data needed to prove compliance with specified requirements. Term "Compliance" is understood to mean that Contractor certifies that submitted equipment meets or exceed Contract Document requirements. Items that do not clearly meet this definition should be identified and explained as required in following paragraph.
- C. Identify difference between specified item and proposed item. Explain with enough detail so that it can easily be determined that item complies with functional intent. List disadvantages or advantages of proposed item versus specified item. Submit technical data sheets and/or pictures and diagrams to support and clarify. Organize in clear and concise format. Substitutions shall be approved in writing by Engineer. Engineer's decision shall be final.
- D. Allow a minimum of 10 working days for review of each submittal and re-submittal.
- E. Items of equipment that are not accepted in writing as approved equal shall be replaced or revised to comply with Contract Documents at Contractor's expense.

- F. The manufacturers recommended installation procedures shall become basis for accepting or rejecting actual installation procedures used on Work.
- G. Shop drawing shall consist of detailed drawings with dimensions, schedules, weights, capacities, installation details, and pertinent information needed to describe the material or equipment.
- H. Submittals required of materials and equipment under this Division include following listed items not supplied by Owner. These submittal requirements are intended to be complimentary to requirements that may be listed in individual sections. In event of conflict more stringent requirements shall apply.
 - 1. Switchboards
 - 2. Panelboards
 - 3. Disconnect Switches
 - 4. Contactors
 - 5. Light Fixtures
 - 6. Time Clocks
 - 7. Occupancy Sensor
 - 8. Photocells

1.6 SUBSTITUTIONS

- A. The use of manufacturers' names and catalog numbers followed by the phrase "or equal" is generally used to establish a standard of quality and utility for the specified items and to provide a dimensional reference for construction documents that are drawn to scale.
- B. Submittals for "equal" items shall, where applicable, include the following data that are not necessarily required for specified items:
 - 1. Performance characteristics.
 - 2. Materials
 - 3. Finish
 - 4. Certification of conformance with specified codes and standards.
- C. Submittals of "equal" components or systems may be rejected if:
 - 1. The material or equipment would necessitate the alteration of any portion of the mechanical, electrical, architectural or structural design.
 - 2. Dimensions vary from the specified material or equipment in such a manner that accessibility or clearances are impaired or the work of other trades is adversely affected.

1.7 COMPATIBILITY OF EQUIPMENT

- A. Assume full responsibility for satisfactory operation of component parts of electrical systems. Assure compatibility of equipment and performance of integrated systems in accordance with requirements of the Construction Documents. Notify the Engineer before submitting a bid should Specifications or Drawings make acceptance of responsibility impossible, prohibitive, or restrictive.

1.8 PERMITS, UTILITY CONNECTIONS AND INSPECTIONS

- A. Procure all permits and licenses necessary for completion of this project and pay all lawful fees required and necessary pursuant in obtaining said permits and licenses. All required certificates of approvals and inspections by local governing and regulating authorities shall be obtained and paid for by the contractor.
- B. Pay all fees required for the connection of utility power, telephone, and cable TV required for the Work.

1.9 UTILITIES AND TEMPORARY POWER

- A. Verify location and capacity of all existing utility services before starting Work. The locations and sizes of electrical lines are shown in accordance with data secured from Owner's survey, site visits, or record drawings. The data shown is offered as an estimating guide without guarantee of accuracy.
- B. Pay all utility charges for temporary power. Provide temporary lighting and power required. Install in accordance with OSHA and governing code requirements

1.10 COORDINATION

- A. The Contractor shall not hinder and/or delay any work being accomplished by other Divisions at or near the general construction site; nor shall the Contractor impede normal operation of the Owner at any time except as coordinated and scheduled in writing.
- B. The Contractor shall make electrical connections to equipment installed by other Divisions.
- C. The mechanical contractor shall install all motor driven equipment and motors furnished under this contract.
- D. The Contractor shall verify the electrical requirements of equipment and appliances furnished by others with data provided by the successful vendor or vendors.
 - 1. The Contractor shall provide (unless indicated otherwise or provided with packaged factory equipment) manual, magnetic, or combination starters of the sizes and types required for operations shown on the drawings, specified herein or otherwise required for the equipment. All starters shall comply with pertinent requirements of NEMA and NEC.
 - 2. The Contractor shall also provide proper sized circuits, circuit breakers, disconnect switches, receptacles, etc. as required to connect this equipment. If changes are required to electrical systems shown on the drawings, the Contractor shall make these changes at no additional cost to Owner.

1.11 ELECTRICAL IDENTIFICATION

- A. All conductors and circuits shall be color coded as specified and in accordance with the National Electrical Code.
- B. All conductors connected to 120/208 Volt, 3-Phase distribution system shall be color coded as follows:
 - Phase 1 - Black
 - Phase 2 - Red
 - Phase 3 - Blue
 - Neutral - White
 - Ground - Green(Green conductors shall be used for GROUNDING PURPOSE ONLY.)
- C. All conductors connected to 277/480 Volt, 3 phase, 4 wire distribution system shall be color coded as follows:
 - Phase 1 - Brown
 - Phase 2 - Orange
 - Phase 3 - Yellow
 - Neutral - Gray
 - Ground - Green(Green conductors shall be used for GROUNDING PURPOSE ONLY.)
- D. All conductors larger than No. 4 may be color coded by taping of black conductors with the proper color tape where exposed in panel box, junction boxes, pull boxes, etc.
- E. Provide engraving stock melamine plastic laminate, complying with FS L-P-387, engraved with engraver's standard letter style unless otherwise indicated. Plastic laminate shall be 1/16" thick up to 20 sq. in. and 1/8" for larger size. Letters shall be 1/2" high, black on white background.
- F. Underground-type plastic line markers shall be permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates the type of service of the buried cable.
- G. During backfilling/top-soiling of each exterior underground electrical and communication conduit, install a continuous underground-type plastic line marker, located directly over the buried conduit at 6" to 8" below finished grade.
- H. Wherever reasonably required to ensure safe and efficient operation and maintenance of the electrical systems, and electrically connected mechanical systems and general systems and equipment, including the prevention of misuse of electrical facilities by unauthorized personnel, install engraved plastic signs bearing identification, instruction or warnings on switches, outlets and other controls, devices and covers of electrical enclosures.
- I. Install danger signs required by governing regulations and authorities.

- J. Identify with engraved laminated nameplates, designating load served, on each electrical item on the project. Items to be identified and location of nameplates are as follows:
1. Each main circuit breaker -- adjacent to circuit breaker.
 2. Each circuit breaker in each distribution panel -- adjacent to circuit breaker. Spares shall be labeled "Spare".
 3. Each lighting and appliance panel -- panel name on panel trim cover immediately above panel door. Circuit numbers shall be permanently labeled at factory. Stick-on decals for field installation are not acceptable. Each panel shall be provided with a typewritten circuit directory in each panel door identifying each breaker and the equipment served.
 4. Each disconnect switch -- on outside of cover.
 5. Each relay cabinet -- on outside of cover.
 6. Each time clock -- on outside of cover.
 7. Each dry type transformer -- on outside of enclosure.
 8. Nameplates shall be securely attached with an approved mechanical fastener. Adhesive attachment shall not be permitted.
 9. The appropriate panel and circuit number shall be custom engraved with 1/8" lettering on the front of all switch and receptacle faceplates. J-boxes for circuiting distribution shall also indicate panel and circuit numbers on front of wall cover plates where J-boxes are above ceiling and on back for exposed J-boxes.

