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 ¾-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)

l. 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

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 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/EEE 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/EEE 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.

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. 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 ¼ to ¾ hp shall be Subtype II and meet the minimum requirements of EPAct92 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 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 then 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 phases: 200 volts for 208-volt nominal system voltage.

3. Three phases: 230 volts for 240-volt nominal system voltage.

4. Three phases: 230/460 volts for 240/480-volt nominal system voltage.

5. Three phases: 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:

Horsepower	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6 – 1/3	1.35	1.35	1.35	1.35
½	1.25	1.25	1.25	1.15
¾	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

PART 3 - 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): ∅A _____, ∅B _____, ∅C _____

VOLTAGE (VOLTS): ∅BA _____, ∅BC _____, ∅CA _____

∅AN _____, ∅BN _____, ∅CN _____

END OF SECTION 20 05 13

SECTION 20 05 29

SUPPORTS AND SLEEVES

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 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.

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. 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.

PART 3 - 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 07 19

PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

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 Celluar 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.

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. 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/ft^2.

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 jacketi where material is exposed to ultraviolet rays.

6. P6 Insulation Underground: Provide factory applied (50 mil thicknesses) self-sealing membrane bituminous compound reinforce 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: 3/4 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: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.

PART 3 - 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”

Piping Systems	Location	Type	Pipe Size	Insulation Thickness
			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”
	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”
		P1	2" to 4”	1/2"

Piping Systems	Location	Type	Pipe Size	Insulation Thickness
	Interior Concealed		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	1”
			6” & Larger	1-1/2”
	Interior Concealed	P3	All Sizes	3/4”
		P6	All Sizes	1"
Refrigerant Suction Piping (35 Degrees F – Nominal)	All	P3	2-1/2” and Smaller	3/4"

END OF SECTION 20 07 19

SECTION 211000

WATER-BASED FIRE PROTECTION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Fire protection system drawings, refer to sheets beginning with "FP."

1.2 SUMMARY

A. Perform all Work required to provide and install pipe, fittings, valves, connections, hangers, supports, sleeves and appurtenances for new, rework and/or expansion of existing wet combination sprinkler and standpipe systems with supplementary items necessary for complete, code compliant and approved installation.

B. Contractor shall include within his bid all materials and Work to provide standpipe and 100% sprinkler protection for all areas in new construction or for the entire smoke compartment affected under the scope of this project.

C. Size all branches and mains by hydraulic calculations. Contractor shall conduct a water flow test to obtain water supply information to determine actual available volume and pressures as a design basis for the system, including storage tank replenishment on new systems. Provide a 10 psi cushion for all hydraulic designs. This Contractor shall verify that the affected existing systems are configured and functioning properly according to NFPA 13. Hazard classifications for fire protection system design, installation and water supplies shall be in accordance with NFPA Standards. EXCEPTION: All pipe sizes and water flow demand for Light Hazard Occupancies shall be based upon Ordinary Hazard (Group 1) as the minimum system design. Sprinkler head locations and spacing for Light Hazard Occupancies shall be in accordance with NFPA 13 requirements.

D. Interface all new flow and valve supervisory switches with building fire and smoke alarm systems.

E. The Work covered by this Specification Section includes providing and furnishing all design, engineering, labor, materials, transportation, tools, piping, fittings, valves, hangers and supports, devices, sprinklers, and any other components and services required for the installation of a complete, operational, fully functional, and code compliant automatic sprinkler systems.

F. The Work must comply with all requirements of these specifications, including where the specified requirements are exceeding minimum code requirements. Any design inconsistencies or conflicts within this document must be resolved through the Request for Information (RFI) process prior to the contractor's bid submission. All fire protection system related RFIs will be reviewed and processed by the Owner's Representative and Design Team.

G. The Contractor shall perform all Work in accordance with the Specifications, and subject to the terms and conditions of the Contract. Work shall include, but not be limited to, the following as applicable:

1. Wet pipe automatic sprinkler systems.

H. No Work shall be performed until the Shop Drawings, calculations, and product data have been reviewed by the Owner's Representative, Design Team, and Authority Having Jurisdiction (AHJ). The Contractor is solely liable for any material purchases made prior to the approval of the drawings.

1.3 DEFINITIONS

A. Design Team: engineers of record, architect, and other professionals involved in the development of the contract documents.

B. Standard-Pressure Sprinkler Piping: Wet pipe sprinkler system piping designed to operate at working pressure of 175 psi maximum.

1.4 SYSTEM DESCRIPTIONS

A. Wet-Pipe Automatic Sprinkler System: Automatic sprinklers are attached to water-filled piping that is connected to a reliable water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device.

1.5 PERFORMANCE REQUIREMENTS

A. Delegated Design: Contractor is responsible for a complete design complying with the applicable codes and standards, this Specification Section, and all Related Documents.

B. Automatic sprinkler system design shall be approved by the authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 5 psi or greater where required by the local authority having jurisdiction (AHJ), including losses through water-service piping, valves, hose connections, and backflow preventers.