PART 2 - MATERIALS

2.1 WIRING AND POWER FOR EQUIPMENT FURNISHED BY OTHERS

- A. Power wiring shall be furnished and installed by this Contractor for any air conditioning equipment, plumbing equipment, kitchen equipment, equipment furnished by Owner, or other equipment requiring electrical connection, unless specifically called out in specifications or plans to be provided by others.
- B. Mechanical Contractor shall furnish and Electrical Contractor shall install magnetic starter with each motor furnished under Mechanical Section of the documents. (Starters indicated furnished in motor control centers on electrical drawings shall be by Electrical Contractor). Electrical Contractor shall provide all power and wiring for mechanical work. If power required for the equipment furnished by Mechanical Contractor differs from that submitted or shown on the electrical drawings, Mechanical Contractor shall be responsible for cost of any required changes in breakers, starters, wiring, etc., required to serve the particular equipment.
- C. The Electrical Contractor shall furnish and install all wire pertaining to the temperature control system and leave adequate lengths of wire at each device for final connections to be made by the Mechanical Contractor. The Electrical Contractor shall coordinate locations, types, and number of wires, etc. with the Mechanical Contractor prior to rough-in.

2.2 ELECTRIC SERVICE

- A. Building electric services shall be as noted on drawings. Coordinate all work with local utility company.

2.3 NETWORK RACEWAYS

- A. Provide raceways, conduits and terminal boxes. Provide empty conduit with pull wire from outlet location to above ceiling (or other location as indicated on drawings) and interconnecting conduits.

2.4 CONCRETE

- A. Provide strength classes as follows, for the indicated applications and similar required applications:
 - B. Provide 3000 PSI Class for miscellaneous underground structural concrete, reinforced encasement, block-type foundations (with smallest dimension at least 0.2 x largest dimension), curbs, pads, and similar structural support work.
 - C. Provide 2500 PSI Class for plain encasement, filling steel-framed units, and similar work.
 - D. Install steel reinforced concrete housekeeping pad under all floor-mounted electrical equipment such as switchgear and transformers. Indoor pads shall be a minimum of 4" thick. Outdoor pads shall be a minimum of 8" thick. Reinforce all pads with No. 4 rebar 6" on center unless noted or detailed otherwise. Provide concrete pads for pad mounted transformers per Power Company specifications.
 - E. Install pad 6" larger in all dimensions than equipment supported, installed to walls, etc., to prevent dirt traps.
 - F. Trowel finish and chamfer edges 1/2".

2.5 CONDUITS AND BOXES

- A. All wiring of every description shall be installed in conduit unless specifically noted or specified otherwise. No conduit shall be smaller than 1/2" unless indicated otherwise. For each electrical raceway system, provide a complete assembly of conduit, tubing or duct with fittings including, but not necessarily limited to, connectors, nipples, couplings, locknuts, bushings, expansion fittings, other components and accessories as needed to form a complete system of the type indicated.
- B. Conduits shall be concealed in all finished parts of the building and in unfinished parts where it is possible to conceal same. The only exposed conduits that will be permitted are in the Mechanical/Electrical Equipment Rooms, and where it is absolutely impossible to serve motors without exposing the conduit. Where it is absolutely necessary to expose conduit in these areas, the conduit shall be run neatly and parallel with each other and with the lines of the building and shall be firmly secured in place by means of approved hangers, straps, and screws and expansion shields where required. Where exposed conduit is permitted, no portion of the conduit bend where conduit turns from a concealed location (below floor, above ceiling or in wall) to an exposed run shall be visible. The entire bend in all such locations shall be concealed and no portion of it exposed to view. Where conduit is exposed above surface

- mounted electrical panels, same shall be extended from panel without offsets or bends up through the ceiling in a neat manner with Unistrut members between the wall and conduit to support the conduit sufficiently distant from the wall to permit the installation of escutcheon plates without overlapping exposed ceiling grid system and chrome plated escutcheon plate provided for each conduit. Conduit shall be spaced a sufficient distance in all directions from each other to permit the installation of chrome plated escutcheons without altering or notching of escutcheons or ceiling suspension members.
- C. All conduits in and below concrete slabs shall be PVC with rigid steel risers. EMT conduit with set screw or compression fittings shall be used elsewhere in dry locations. Exposed conduits in exterior locations shall be galvanized rigid steel. All conduit shall be galvanized on both exterior surfaces and interior surfaces. All conduits shall bear the Underwriter's inspection label.

MC cable or Flex conduit will not be allowed other than where specifically stated on construction drawings or as hereinafter specified.

- D. Where conduits terminate at panels, switchboard, junction, or outlet boxes, they shall be secured thereto with two locknuts and insulating bushings or throats. All openings in conduits immediately upon installation shall be capped for protection against entry of foreign matter, pending the pulling in of wires.
- E. Joints of all conduit installed underground, in floor slabs, or in other locations subject to moisture, shall be sealed with an approved waterproof compound to insure 100% moisture tightness.
- F. This Contractor shall furnish all labor, equipment and materials to provide all flashing and counterflashing required for all conduits passing through the roof.
- G. Conduits of sufficient number and size to carry the number and size of future wires for spare breakers and spaces provided in flush panelboards shall be stubbed up above ceiling for future connection and extension. Provide minimum of (5) 1" conduits.
- H. Connections to all motors and other equipment subject to vibration, including dry type transformers, shall be made using flexible conduit not less than 4" nor more than 18" in length. Flexible conduit exposed to weather shall be liquid-tight. Liquid-tight flexible conduit and fittings shall consist of single strip, continuous, flexible, interlocked, double-wrapped steel, galvanized inside and outside, forming smooth internal wiring channel with liquid tight covering of flexible polyvinyl chloride (PVC). Connections to ceiling mounted fixtures may be made with flexible metal conduit providing the flexible conduit is not more than 36" in length and all flexible conduits is in a concealed location. No flexible conduit connections to any light fixtures will be permitted in exposed locations.
- I. Pull cords shall be left in all empty conduits.
- J. All underground conduits outside of building lines shall have 36" minimum cover unless otherwise indicated or approved. Additional depth as required by power company, telecom company, or as required to maintain clearance from other utilities.