2. Sprinkler Occupancy Hazard Classifications shall be in accordance with the applicable edition of NFPA 13.

3. Minimum Density for Automatic-Sprinkler Piping Design:

   a. Light Hazard: 0.10 gpm/ft2 over 1,500 ft2.

   b. Ordinary Hazard Group 1: 0.15 gpm/ft2 over 1,500 ft2.

   c. Ordinary Hazard Group 2: 0.20 gpm/ft2 over 1,500 ft2.

   d. Wet pipe automatic sprinkler system design may be decreased for the use of quick response sprinklers in accordance with NFPA 13.

4. Maximum Protection Area per Sprinkler: Per NFPA 13.

5. Total Combined Hose-Stream Demand Requirement: Per NFPA 13.

6. System area shall not exceed 52,000 square feet.

7. Standard Piping System Component Working Pressure: Listed for at least 175 psi.

1.6 ACTION SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be reviewed by the Design Team prior to submitting them to authorities having jurisdiction for approval.

a. Should any submittal not be approved by the owner, owner's representative, or local authority and require re-submittal, all changes to the drawings, resulting from comment corrections or drawing changes, shall be individually clouded, provided with a reference number reflecting the date of resubmission, and provided with a general description of the changes.

b. Should re-submission (submittal after initial submittal) not be approved and require a subsequent submittal (third and beyond), the owner reserves the right to back charge the contractor for any review costs and/or permit fees for subsequent submittals incurred by the owner and/or the owner's representatives, including but not limited to the architect and the fire protection consultant.

2. Comply with NFPA 13 "Plans and Calculations" chapter.

B. Simultaneous Action Submittals: Specification Compliance Confirmation, Delegated-Design Product Data Submittal, Delegated-Design Calculation Submittal, and Delegated-Design Shop Drawings shall be submitted simultaneously. Incomplete submittals will be returned as "Rejected".

C. Specification Compliance Confirmation: Provide a copy of this specification annotated to confirm review and compliance with all applicable sections. Indicate compliance with a green checkmark adjacent to the respective section. Where a section is not applicable, mark the section as "NA" in red text and provide a concise explanation why the section is not applicable. Substitution requests shall be marked with an "S" in blue text and a reference to the formal Request for Information (RFI).

D. Delegated-Design Product Data Submittal: Provide product data sheets for all piping, material, equipment, and devices being proposed. If the product data sheet lists more than a single product, provide a clear indication of which product/model number is being proposed. Product submittals shall be electronically submitted in .pdf format with linked bookmarks corresponding with a table of contents organized by component type. Include the following:

1. Piping materials, including dielectric fittings, flexible connections, and specialty fittings.

2. Pipe hangers and supports, including seismic restraints where applicable.

3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.

4. Sprinklers, escutcheons, cover plates, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.

5. Alarm devices, including electrical data.

6. Hydraulic information for fittings, valves, and sprinklers.

E. Delegated-Design Calculation Submittal: Signed and sealed/stamped by the qualified professional responsible for their preparation. Hydraulic calculation submittals shall be electronically submitted in .pdf format with linked bookmarks corresponding with a table of contents organized by design area. Include the following:

1. Hydraulic calculations in accordance with NFPA 13.

2. Engineered piping support calculations in accordance with NFPA 13.

3. Seismic bracing calculations in accordance with NFPA 13, where applicable.

F. Delegated-Design Shop Drawings: Signed and sealed/stamped by the qualified professional responsible for their preparation. Include the following:

1. All applicable information listed in Chapter 27 of NFPA 13.

2. Riser detail showing valves, fittings, pipe diameters and lengths, devices, and hydraulic nodes.

3. Sufficient building information to convey the hazards, obstructions, uses, walls, ceilings, structure, ceiling/deck heights, and pertinent information necessary to confirm the design is compliant.

4. Sprinkler legend on each sheet with the total sprinkler count, coverage type (e.g., standard, extended, etc.), SIN, response-type, temperature rating, finish, color, k-factor, minimum operating pressure or flow (where manufacturer specified), dry-type (where applicable), maximum spacing calculated and used for extended coverage sprinklers (where permitted), and orientation.

5. Where flexible sprinkler drops are used, indicate on the drawings the manufacturer, maximum length, maximum number of bends, and equivalent length used at each location (where it varies). Must match the product data and the hydraulic calculations.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Designer and Installer.

1. Copy of State license showing the fire sprinkler contractor to be certified in the layout and installation of fire sprinkler systems.

2. Copy of NICET certification showing the fire sprinkler contractor to be certified in the layout, equipment selection, installation, acceptance testing, troubleshooting, servicing and sales of automatic sprinkler systems.

1.8 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire protection systems and components to be included in operation and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Provide a minimum of one (1) hardcopy of NFPA 25, edition referenced by the applicable edition of NFPA 13. The copies provided shall be purchased from NFPA and shall not violate copyright laws.
2. Manufacturer's required maintenance related to system warranty requirements.