- K. For Direct Burial in Earth Power and Communications Duct: Conduit shall be Carlon PV-Duit, Schedule 40, 90 degrees C., UL rated or approved equal. Conduit shall be composed of Polyvinyl Chloride and shall conform to NEMA standards. It shall be UL listed in conformity with Article 347 of the National Electric Code. Conduit, fittings, and cement shall be produced by the same manufacturer, who must have had at least 5 years of experience in manufacturing the products. Material must have tensile strength of 7,000 PSI at 73.4 degrees F., flexural strength of 11,000 PSI, and compressive strength of 8,600 PSI. All joints shall be solvent welded in accordance with the recommendations of the manufacturer. Provide Schedule 80 or galvanized RMC as required by utility company.
- L. No intermixing of systems will be allowed in same conduit run (i.e.: 120V with alarm, or comm. system with power, etc.).
- M. Galvanized steel interior outlet wiring boxes shall be of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.
- N. Outlet box accessories shall be as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual situations. Outlet boxes shall be supported between two studs.
- O. Corrosion-resistant cast metal weatherproof exterior outlet wiring boxes shall be of the type, shape and size, including depth of box, with threaded conduit ends, suitably configured for each application, including face plate gasket and corrosion-proof fasteners. Outlets located where subject to contact with rain or dripping water shall be equipped with a closed while-in-use weatherproof cover equal to Thomas & Betts "Red Dot" series with die-cast metal construction and NEMA 3R rating.
- P. Outlet boxes in poured concrete shall be plenum type without holes and with reset knockouts. Where extension rings are used to offset conduit between wall reinforcing steel, joint between extension ring and box shall be sealed to prevent concrete from entering box during pour.
- Q. Surface mounted outlet boxes in interior locations shall be threaded cast type with steel cover. Allow minimum of 6" clearance at flues and heat sources.
- R. Conduits running to rooftop and exterior wall mounted equipment shall be routed inside the building and stubbed out at equipment. Conduits serving loads outside new and existing buildings shall be concealed unless specifically noted otherwise.
- S. Install expansion fittings at locations subject to thermal expansion and as required by NEC.
- T. Conduits shall not be supported from acoustic ceiling supports. Wireways and gutters are not permitted except as detailed on drawings.

2.6 CONDUCTORS AND WIRING

- A. All conductors and wiring shall be in accordance with the requirements set forth in the most recent National Electric Code. Wire/conductor size shown on drawings shall not be reduced.
- B. All conductors shall be insulated and protected as required by the National Electric Code for the service to which they are used. All conductors shall be THW, THWN, THHN or XHHW. Conductors in underground conduit or conduit exposed outdoors shall be RHW, THW, THWN or XHHW unless otherwise noted or specified.
- C. Branch lighting and power conductors shall be not less than No. 12 AWG for 20 amp circuits with the farthest outlet not more than 50' length from the panelboard. 20 amp branch lighting and power circuits with farthest outlets more than 50' from panelboard shall have conductors not less than No. 10 AWG. All conductors from junction box to unit heaters and all branch circuit conductors run in wiring channel of light fixtures shall be Type "AF".
- D. Control, communication, and signal circuits shall conform in every respect with the requirements of the Control and/or Intercommunication Equipment Manufacturers. Circuit breakers and/or fuses of the proper rating for the control and/or signal conductors shall be provided to properly protect these conductors from overload.
- E. Conductors up to and including No. 10 AWG shall be solid, and sizes No. 8 AWG and larger and all control and interlocking wiring shall be stranded.

Stranded wire found in violation during any phase of construction shall be removed and replaced at no additional cost to the owner.

- F. All conductors shall be copper. Aluminum conductors are not acceptable.
- G. All wiring inside panel cabinets shall be neatly arranged, run parallel and perpendicular to the lines of the cabinets, neatly laced to hold same in place, and shall be arranged so that each conductor can be easily and readily traced from its circuit breaker to its conduit leaving the cabinet.
- H. Feeder or Branch Circuit Size Omission: In the event that an electrical feeder or branch circuit size is omitted, the Contractor shall report the same to the Engineers in time to issue an Addendum prior to bid date. If the omission is not discovered in time to issue an Addendum, the Contractor shall base his bid on installation of Conductors sized in accordance with the National Electrical Code, and protected by an overcurrent device sized per the N.E.C. (maximum of 5% total voltage drop from main switchboard to equipment). Conduit for these conductors shall be sized in accordance with the National Electrical Code. Contractor shall confirm the conduit and conductor sizes with the Architect/Engineer before purchasing or installing same.
- I. If more than three phase conductors are installed in a single raceway, the conductors shall be derated in accordance with the National Electrical Code. Increase wire size so that resulting ampacity, after derating factor is applied, is equal to or greater than ampacity of conductor specified.

J. Provide factory-fabricated, metal connectors of the size, rating, material, type and class as indicated for each service. Where not indicated, provide proper selection as required to comply with installation requirements and with NEC standards. Select from only following types, classes, kinds and styles:

1. Type:
 - a. Pressure (compression).
 - b. Threaded.
 - c. Insulated spring wire connectors with plastic caps for 10 AWG and smaller, 3M Scotchlok.
2. Class: Insulated.
3. Kind: Copper (for Cu to Cu connection).
4. Style: Pigtail connector.

Parallel and tee connectors equal to ILSCO and GTA and GTT with ILSCO insulating cover. Parallel and tee connections shall be used only where specifically detailed. (Split bolt type connectors are not permitted.)

NOTE: Connectors in outdoor lighting poles shall be insulated compression type (Scotchlok type shall not be used).

Place an equal number of conductors for each phase of a circuit in same raceway.

2.7 WIRING DEVICES

- A. Weatherproof duplex receptacles shall be GFI, rated at 20 amp, 125 volts, bear the U.L. label and be equal to "Hubbell" No. GFR5362I. Receptacles shall be mounted 18" above finished floor unless noted otherwise on plans.
- B. Where required by N.E.C. or governing code, provide ground fault circuit protection for receptacles (outdoors, washrooms, kitchen, toilets, etc.), even if not indicated on plans.
- C. Duplex receptacles shall be rated at 20 amperes, 125 volts, bear the U.L. label and be equal to Hubbell No. 5362-I. Receptacles shall be mounted 1'-3" (to bottom of box) above floor unless noted otherwise on plans. Wall switches shall be single pole rated at 20 amperes, 120/277 volts, bear the U.L. label, equal to Hubbell No. 1221-I and be the quiet type. Wall switches shall be installed 48" above floor on strike side of door unless noted or detailed otherwise.
- D. Outlets shown at cabinet work, work benches, etc., shall be installed 4" (to bottom of box) above the work surface. Where no mounting heights are shown on plans, exact location shall be verified with Architect/Engineer.
- E. Special Outlets: Electrical Contractor shall provide receptacles as required to match connection from all equipment requiring specialized plug connections; or provide disconnecting means for equipment and make a permanent connection for equipment, where codes permit.
- F. Switches and receptacles shall be manufactured by Hubbell, Leviton, Lutron, or Pass & Seymour. **No other brands will be approved.**

- G. Locations and mounting heights of any special receptacles shall be verified prior to installation.

2.8 LIGHT FIXTURES

- A. Shall be in accordance with NFPA, UL, as shown on drawings, and as specified in Lighting Fixture Schedule.