B. Final Testing and Completion Documents: Indicate, document, and interpret test results for compliance with performance requirements in accordance with NFPA 13.

C. Welding certificates.

D. Field quality-control test reports.

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

F. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

1.9 QUALITY ASSURANCE

A. The installation shall be performed by a company specializing in designing and installing the products specified in this Section with a minimum of five (5) years of experience, and certified/licensed by the appropriate State agency for such work.

B. Common Requirements for Code Compliance: In cases where differences occur between building codes, state laws, local ordinances, industry standards, and the Contract Documents, the most stringent shall apply. Perform the following:

1. Promptly notify the Owner or Owner's Representative in writing of any such difference.
2. Obtain approval from the Owner or Owner's Representative before proceeding with the Work.
3. Should the Contractor perform any work that knowingly does not comply with local codes, laws and ordinances, industry standards, or other governing regulations, the Work shall be corrected at no cost to the Owner.

C. Common Requirements for Compliance with AHJ Instructions: In cases where the Authority Having Jurisdiction requires deviations from the requirements of the Contract Documents, perform the following:

1. Promptly notify the Owner or Owner's Representative in writing of any such difference.
2. Obtain approval from Owner or Owner's Representative before proceeding with the Work.

D. Common Requirements for Material Quality: Materials, equipment, and devices shall be new and of the quality specified and shall be free from defects at the time of installation. Materials, equipment, and devices damaged in shipment or otherwise damaged or found defective prior to acceptance by the Owner shall be replaced with new materials, equipment, or devices identical with those damaged, unless approved otherwise by the Owner in writing.

E. Designer Qualifications: Shop Drawings and Calculations shall be prepared and signed by personnel with the following qualifications:

1. Certified by NICET as Level III (or higher) in Water-based Fire Protection Systems or a qualified professional engineer.

2. Current Qualifying License issued by the State.

F. Installer Qualifications: Personnel shall be trained and be certified by NICET in Water-based Fire Protection Systems as follows:

1. Foreman: Level II or higher.

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

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

1. NFPA 13, Standard for the Installation of Sprinkler Systems, 2019 edition.

I. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer.

1.10 COORDINATION

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

B. Coordinate the installation of supervised and activated devices with the fire alarm contractor.

C. Coordinate the installation of piping in shared support systems with other trades using the shared support system.

D. Space allocations for materials, equipment, and devices have been made based on present and known future requirements and the dimensions of items of equipment or devices of a specific manufacturer. Verify that all materials, equipment, and devices proposed for use on this Project are within the constraints of the allocated space.

E. Coordinate arrangement, mounting, and support of materials, devices, and equipment:

1. To allow maximum possible headroom.

2. To provide for ease of accessing equipment and devices with minimum interference to other installations.

F. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components, as they are constructed.

G. Coordinate access panel and door locations for valves that are behind finished surfaces or otherwise concealed.

H. Coordinate sleeve selection and application with selection and application of Firestopping

1.11 EXTRA MATERIALS

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

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

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Threaded-End, Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed threaded ends.

1. Cast-Iron Threaded Flanges: ASME B16.1.

2. Ductile- and Malleable-Iron Threaded Fittings: ASME B16.3.

3. Gray-Iron Threaded Fittings: ASME B16.4.

4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe. Include ends matching joining method.

5. Steel Threaded Couplings: ASTM A 865.

B. Plain-End, Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.

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

2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Schedule 10 or Schedule 40 Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, with factory- or field-formed, roll-grooved ends in NPS 1¼ and larger.

1. Grooved-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 1¼ and larger; and NFPA 13-specified wall thickness in NPS 1¼ to NPS 10; with factory- or field-formed, roll-grooved ends.

2. Grooved-Joint Piping Systems:

a. Manufacturers:

1) ASC Engineered Solutions.

2) Victaulic Co. of America.

3) Reliable Automatic Sprinkler Co., Inc

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD or ASTM A53 forged or fabricated from carbon steel pipe with factory grooved ends designed to accept grooved mechanical couplings from the same manufacturer.

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

1) Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13. Tongue and recess rigid type couplings shall only be used if the contractor uses a torque wrench for installation. Required torque shall be in accordance with the manufacturer's latest recommendations.

a) 1¼" through 4": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts.

b) 5" and larger: Standard rigid coupling.

2) Flexible Type:

a) 2" through 8": "Installation Ready" stab-on design, for direct 'stab' installation onto grooved end pipe without prior field disassembly and no loose parts.

b) 10" and larger: Standard flexible coupling.

d. Grooved-End-Pipe Flange Adapters: UL213 and AWWA C606, steel pipe OD dimensions, ASTM A536 ductile iron housing, flat faced, designed for incorporating flanged components with ANSI Class 125 bolt-hole patterns to a grooved piping system.

D. Plain-End, Schedule 10 Steel Pipe: ASTM A 135 or ASTM A 795, Schedule 10 in NPS 4 and smaller; and NFPA 13 specified wall thickness in NPS 6 to NPS 10.

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

2. Steel Flanges and Flanged Fittings: ASME B16.5.

2.2 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FM approved, with 175-psig minimum working-pressure rating, and made of materials compatible with piping.

B. Outlet Specialty Fittings:

1. Mechanical-T and Cross Fittings are prohibited except for connections to existing piping. Pipe coupons shall be retained and secured to the mechanical-T.

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

1. Manufacturers:

a. Tyco Fire Products, by JCI

b. AGF Manufacturing Co.

c. Viking Corp.

d. Victaulic Co. of America.

e. Reliable Automatic Sprinkler Co., Inc..

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

1. Manufacturers:

a. Tyco Fire Products, by JCI

b. AGF Manufacturing Co.

c. Viking Corp.

d. Victaulic Co. of America.

e. Reliable Automatic Sprinkler Co., Inc..

E. Flexible, Sprinkler Hose Fittings:

1. Manufacturers:

a. FlexHead Industries, Inc.

b. Victaulic Co. of America.

2. Standard: UL 2443 and FM 1637.

3. Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.

4. Pressure Rating: 175 psig minimum.

5. Size: Same as connected piping, for sprinkler.

2.3 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FM approved, with 175-psig minimum pressure rating.

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

1. NPS 1½ and Smaller: Bronze body with threaded or grooved ends.

2. NPS 2 and NPS 2½: Bronze body with threaded or grooved ends or ductile-iron body with grooved ends.

3. Manufacturers:
    a. NIBCO.
    b. Victaulic Co. of America.
    c. Reliable Automatic Sprinkler Co., Inc..

C. Butterfly Valves: UL 1091.
    1. NPS 2½ and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends. Weather-proof actuator with pre-wired supervisory switches monitoring the valve in the open or closed positions. Maximum 365 psig (2517 kPa) working pressure.
        a. Manufacturers:
            1) Tyco Fire Products.
            2) McWane, Inc.; Kennedy Valve Div.
            3) Mueller Company.
            4) NIBCO.
            5) Reliable Automatic Sprinkler Co., Inc.
            6) Victaulic Co. of America.

D. Check Valves NPS 2 and Larger: UL 312, swing type, cast-iron or ductile-iron body with flanged or grooved ends. Up to 365 psig (2517 kPa) maximum working pressure.
    1. Manufacturers:
        a. Tyco Fire Products.
        b. Crane Co.; Crane Valve Group; Crane Valves.
        c. Mueller Company.
        d. NIBCO.
        e. Potter-Roemer; Fire Protection Div.
        f. Reliable Automatic Sprinkler Co., Inc.
        g. Victaulic Co. of America.
        h. Watts Industries, Inc.; Water Products Div.

E. Gate Valves: UL 262, OS&Y type.
    1. NPS 2 and Smaller: Bronze body with threaded ends.
        a. Manufacturers:
            1) Crane Co.; Crane Valve Group; Crane Valves.
            2) Milwaukee Valve Company.
            3) Mueller Company.

4) NIBCO.

5) Victaulic Company.

6) Reliable Automatic Sprinkler Co., Inc.

7) Tyco Fire Products.

2. Tyco Fire Products. NPS 2-1/2 and Larger: Cast-iron or ductile-iron body with flanged ends.

a. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.

2) Milwaukee Valve Company.

3) Mueller Company.

4) NIBCO.

5) Victaulic Company.

6) Reliable Automatic Sprinkler Co., Inc.

7) Tyco Fire Products.

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

1. Indicator: Electrical, 24-Vdc, prewired, 2-circuit, supervisory switch.

2. NPS 2 inch and Smaller: Ball or butterfly valve with bronze body and threaded ends.

a. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.

2) Milwaukee Valve Company.

3) Mueller Company.

4) NIBCO.

5) Victaulic Company.

6) Reliable Automatic Sprinkler Co., Inc.

7) Tyco Fire Products.

3. NPS 2½ inch and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.

a. Manufacturers:

1) Crane Co.; Crane Valve Group; Crane Valves.

2) Milwaukee Valve Company.

3) Mueller Company.

4) NIBCO.

5) Victaulic Company.

6) Reliable Automatic Sprinkler Co., Inc.

7) Tyco Fire Products.

2.4 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FM approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig minimum pressure rating.

1. Manufacturers:

a. Tyco Fire Products.

b. Reliable Automatic Sprinkler Co., Inc.

c. Victaulic Co. of America.

d. Viking Corp.

2. Riser Check Valves: UL listed or FM approved, designed for vertical or horizontal installation. Include trim sets for drain and pressure gauges. Valve internal components shall be replaceable without removing the valve from the installed position.

3. Commercial Riser: UL listed or FM approved, designed for vertical or horizontal installation. Include trim sets for test/drain with orifice sized for the smallest K-factor in the system, 175 psi pressure relief valve, water flow switch, and pressure gauge.