Approved light fixture manufacturers:

1. Cooper Lighting
2. Hubbell Lighting
3. Lithonia Lighting

- B. General Requirements

1. Sheet Metal:
 - a. Shall be formed to prevent warping and sagging. Housing, trim and lens frame shall be true, straight (unless intentionally curved), and parallel to each other as designed.
 - b. Wireways and fittings shall be free of burrs and sharp edges, and shall accommodate internal and branch circuit wiring without damage to the wiring.
 - c. When installed, any exposed fixture housing surface, trim frame, door frame, and lens frame shall be free of light leaks.
 - d. Hinged door frames shall operate smoothly without binding. Latches shall function easily by finger action without the use of tools.
2. Components shall be serviceable while the fixture is in its normally installed position. Ballasts / Drivers shall not be mounted to removable reflectors or wireway covers unless so specified.
3. Recessed fixtures mounted in an insulated ceiling shall be listed for use in insulated ceilings.
4. Mechanical Safety: Lighting fixture closures (lens doors, trim frame, hinged housings, etc.) shall be retained in a secure manner by captive screws, chains, aircraft cable, captive hinges, or fasteners such that they cannot be accidentally dislodged during normal operation or routine maintenance.
5. Metal Finishes:
 - a. The manufacturer shall apply standard finish (unless otherwise specified) over a corrosion-resistant primer, after cleaning to free the metal surfaces of rust, grease, dirt and other deposits. Edges of pre-finished sheet metal exposed during forming, stamping or shearing processes shall be finished in a similar corrosion resistant manner to match the adjacent surface(s). Fixture finish shall be free of stains or evidence of rusting, blistering, or flaking, and shall be applied after fabrication.

- b. Interior light reflecting finishes shall be white with not less than 85 percent reflectance, except where otherwise shown on the drawing.
 - c. Exterior finishes shall be as shown on the drawings.
6. Lighting fixtures shall have a specific means for grounding metallic wireways and housings to an equipment grounding conductor.
 7. Lighting fixtures in hazardous areas shall be suitable for installation in Class and Division areas as defined in NFPA 70.

C. LED Light Fixtures

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
 2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
 3. LED drivers shall include the following features unless otherwise indicated:
 - a. Minimum efficiency: 85% at full load.
 - b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
 - c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
 - d. Integral short circuit, open circuit, and overload protection.
 - e. Power Factor: ≥ 0.95 .
 - f. Total Harmonic Distortion: $\leq 20\%$.
 - g. Comply with FCC 47 CFR Part 15.
 4. LED modules shall include the following features unless otherwise indicated:
 - a. Comply with IES LM-79 and LM-80 requirements.
 - b. Minimum CRI 80 and color temperature 3500° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
 - c. Minimum Rated Life: 50,000 hours per IES L70.
 - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.
 5. LED Downlights:
 - a. Housing, LED driver, and LED module shall be products of the same manufacturer.
 6. LED Troffers:
 - a. LED drivers, modules, and reflector shall be accessible, serviceable, and replaceable from below the ceiling.
 - b. Housing, LED driver, and LED module shall be products of the same manufacturer.
- D. Exterior fixtures shall be complete with gaskets to form weatherproof seal and UL approved for wet locations, except where recessed in soffit which is classified as a damp location.

E. LED Exit Light Fixtures

1. Exit light fixtures shall meet applicable requirements of NFPA and UL.
2. Provide emergency lighting units self-contained complete with batteries, charger, and lamps to provide automatic emergency lighting upon failure of normal power. Battery shall be maintenance free, with 1.5 hour minimum capacity to supply the connected fixture load.
 - a. Lamps shall be luminous Light Emitting Diodes (LED) mounted in center of letters on red color stable plastic or fiberglass.
 - b. Double-Faced Fixtures: Provide double-faced fixtures where required or as shown on drawings.
 - c. Directional Arrows: Provide directional arrows as part of the inscription panel where required or as shown on drawings. Directional arrows shall be the "chevron-type" of similar size and width as the letters and meet the requirements of NFPA 101.
 - d. Voltage: Multi-voltage (120 – 277V).
- F. Check the building electrical system requirements and architectural finishes, and regardless of the catalog number prefixes and suffixes shown, furnish fixtures with the proper trim, frames, supports, hangers, ballasts, voltage rating, and other miscellaneous appurtenances to properly coordinate with said conditions. Verify with Architect/Engineer prior to ordering.

2.9 OCCUPANCY SENSORS

- A. Approved manufacturers:
1. Hubble
 2. Lithonia
 3. Lutron
- B. General Requirements: Occupancy sensors shall be equal to those scheduled or noted on drawings and/or specified herein.
1. 0-10V Dimmer Wall Switch:
 - a. Lutron Diva Series, Model DVSTV; 8A (120-277V); single-pole / 3-way;
 2. Passive Infrared, Wall Switch Combination Occupancy/Vacancy Sensor:
 - a. Lutron Maestro Series, Model MS-OPS6M2N-DV: 6A lighting (120-277V), 3A (120V); neutral required; coverage of 900 square feet with mounting height of 4 feet; 180 degree field of view.
 3. Passive Infrared, 0-10V Dimmer Combination Occupancy/Vacancy Sensor.
 - a. Lutron Maestro Series, Model MS-Z101: 8A lighting (120-277V); coverage of 900 square feet with mounting height of 4 feet; 180 degree field of view.

4. Dual Technology Infrared/Ultrasonic Ceiling Mounted Sensor(s).
 - a. Lutron Model LOS-CDT-2000-WH; coverage of 1000 sq.ft with ceiling height of 8-12 feet; 360 degree field of view.
 - b. Provide required power and/or slave packs as required.
- C. Coverage of sensors shall remain constant after sensitivity control has been set. Sensors shall have readily accessible, user adjustable controls for time delay and sensitivity.
- D. Ultrasonic operating frequency shall be crystal controlled to within plus or minus 0.005% tolerance to assure reliable performance and eliminate sensor cross talk. Sensors using multiple frequencies are not acceptable.
- E. All sensors shall provide a method of indication to verify that motion is being detected during testing and that the unit is working. All sensors shall have UL rated, 94V-0 plastic enclosures.
- F. Circuit Control Hardware:

Control Units - For ease of mounting, installation and future service, control unit(s) shall be able to mount through a 1/2" knock-out in a standard electrical enclosure and be an integrated, self-contained unit consisting internally of an isolated load switching control relay and a transformer to provide low-voltage power. Transformer shall provide power to a minimum of two (2) sensors.

Relay Contacts shall have ratings of:

 - 20A - 120 VAC Ballast
 - 20A - 277 VAC Ballast
- G. Control wiring between sensors and control units shall be Class II, 18-24 AWG, stranded U.L. Classified, Teflon jacketed cable suitable for use in plenums, where applicable.
- H. It shall be the contractor's responsibility to locate and aim sensors in the correct location required for a complete and proper volumetric coverage within the range of coverage(s) of controlled areas per the manufacturer's recommendations. Rooms shall have one hundred (100) percent coverage to completely cover the controlled area to accommodate all occupancy habits of single or multiple occupants at any location within the room(s). The locations and quantities of sensors shown on the drawings are diagrammatic and indicate only the rooms which are to be provided with sensors. The contractor shall provide additional sensors if required to properly and completely cover the respective room.
- I. It is the contractor's responsibility to arrange a pre-installation meeting with the manufacturer's factory authorized representative, at the owner's facility, to verify placement of sensors and installation criteria.
- J. Proper judgment must be exercised in executing the installation so as to ensure the best possible installation in the available space and to overcome local difficulties due to space limitation or interference of structural components. The contractor shall also provide at the owner's facility, the training necessary to familiarize the owner's personnel with the

operation, use, adjustment, and problem solving diagnosis of the occupancy sensing devices and systems.