B. Pressure-Relief Valves: UL Listed and/or FM Approved, brass or bronze, NPS 1/2 or NPS 3/4, 175-psig minimum rating. Include male NPS inlet and female NPS outlet, non-adjustable, and 90-degree-angle pattern design as indicated.

1. Finish: Rough metal.

2. Manufacturers:

a. AGF Manufacturing Co.

b. Croker Corp.

c. Tyco Fire Products.

d. Reliable Automatic Sprinkler Co., Inc.

e. Viking Corp.

f. Victaulic Company

g. Zurn Industries, Inc.; Wilkins Div.

C. Automatic Drain Valves: UL 1726, NPS 3/4, ball-check device with threaded ends.

1. Manufacturers:

a. Tyco Fire Products.

b. Reliable Automatic Sprinkler Co., Inc.

c. Viking Corp.

D. Automatic Air Vent:

1. Manufactures:

a. AGF Manufacturing Co.

b. Potter Signal.

c. Engineered Corrosion Solutions.

2. Description: Automatic air vent that automatically vents trapped air without human intervention.

3. Standard: UL listed or FM Global approved for use in wet-pipe fire sprinkler systems.

4. Vents oxygen continuously from system.

5. Float valve to prevent water discharge.

6. Minimum Water Working Pressure Rating: 175 psig (1207 kPa).

2.5 SPRINKLERS

A. Sprinklers shall be UL listed or FM approved, with 175-psig minimum pressure rating.

B. Manufacturers:

1. Tyco Fire Products.

2. Reliable Automatic Sprinkler Co., Inc.

3. Victaulic Co. of America.

4. Viking Corp.

C. Automatic Sprinklers: with heat-responsive element complying with the following:

1. UL 199, for nonresidential applications.

D. Sprinkler Types and Categories: Minimum nominal 1/2-inch orifice for "Intermediate" temperature classification rating, unless otherwise indicated or required by application.

1. All Sprinklers shall be Quick Response, unless required otherwise.

E. Sprinkler types, features, and options as follows:

1. Concealed ceiling sprinklers, including cover plate.

2. Pendent sprinklers.

3. Quick-response sprinklers.

4. Upright sprinklers.

F. Sprinkler Finishes:

1. Finished ceilings: White.

2. Exposed: Bronze or Brass.

G. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Steel, white, one piece, flat.

H. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler. Sprinkler guards shall be listed, supplied, and approved for use with the sprinkler, by the sprinkler manufacturer.

2.6 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-Vac and 0.25 A, 24-Vdc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

1. Manufacturers:

a. Potter Electric Signal Company.

b. System Sensor.

C. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

1. Manufacturers:

a. Potter Electric Signal Company.

b. System Sensor.

2.7 PRESSURE GAUGES

A. Available Manufacturers:

1. AGF Manufacturing Co.

2. AMETEK, Inc.; U.S. Gauge.

3. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch-diameter, dial pressure gauge with range of 0 to 300 psig.

1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in a formal written report documenting the results in accordance with NFPA 13 and NFPA 291.

3.2 EXAMINATION

A. Examine roughing-in for risers and valves to verify actual locations of piping connections before installation.

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

3.3 SYSTEM APPLICATIONS

A. Wet-Pipe Automatic Sprinkler System: Provided throughout the building.

3.4 PIPING APPLICATIONS, GENERAL

A. Flanges, flanged fittings, unions, nipples, transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig Maximum Working Pressure:

1. NPS 1: Threaded-end, black, Schedule 40 steel pipe; cast-, duct-, or malleable-iron threaded fittings; and threaded joints.

2. NPS 1¼ to NPS 6: Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.6 VALVE APPLICATIONS

A. Listed Fire-Protection Valves: UL listed and FM approved for applications where required by NFPA 13.

1. Shutoff Duty: Use ball, butterfly, or gate valves.

3.7 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

C. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe with wall thickness less than Schedule 40.

D. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.

1. Steel Pipe: Roll-groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.

2. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be molded and produced by the grooved coupling manufacturer.

3. Grooved end shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove for proper gasket sealing.

3.8 PIPING INSTALLATION

A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

B. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

C. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

D. Install sprinkler piping with drains for complete system drainage.

E. Install alarm devices in piping systems.

F. Hangers and Supports: Comply with NFPA 13 for hanger materials.

1. Install system piping supports according to NFPA 13.

G. Install pressure gauges on risers on both the system side of the system valve and the supply side of the system valve. Include pressure gauges with connection not less than NPS 1/4 and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gauges to permit removal and install where they will not be subject to freezing.

H. Fill wet-pipe sprinkler system piping with water.

I. Install sleeves for piping penetrations of fire-resistance and smoke-resistance rated walls, ceilings, and floors.

J. Install sleeve seals for piping penetrations of CMU and concrete walls and slabs.

K. Install pipe escutcheons for piping penetrations of walls, ceilings, and floors.

L. Water-filled piping shall be limited in and coordinated in low voltage, electrical, and IT rooms.

3.9 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve. Install in accessible and approved locations. Coordinate locations with Architect.