- K. Upon completion of the installation, the system shall be completely commissioned by the manufacturer's factory authorized technician who will verify all adjustments and sensor placement to ensure a trouble-free occupancy-based lighting control system.
- L. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the scheduled commissioning date. Upon completion of the system fine-tuning the factory authorized technician shall provide the proper training to the owner's personnel in the adjustment and maintenance of the sensors.

2.10 DISCONNECT SWITCHES

"Square D", "GE", and "Siemens" are the only approved switch manufacturers. No other manufacturers will be approved.

- A. Depending upon the service indicated, use 250 or 600 volt switches, single throw, fusible, or non-fusible, horsepower rated, heavy duty, designed for locking in "ON" or "OFF" position, in code-gage steel cabinets.
- B. Use switches which have number of poles required, dependent upon phase serving equipment.
- C. Switches shall be NEMA 1 Underwriters' approved for duty shown. In wet locations, use NEMA 3R. Where exposed to weather in exterior applications, use NEMA Krylon, corrosion resistant type. NEMA 3R and NEMA Krylon switches shall have weatherproof threaded hubs for all conduit entries into switch.
- D. Identify switches, as to equipment served, with engraved laminated phenolic name plates. Refer to Section 26 00 00 for name plate information.
- E. All disconnects shall be equipped with ground lug.

2.11 PANELS

"Square D", "G.E." and "Siemens" are the only approved panel manufacturers. No other manufacturer will be approved.

- A. All panels shall be constructed in accordance with the requirements of Underwriters' Laboratories specifications and recommendations of NEMA, and shall bear the Underwriters' inspection label.
- B. Cabinets shall be galvanized or bonderized code gauge steel with wiring gutters of at least 4" on all sides; gutters greater than 4" in width shall be provided where required by Article 373 of the National Electric Code. Front shall be manufactured from one piece sheet steel. Door shall be mounted with concealed butt hinges and shall include directory frame, flush-type combination lock and catch. Cabinets shall be for flush or surface mounting as indicated on drawings. Enclosure shall be NEMA Type 1, except NEMA 3R where exposed to the weather.

- C. All panels shall be dead-front type and shall be equipped with main circuit breaker or main lugs as indicated on plans, and with feeder and branch breakers as shown on panel schedules.
- D. Breakers shall be molded case, industrial bolt-on type, integral inverse time delay, thermal and instantaneous magnetic trip. Breakers 400 ampere frame and less shall be manufacturer's standard industrial construction, bolt-on type, integral inverse time delay thermal and instantaneous magnetic trip. Breakers 225 ampere through 400 ampere shall have continuously adjustable magnetic pickups of approximately five to ten times trip rating. Breakers 600 ampere frame and above shall be equipped with solid-state trip complete with built-in current transformers, solid-state trip unit and flux transfer shunt trip.
- E. All breakers shall have positive handle indication to show when a breaker has tripped automatically. All breakers shall be distinctly marked on face of breaker giving capacity of breaker trip. Multi-pole breakers shall be 2-pole or 3-pole as specified. Handle ties are not permitted.
- F. Circuit breakers serving HVAC equipment shall be HACR rated if so labeled on HVAC equipment. Verify requirements for HACR breakers with Mechanical Contractor.
- G. Buses in panels shall have a current carrying capacity of not less than the trip setting of the breaker protecting the buses and shall be braced for the maximum fault current for which the breaker protecting the panel is designed to interrupt. All buses shall be constructed of copper.
- H. A neutral bus shall be provided in each panel and same shall be insulated from the panel enclosure. An equipment ground bus shall also be provided in each panel and it shall be grounded to the panel enclosure.

2.12 TIME CLOCK

- A. Time clock shall be astronomic type with back-up power supply. Time clock shall have provisions for different settings for each day of the week, with provisions for omitting selected days. Enclosure shall have provisions for locking and be rated for min. of 0°F-150°F. Clock shall be "Intermatic", "Tork", or equal.

2.13 LOW VOLTAGE FUSE SPECIFICATION

- A. Fuses 600 amperes and less shall be equal to Bussman LOW-PEAK Dual-Element fuses Type LPJ-SP (600 V.) as shown on the drawings. (UL Class J).
- B. Three spare fuses of each size 601 amperes and larger and 10% of all other sizes (Minimum of three) shall be given to the Owner. It shall be the Electrical Contractor's responsibility to obtain a signed receipt noting acceptance of fuses by Owner. Failure to obtain signed documentation from Owner does not relieve Contractor from the obligations set forth herein.

2.14 CONTACTORS AND RELAYS

- A. Provide mechanically held relays and contactors of the size and rating indicated and scheduled on the drawings. Relays and contactors shall be mounted in suitable NEMA enclosures. Provide necessary relays and devices as required for proper control operation. Provide auxiliary relays as necessary for 2-wire control. Acceptable manufacturers include Square D and ASCO.

2.15 GROUNDING

A. Grounding Electrode System:

1. The following grounding electrodes that are present shall be bonded together to form the grounding electrode system:
 - a. Metal underground water pipe.
 - b. Metal frame of building or structure.
 - c. Ground encased electrode.
 - d. Ground ring.
 - e. Rod and pipe electrodes.
 - f. Plate electrodes.
2. Where none of the above electrodes exist, two or more of the following shall be installed and used:
 - a. Ground ring.
 - b. Rod and pipe electrodes.
 - c. Plate electrodes.
3. In addition to above requirements, (3) ground rods shall be installed as detailed on drawings.

B. All equipment grounds shall be to equipment ground bus in panel or switchboard serving the equipment or device and not to neutral bus.

C. All grounding of equipment, conduits, housing, etc., shall be in accordance with National Electrical Code. Bond all components of the electrical system, including cabinets, junction boxes, raceways, building steel, etc. in a substantial manner to insure ground continuity.

D. A separate green grounding conductor the same size as the circuit conductor shall be installed with each branch circuit and shall be connected to the grounding terminals of all switches, duplex receptacles, light fixtures and their ballasts. A separate green equipment grounding conductor shall be installed with each branch circuit and each feeder sized as shown on drawings or sized per NEC, whichever is greater. The conduit shall not be used as a ground. Ground each outlet by the use of equipment bonding jumper from box to device. Equipment grounding conductor shall be bonded to box.

E. Ground and bond separately derived systems per NEC 250.30.

PART 3 - EXECUTION

3.1 SURFACE CONDITIONS

- A. Examine the areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of the Work. Do not proceed until unsatisfactory conditions are corrected.

3.2 DELIVERY, STORAGE, AND PRODUCT HANDLING

- A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.
- B. Deliver products to the project at such time as the project is ready to receive the equipment, properly protected from incidental damage and weather damage.
- C. Damaged equipment shall be promptly removed from the site and new, undamaged equipment shall be installed in its place promptly with no additional charge to the Owner.

3.3 TRENCHING AND BACKFILLING

- A. All safety systems shall meet Occupational Safety and Health Administration Standards.
- B. Prior to any ditching and/or excavation contractor shall notify the appropriate authorities in compliance with the Texas Utilities Code, Chapter 251. This notification shall be at least two working days before ditching and/or excavation begins. Contractor shall maintain records of the required notification.
- C. Trenching shall be in accordance with Occupational Safety and Health Document, Part 1926 - Safety and Health Regulations for Construction; 1926-652 - General Trenching Requirements.
 - 1. Banks more than 5 feet high shall be shored, laid back to a stable slope, or some other equivalent means of protection shall be provided where employees may be exposed to moving ground or cave-ins. Refer to drawings for standard trenching details.
 - 2. The Contractor may also have supporting systems, pilings, cribbing, shoring, etc., designed by a Registered Professional Structural Engineer and submitted to the Architect/Engineer as a shop drawing submittal before trenching work is done. Submittal drawings shall be sealed by the Engineer.
- D. Excavation for Trenches: Dig trenches to the uniform width required for particular item to be installed, sufficiently wide to provide ample working room.
- E. Excavate trenches to depth indicated or required. Carry depth of trenches for piping to establish indicated flow lines and invert elevations. Beyond building perimeter, keep bottoms of trenches sufficiently below finish grade to avoid freeze-ups.
- F. Where rock is encountered, carry excavation 6" below required elevation and backfill with a 6" layer of crushed stone or gravel prior to installation of pipe.
- G. Grade bottoms of trenches as indicated, notching under pipe bells to provide solid bearing for entire body of pipe.

3.4 COMPACTION

- A. General: Control soil compacting during construction providing minimum percentage of density specified for each area classification.
- B. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum dry density for soils which exhibit a well-defined moisture density relationship determined in accordance with ASTM D 1557.
 - 1. Structures, Building Slabs: Compact top 12" of subgrade and each layer of backfill or fill material at 95% maximum dry density per ASTM D698-78 at or near optimum moisture content.
 - 2. Lawn or Unpaved Areas: Compact top 6" of subgrade and each layer of backfill or fill material at 90% maximum dry density per ASTM D698-78 at or near optimum moisture content.
 - 3. Walkways: Compact top 6" of subgrade and each layer of backfill or fill material at 95% maximum dry density per ASTM D698-78 at or near optimum moisture content.
- C. Pavements: Compact top 12" of subgrade and each layer of backfill or fill material at 95% maximum dry density per ASTM D698-78 at or near optimum moisture content.
- D. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water to surface of subgrade, or layer of soil material, to prevent free water appearing on surface during or subsequent to compaction operations.
- E. Remove and replace, or scarify and air dry, soil material that is too wet to permit compaction to specified density.
 - 1. Soil material that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing until moisture content is reduced to a satisfactory value.

3.5 BACKFILL AND FILL

- A. General: Place acceptable soil material in layers to required subgrade elevations, for each area classification listed below.
 - 1. In excavations, Select fill.
 - 2. Under grassed areas, Site top soil.
 - 3. Under walks, Select fill.
 - 4. Under steps and ramps, Select fill.
 - 5. Under building slabs, Select fill.
- B. Backfill excavations as promptly as work permits, but not until completion of the following:
 - 1. Acceptance of construction below finish grade including, where applicable, dampproofing, waterproofing, and perimeter insulation.
 - 2. Inspection, testing, approval and recording locations of underground utilities.

3. Removal of shoring and bracing, and backfilling of voids with satisfactory materials. Cut off temporary sheet piling driven below bottom of structures and remove in manner to prevent settlement of the structure or utilities, or leave in place if required.
 4. Removal of trash and debris.
 5. Permanent or temporary horizontal bracing is in place on horizontally supported walls.
- C. Ground Surface Preparation: Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills. Plow, strip, or break-up sloped surfaces steeper than 1 vertical to 4 horizontal so that fill material will bond with existing surface.
 - D. When existing ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface, pulverize, moisture-condition to optimum moisture content, and compact to required depth and percentage of maximum density.
 - E. Placement and Compaction: Place backfill and fill materials in layers not more than 8" in loose depth for materials compacted by heavy compaction equipment, and not more than 4" in loose depth for material compacted by hand-operated tampers.
 - F. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
 - G. Place backfill and fill materials evenly adjacent to structures, to required elevations. Take care to prevent wedging action of backfill against structures by carrying material uniformly around structure to approximately same elevation in each lift.
 - H. Cut bottom of trenches to grade. Make trenches 12" wider than the greatest dimension of the pipe(s).
 - I. Trenches shall not be backfilled until all required tests are performed, installation has been approved, and systems conform to the requirements of the specifications.

3.6 FLASHINGS, SLEEVES, AND INSERTS

- A. Furnish and install flashings where conduits pass through outside walls. Flashings shall be properly formed to fit around conduit and shall be caulked, with 790 Silicone Building Sealant by Dow Corning Corporation, so as to make watertight seal between conduit and building.
- B. Unless otherwise specified, install sleeves for each conduit where it may pass through interior walls or floors. Galvanized 22-gauge sheet iron sleeves shall be used. Finish flush with each finished wall surface. In pipe chases, the sleeve shall extend 1-1/2" inches above floor slab and shall be watertight.

- C. Raceways that pass through concrete beams or walls and masonry exterior walls shall be provided with galvanized wrought iron pipe sleeve, unless shown otherwise on drawings. Inside diameter of these sleeves shall be at least 1/2" greater than outside diameter of service pipes. After pipes are installed in these sleeves, fill annular space between pipes and sleeves with 790 Silicone Building Sealant by Dow Corning Corporation. Completed installation shall be watertight.

3.7 ROOF PENETRATIONS

- A. Conduit penetrating the roof shall be installed as directed by roofing supplier/installer and shall be compatible with roofing system.

3.8 CUTTING AND PATCHING

- A. The Contractor shall coordinate work to eliminate cutting of the construction except as specified. Where it becomes necessary to cut through the construction to permit the installation of work or the repair of defective work, it shall be performed by trades specializing in the type of work involved.

Request for Engineer's consent:

1. Prior to cutting which affects structural safety, submit a written request to Engineer for written permission to proceed with cutting.
 2. When conditions of Work or schedule require a change of materials or methods for cutting and patching, notify Engineer and secure written permission to proceed with work.
- B. Perform, Architect-approved, cutting and patching by methods which will prevent damage to other portions of the work and provide proper surfaces to receive installation of new work and/or repair.
 1. Openings cut through concrete and masonry shall be made with masonry saws and/or core drills and at such locations acceptable to the Architect. Impact-type equipment will not be used except where specifically acceptable to the Architect.
 2. Openings in precast concrete slabs or walls for pipes, etc., shall be core drilled to exact size. Oversize the hole to allow for link seals, and to deter pipe corrosion condensation from forming.
 3. Where openings are cut through masonry walls, provide and install lintels or other structural supports to protect the remaining masonry. Adequate supports shall be provided during the cutting operation to prevent any damage to the masonry occasioned by the operation. All structural members, supports, etc., shall be of the proper size and shape, and shall be installed in a manner acceptable to the Architect.
 4. Openings cut through plaster or drywall shall be cut prior to plaster finish coat or texture coat on drywall. Cutting of the finish coat of plaster or texture coat of drywall will not be permitted unless written approval of the Architect is obtained.