C. Install check valve in each water-supply connection.

D. Specialty Valves:

1. Riser Check Valves: Install in vertical position for proper direction of flow.

E. Air Vent:

1. Provide at least one air vent at high point in each wet-pipe sprinkler system in accordance with NFPA 13 requirements. Connect vent into top of fire sprinkler piping in an accessible location and piped to an approved drain location.

2. Provide dielectric union for dissimilar metals, ball valve, and strainer upstream of automatic air vent.

3.10 SPRINKLER APPLICATIONS

A. Where specific types are not indicated, use the following sprinkler types:

1. Rooms without Ceilings: Bronze or Brass Upright sprinklers.

2. Concealed sprinklers shall be installed in finished ceilings.

3.11 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. The sprinkler bulb protector must remain in place until the sprinkler is completely installed and before the system is placed in service. Remove bulb protectors carefully by hand after installation. Do not use any tools to remove bulb protectors.

C. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

3.12 CONNECTIONS

A. Install piping adjacent to equipment to allow service and maintenance.

B. Connect water-supply piping to fire-suppression piping.

C. Connect piping to specialty valves, specialties and accessories.

D. Electrical Connections: Power wiring is specified in Division 26.

E. Connect alarm devices to fire alarm.

F. Ground equipment according to Division 26.

G. Connect wiring according to Division 26.

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

3.13 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.

B. Provide hydraulic design information signs and general information signs at all system risers and control valve assemblies in accordance with NFPA 13.

3.14 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Energize circuits to electrical equipment and devices.

4. Start and run air compressors.

5. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

6. Coordinate with fire alarm tests. Operate as required.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

C. Refer to Division 01 for additional field testing and commissioning requirements and information.

3.15 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.16 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01.

B. Grooved coupling manufacturer’s factory-trained field representative shall provide on-site training for contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. Factory-trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

END OF SECTION

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: 0.125 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, Trerice, Weksler
13. Pressure Gauges: Ashcroft, Trerice, 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 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.

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-eight (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 therof, 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 20 23

NATURAL GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

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.

PART 2 - PRODUCTS

2.1 GENERAL

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

B. Natural gas pressures shall not exceed five (5) pounds per square inch gauge on 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.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe ends and remove cutting burrs. Bevel plain end ferrous pipe.

B. Remove cutting oil, scale and dirt, on inside and outside of piping, before assembly.

3.2 EQUIPMENT CONNECTIONS

A. Provide specified connections, shutoff valves, regulators and unions at each and every appliance and piece of equipment requiring natural gas, 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 Polymerics 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 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The Contractor shall familiarize himself with all drawings and specification and properly use information found on the Architectural, Civil, Structural, Mechanical, Electrical, and Plumbing drawings and specifications affecting his work.

1.2 SUMMARY

A. Testing, adjusting, and balancing (TAB) of Heating, Ventilation, and Air Conditioning (HVAC) systems and related ancillary equipment shall be performed by a technically qualified TAB Firm.

B. TAB Firm shall be capable of performing the TAB services as specified in accordance with the Contract Documents, including the preparation and submittal of a detailed report of the actual TAB Work performed.

C. TAB Firm shall check, adjust, and balance components of HVAC systems which will result in optimal noise, temperature, and airflow in the conditioned spaces of the building while the system equipment is operating economically and efficiently. This is intended to be accomplished after the system components are installed and initial startup has been completed by Mechanical Contractor.

D. During the balancing process, as the TAB Firm discovers abnormalities and malfunctions of equipment or components, the TAB Firm shall advise the General Contractor and Engineer in writing so that the condition can be corrected by the Mechanical Contractor prior to finishing TAB scope of Work. Data from malfunctioning equipment shall not be recorded as final condition in the final TAB report.

E. The TAB Firm shall perform an inspection of the HVAC systems during the opposite season from that which the initial adjustments were made. The TAB Firm shall make any necessary modifications to the initial adjustments to produce optimum system operation.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequent of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording rest data in logical order.

I. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

J. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

K. Test: A procedure to determine quantitative performance of systems or equipment.

L. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

M. AABC: Associated Air Balance Council.

N. NEBB: National Environmental Balancing Bureau.

O. TAB: Testing, adjusting, and balancing.

P. TABB: Testing, Adjusting, and Balancing Bureau.

Q. TAB Specialist: An entity engaged to perform TAB Work.

1.4 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. AABC – National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

2. NEBB – National Environmental Balancing Bureau, Procedural Standards for Testing, Adjusting, Balancing of Environmental Systems.

3. ASHRAE HVAC Applications Chapter 37: Testing, Adjusting, and Balancing.

4. ANSI/ASHRAE Standard 111: Practices for Measurement, Testing, Adjusting and Balancing of Buildings, Heating, Ventilation, Air Conditioning And Refrigeration Systems.