5. Openings shall be restored and/or repaired as required to replace the cut surface to an "as-new" and/or "as original" condition. Refer to the appropriate section of the specifications for the material involved.
- C. Perform fitting and adjusting of products to provide finished installation complying with the specified tolerances and finishes.

3.9 TESTING ELECTRICAL SYSTEMS

- A. Loads on distribution panels shall be balanced. 600V Conductors:
1. Megger test feeder conductors at 600 volts dc. Record value for each feeder conductor. Conductors which test below 30 megohms shall be replaced. Retest new conductors and record data.
 2. Perform continuity test on all feeder and branch circuit conductors.
 3. Torque all feeder and branch circuit connections and terminations to manufacturer's recommended values.
- B. Grounding:
1. Test of grounding installation, include:
 - a. Measure ground resistance with appropriate earth test equipment.
 - b. Test the continuity and proper connection of each ground conductor and system to assure that the grounding system is complete and uninterrupted. Perform testing using appropriate test instruments for the purpose.
 - c. Verify polarity and connections of each receptacle to assure compliance with NEC.
 - d. Ground resistance measurements of each ground rod: Take measurements and certify by the Contractor to the Owner. Submit in writing to the Owner upon completion of the project, the measured ground resistance of each ground rod and grounding system, indicating the location of the rods and grounding system, as well as the resistance and soil conditions at the time the measurements were made. Make ground resistance measurements of the connection to the building water service and all other electrodes. Make ground resistance measurements in normally dry weather, not less than 48 hours after rainfall, and with the ground under test isolated from other grounds. Measure the resistance to ground using the fall of potential method described in IEEE No. 142. Replace rejected grounds at no additional cost to the owner. Grounding electrode system resistance shall not exceed 2 ohms.
- A. Equipment manufacturer field service personnel shall adjust and set all devices in accordance with approved results of "Short Circuit and Coordination Study".

3.10 LOCKING OF ELECTRICAL FACILITIES

- A. Provide padlocks or lockable latches for electrical facilities subject to unauthorized entry, such as panelboards, switchboards, disconnects, etc.
 - 1. Furnish locks to match existing school district locking system. Key all locks alike.
 - 2. Furnish Owner with two keys per lock up to a quantity of ten keys.
 - 3. Install locks immediately upon installation of electrical facility.

3.11 TESTING AND INSPECTION

- A. Provide personnel and equipment, make require tests, and secure required approvals from Engineer and Governmental Agencies having jurisdiction.
- B. Make written notice to Engineer adequately in advance of each of following stages of construction:
 - 1. When rough in is complete, but not covered.
 - 2. At completion of Work of this Section.
 - 3. In underground condition prior to placing backfill, concrete floor slab, and when associated electrical Work is in place.
- C. When material or workmanship is found to not comply with specified requirement, remove items from job site and replace them with items complying with specified requirements at no additional cost to Owner. This shall be performed within 3 days after receipt of written notice of noncompliance.
- D. In Engineer's presence, test parts of electrical system and prove that items provided under this Section function electrically in require manner.

3.12 ARC FLASH WARNING LABELING

- A. Electrical Contractor shall perform calculations and provide proper Arch Flash warning labeling of equipment per Article 110 of NEC and NFPA 70E.

3.13 SHORT CIRCUIT AND COORDINATION STUDY

- A. Switchboard/panel manufacturer shall perform Short Circuit and Coordination Study to determine appropriate setting of all devices. Submit proposed settings for approval. A.I.C. ratings of equipment shall be based on this study. A.I.C. ratings shown on drawings are minimum requirements and shall not be reduced. Provide increased A.I.C. ratings as determined by short circuit study at no additional cost.
- B. Loads on distribution panels are to be balanced.
- C. Power feeders and circuits with wire size #2 and larger are to be tested for leakage phase-to-ground and phase-to-phase. A written report is to be submitted to the Owner showing method and readings taken.

- D. Secondary feeders from main service transformers are to be tested with leakage instruments prior to feeders being energized. The voltage applied for testing shall not exceed two times normal operating voltage.

3.14 OPERATION AND MAINTENANCE DATA

- A. Submit two copies of preliminary draft of proposed manual or manuals to Engineer for review and comments. Allow minimum of 10 working days for review.
- B. Submit approved manual to Engineer prior to indoctrination of operation and maintenance personnel.
- C. Where instruction manuals are required for submittal, they shall be prepared in accordance with the following:

Format:

- Size: 8-1/2" x 11"
- Paper: White Bond, at least 20 lb.
- Text: weight Neatly written or printed.
- Drawings: 11" in height preferable; bind in with text; foldout
- Flysheets: Separate each section of the Manual with neatly prepared flysheets briefly describing contents of the ensuing section; flysheets may be in color
- Binding: Use heavy-duty plastic or fiber-board covers with binding mechanism concealed inside the manual; 3-ring binders will be acceptable; all binding is subject to the Architect's approval.
- Measurements: Provide all measurements in U.S. standard units such as feet-and-inches, lbs, and cfm. Where items may be expected to be measured within ten years in accordance with metric formulae, provide additional measurements in the "International System of Units" (SI).

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

OPERATING AND MAINTENANCE INSTRUCTIONS

Name and Address of Work

Name of Contractor

General subject of this manual

Space for approval signature of Engineer and approval date[s]

- E. Contents: Include at least following:
 - 1. Neatly typewritten index near front of Manual, giving immediate information as to location within manual of emergency information regarding installation.

2. Complete instructions regarding operation and maintenance of equipment involved including lubrication, disassembly, and reassembly.
3. Complete nomenclature of parts of equipment.
4. Complete nomenclature and part number of replaceable parts, name and address of nearest vendor and other data pertinent to procurement procedures.
5. Copy of guarantees and warranties issued.
6. Manufacturer's bulletins, cuts, and descriptive data, where pertinent, clearly indicating precise items included in this installation and deleting, or otherwise clearly indicating, manufacturers' data with which this installation is not concerned.
7. Other data as required in pertinent Sections of these Specifications.

3.15 WARRANTY

- A. Warrant equipment and workmanship for period of one year after date of substantial completion and replace or repair faulty equipment or installation at no cost to Owner for service during this period.
- B. Warranty shall not void specific warranties issued by manufacturers for greater periods of time or void rights guaranteed to Owner by law.
- C. Warranties shall be in writing in form satisfactory to Owner, and shall be delivered to Owner before final payment is made.

3.16 PROJECT COMPLETION

- A. Upon completion of Work of this Division, thoroughly clean exposed portions of electrical installation, removing traces of soil, labels, grease, oil, and other foreign material, and using only type cleaner recommended by manufacturer of item being cleaned.
- B. Thoroughly indoctrinate Owner's operation and maintenance personnel in contents of operations and maintenance manual required to be submitted as part of this Division of these Specifications.
- C. Date of final acceptance shall be the date documented in writing and signed by Architect / Engineer.

END OF SECTION 26 00 00

SECTION 26 28 17

MOTOR AND CIRCUIT DISCONNECTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Shop Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. This Section specifies the requirements for disconnect switches, fusible and non-fusible.

1.3 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:
 - 1. Federal Spec. W-S-865 - Switch, Box (Enclosed), Surface Mounted.
 - 2. NEMA KS 1 - Enclosed Switches.

1.4 SUBMITTALS

- A. Submit manufacturer's product data.
- B. Submit dimensioned Shop Drawings and equipment ratings for voltage, capacity, horsepower, and short circuit.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver switches individually wrapped in factory-fabricated water-resistant type containers.
- B. Handle switches carefully to avoid damage to material components, enclosure and finish.
- C. Store switches in a clean, dry space protected from weather.

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.

2.2 MANUFACTURERS

- A. General Electric Company.
- B. Square D Company.
- C. Siemens.

2.3 FABRICATED SWITCHES

- A. Depending upon the service indicated, use 250 or 600 volt switches, single throw, fusible, or nonfusible, horsepower rated, heavy duty, designed for locking in “ON” or “OFF” position, in code-gage steel cabinets.
- B. Use switches which have number of poles required, dependent upon phase serving equipment.
- C. Switches shall be NEMA 1 Underwriters’ approved for duty shown. In wet locations, use NEMA 3R. Where exposed to weather in exterior applications, use NEMA Krylon, corrosion resistant type. NEMA 3R and NEMA Krylon switches shall have weatherproof threaded hubs for all conduit entries into switch.
- D. Use fuse clips that are rejecting type to accept Class RK or L fuses.
- E. Identify switches, as to equipment served, with engraved laminated phenolic name plates. Refer to Section 26 00 00 for nameplate information.

PART 3 - EXECUTION

3.1 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. Install safety or disconnect switches for all electrical equipment, in accordance with the applicable requirements of NEC and the National Electrical Contractors Association “Standard of Installation.”

- D. For all equipment with motors larger than 1/8 horsepower, provide motor rated disconnect switches within sight of the motor.
- E. Disconnect switches for such equipment shall be mounted independent of the unit to allow for maintenance access.

END OF SECTION 26 28 17

SECTION 26 29 14
MOTOR STARTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.

1.2 SUMMARY

- A. This Section specifies the requirements for motor control with full voltage non-reversing and combination magnetic motor starters.

1.3 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:
 - 1. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems.
 - 2. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies.
 - 3. NEMA AB 1 - Molded Case Circuit Breakers.
 - 4. NEMA KS 1 - Enclosed Switches.
 - 5. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.

1.4 SUBMITTALS

- A. Product Data:FC
 - 1. Submit manufacturer's product data.

B. Record Documents:

1. Submit dimensioned Drawings showing size, circuit breaker, fusible switch and combination starter arrangement and equipment ratings including, but not limited to, voltage, bus ampacity, integrated short circuit ampere rating.
2. Provide data on relays, pilot devices, switching and overcurrent protection.
3. Indicate enclosure NEMA rating and material.

C. Operation and Maintenance Data:

1. Provide operating and maintenance manuals.

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.

2.2 MANUFACTURERS

- A. General Electric Company.
- B. Square D.
- C. Siemens.

2.3 MOTOR STARTERS

- A. Each motor shall be provided with proper starting equipment.
1. Starting equipment, unless specified or scheduled to the contrary, shall be provided by the trade furnishing the motor.
 2. All motor starting equipment provided by any one trade shall be of the same manufacturer unless such starting equipment is an integral part of the equipment on which the motor is mounted.
 3. The Division 23 Subcontractor shall furnish all starters for Division 23 Work, except those stated and/or scheduled to be provided in 26 24 19, Motor Control Centers. Motor control centers shall be provided under this Section.

4. All applicable motors shall be compatible with variable speed motor controller. Variable speed motor controllers shall be furnished with the drive equipment, run tested and certified at factory prior to shipping. Certified tests shall be submitted to Owner with submittals.

B. Magnetic Motor Starter:

1. Type: Provide magnetic, full-voltage, nonreversing motor starters unless otherwise indicated.
2. Overload Relays: Provide an ambient-compensated thermal overload relay in each phase leg.
3. Contractor:
 - a. Size contactors according to NEMA standards or as shown; however, minimum shall be size 1.
 - b. Provide main pole in each phase leg, the number and type of auxiliary contacts to perform the required functions, and two (2) spare auxiliary contacts, one (1) normally open and one (1) normally closed.
 - c. Use double break contacts of silver-cadmium oxide or similar material to minimize sticking or welding.
 - d. Provide contactor coils suitable for continuous operation at 120 volts, 60 hertz.
4. Enclosure: Provide a NEMA 1 enclosure unless otherwise indicated on Drawings.
5. Control Devices: Provide control devices as indicated on the Drawings, in front of enclosure as follows:
 - a. Selector Switches: Heavy-duty, oil-tight, maintained contact, 3-position, with marked nameplate HAND-OFF-AUTOMATIC, unless otherwise indicated on two speed motors provide OFF-LOW-HI selector switch.
 - b. Indicating Lights: Indicating lights shall be heavy-duty LED type. Neon lamps are not acceptable. Provide red (running) lens. On two-speed starters, provide amber (low speed) and red (high speed).

C. Combination Fused Switch-Starter:

1. Type: Provide combination fused switch and magnetic motor started as indicated on the Drawings.
2. Fuses: Provide fuses sized per the Drawings and in accordance with Section 26 28 13.

3. Starter: Provide magnetic motor starter as specified herein.
 4. Enclosure: Provide a NEMA 1 enclosure unless otherwise indicated on Drawings.
- D. Manual Motor Starters: Provide line voltage manual motor starters for each single-phase motor. Include bimetallic thermal overload protection in each ungrounded phase leg. Provide the toggle-operated starter in a NEMA 1 enclosure unless otherwise indicated.

PART 3 - EXECUTION

3.1 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. Anchor assembly to housekeeping pad.
- D. Select overload heaters for motor in accordance with manufacturer's recommendations for the voltage and full load amperes listed on the nameplate data of each motor actually installed.
- E. Adjust operating mechanisms for free mechanical movement.
- F. Touch-up scratched or marred surfaces to match original finish.
- G. Individual motor starters are furnished under Section 20 05 13, however, the installation and all connections are to be done under Division 26, similar to the Work done for motors served from a Motor Control Center.

3.2 TESTING

- A. Subsequent to wire and cable connections, energize motor control centers and demonstrate functioning in accordance with manufacturer's requirements.

END OF SECTION 26 29 14