1.5 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 of the methods needed for proper performance of the work of this Section.

B. TAB Firm shall have operated a minimum of five (5) yeas under TAB Firm's current name and shall be in good standing the State of Texas, Franchise Tax Board. TAB Firm shall submit full incorporated name, Charter Number, and Taxpayer's I.D. Number for proper verification of TAB Firm's status.

C. TAB Firm's personnel performing Work at the Project Site shall be either professional engineers or certified air and water balance technicians, who shall have been permanent, full time employees of the TAB Firm for a minimum of six (6) months prior to the start of Work for this Project.

D. TAB Firm shall possess properly calibrated instrumentation with following items documented:

1. Instrumentation type and make.

2. Serial number.

3. Application.

4. Dates of Use.

5. Dates of Calibration

1.6 SUBMITTALS

A. Comply with pertinent provisions of Submittals in Specifications.

B. Qualification Data: Within 15 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article. Submit list of calibrated instrumentation to be utilized on this Project.

C. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit a review of the construction documents, submittal, and shop drawings for balance ability. Submit a list of suggestions or recommendations to the Architect / Engineer for consideration.

D. Sample Form: Submit sample forms, proposed for use on this Project.

1.7 PROJECT CONDITIONS

A. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

A. Review the construction documents, submittal, and shop drawings for balance ability. Submit a list of suggestions or recommendations to the Architect / Engineer for consideration.

B. Perform a job site observation prior to the ceiling installation to verify that ductwork, dampers, and air terminal devices have been installed per the contract documents. Submit in writing to the Architect / Engineer a list of any discrepancies noted.

C. Mechanical Contractor shall coordinate the HVAC installation and Start- Up schedule with the TAB Firm and General Contractor to allow sufficient time prior to the completion date for testing and balancing to be conducted and deficiency items corrected and retested.

D. The Mechanical Contractor shall install all systems complete and provide balancing dampers, splitter dampers, etc. necessary for TAB work.

E. The Mechanical Contractor shall provide written notification to the T&B agency and General Contractor that equipment Start-Up has been completed and that systems are ready for TAB Work.

F. The Mechanical Contractor shall correct any deficiency items noted during TAB Work including controls, calibration, installation of balancing devices, sheave replacements, and motor replacements at no additional cost to the Owner.

G. The Mechanical Contractor shall coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

H. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

PART 2 - PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.1 TOLERANCES & UNITS

A. The outside air, supply air, return air, and exhaust air for each system shall be adjusted to within +/- 5% of the values scheduled on the drawings.

B. Take and report testing and balancing measurements in inch-pound (IP) units.

3.2 INSTRUMENT TEST HOLES

A. When it is required to make holes in the field to measure temperature, static pressure, or velocity in the ducts:

1. Cut insulation, ducts, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

2. After testing and balancing, install hole plugs or patch holes in ducts with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING AIR DISTRIBUTION SYSTEMS

A. Prepare TAB data forms.

B. Obtain manufacturer's outlet factors and recommended testing procedures.

C. Crosscheck the summation of required outlet volumes with required fan volumes.

D. Verify that all ductwork, dampers, grilles, registers, and diffusers have been installed per design and set full open.

E. Check all dampers for free operations.

F. Examine ductwork for proper sealing.

G. Examine ductwork for airflow blockages.

H. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

I. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

J. Verify that motor starters are equipped with properly sized thermal protection.

K. Verify motor rotation.

L. Verify the correct operation of all interlock systems and installation is per the manufacturer recommendations.

M. Examine HVAC equipment and verify that clean filters are in place, bearings are greased, belts are aligned and tight, heat-transfer coils are clean with straight fins, controls are installed, and equipment start-up has been conducted.

N. Examine automatic temperature system components to verify:

1. Thermostats are located to avoid adverse effects of sunlight, drafts, and cold walls.

2. Sensors are located to sense only the intended conditions.

O. Examine condensate drains for proper connections and function.

P. Filters: Check air filters and filter media and balance only systems with essentially clean filters and filter media. The Mechanical Contractor shall install new filters and filter media prior to the final air balance.

Q. Fan Speeds: Measure and adjust fan RPM to achieve design CFM requirements. Where a speed adjustment is required, the Mechanical Contractor shall make any required changes.

R. Current & Voltage: Measure and record fan motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.

S. Static Pressure: Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment. Static pressure readings shall also be provided for systems, which do not perform as designed.

T. Equipment Air Flow: Adjust and record outside, supply, return, and exhaust air volumes (CFM) to value shown on the Drawings.

U. Adjust patterns of adjustable outlets for proper distribution without drafts.

V. Cooling Coil Temperatures: Set controls for full cooling. Read and record entering and leaving dry bulb and wet bulb temperatures at each cooling coil.

W. Heat Exchanger Temperatures: Set controls for full heating. Read and record entering and leaving dry bulb temperatures at each heat exchanger.

X. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.

3.4 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.

2. Wet-bulb temperature of entering and leaving air.

3. Airflow.

4. Air pressure drop.

5. Refrigerant suction pressure and temperature.

3.5 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.

2. Motor horsepower rating.

3. Motor rpm.

4. Efficiency rating.

5. Nameplate and measured voltage, each phase.

6. Nameplate and measured amperage, each phase.

7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.6 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure and record outside air dry bulb and wet bulb temperatures at time of testing air handling equipment and performance of heat-transfer coils.

C. Upon completion of testing, adjusting, and balancing of all systems measure and record indoor dry bulb and wet bulb temperatures mid-morning and mid-afternoon for two successive days, in each separately controlled zone, to prove correctness of final temperature settings. Measure and record indoor temperatures when the building or zone is occupied. Measure and record outdoor air dry bulb and wet bulb temperatures on each day of recording indoor temperatures.

3.7 PROCEDURES FOR DIRECT EXPANSION EQUIPMENT

A. With each unit operating neat design conditions, measure and record the following:

1. Manufacturer, model number, serial number, and all nameplate data.

2. Ambient temperature, condenser discharge temperature.

3. Amperage and voltage for each phase.

4. Leaving and entering air temperatures.

5. Refrigerant suction and discharge pressures and temperatures.

6. Tons of cooling.

7. Verification that moisture indicator shows dry refrigerant.

3.8 REPORTING

A. Status Reports: As Work progresses prepare reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building.

3.9 FINAL REPORT

A. The activities described in this specification shall be recorded in a report form; and four (4) individually bound copies shall be provided to the Architect / Engineer. Neatly type and arrange data. Include with the data the date tested, personnel present, weather conditions, nameplate record of the test instruments used and list all measurements taken after all corrections are made to the system. Record all failures and corrective action to remedy any incorrect situation. The intent of the final report is to provide a reference of actual operating conditions for the Owner's operations personnel. All measurements and recorded readings (of air, electricity, etc.) that appear in the report must have been made at the Project Site by the permanently employed technicians or engineers of the TAB Firm.

B. Include a listing of the TAB Agency, Contractor, Owner, Architect, and Engineer shall be included.

C. Include a certification sheet containing the seal and name, corporate address, telephone number, and signature of the Certified Test and Balance Engineer.

D. Include a list of the instrumentation(s) used for the procedures along with the proof of calibration.

E. Include a "Preface" which shall include a general summary of project systems and any abnormalities or problems encountered.

F. The report shall present data entered on AABC or NEBB standard forms (modified as necessary to include additional data hereinafter required) or pre-approved acceptable equivalent thereof.

G. The report shall contain copies of fan curves, field test reports, and as-built plans (size 11x17 inches) of the HVAC systems.

H. System Identification: Each supply, return, and exhaust opening shall be identified and numbered on reduced plans no larger than 11x17 inches to correspond to the numbers used on the report data sheets.

I. Air Outlet Test Report Forms: Each grille, diffuser, and register shall be identified as to location (room number) and area served. Record the size, type, and manufacturer of each diffuser, grille, and register.

J. Air Handling Unit Test Report Forms: Record the manufacturer, model number, and motor nameplate data and all design and manufacturer-rated data including supply, return, and outside airflows, fan rpm, sp and bhp. Report the following:

1. Total actual CFM by traverse. Include duct traverse form. If not practical the sum of the outlets may be used, or a combination of each of these procedures.

2. Inlet and outlet static pressures at the fan, coil, and filter sections.

3. Actual outside air and return air total CFM.

4. Actual operating current, voltage, and brake horsepower of each fan motor.

5. Final RPM of the fan and motor.

6. Fan and motor sheave make, sizes, and center distance.

7. Belt size and quantity.

8. Coil EAT and LAT (db/wb), and air pressure drops

9. Outside air temperature (db/wb)

K. Fan Test Report Forms: Record the manufacturer, model number, motor nameplate data and all design and manufacturer-rated data. Report the following:

1. Total actual CFM by traverse. Include duct travers form. If not practical, the sum of the outlets may be used, or a combination of each of these procedures.

2. Suction and discharge static pressure of each fan.

3. Actual operating current, voltage, and brake horsepower of each fan.

4. Final RPM of the fan and motor.

5. Fan and motor sheave make, sizes, and center distance.

6. Belt size and quantity.

L. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. System and air-handling-unit number.

2. Location and zone.

3. Traverse air temperature in deg F.

4. Duct static pressure in inches wg

5. Duct size in inches.

6. Duct area in sq. ft.

7. Indicated air flow rate in cfm.

8. Indicated velocity in fpm.

9. Actual air flow rate in cfm.

10. Actual average velocity in fpm.

11. Barometric pressure in psig.

3.10 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:

    a. Measure airflow of at least 10 percent of air outlets.

    b. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

    c. Verify that balancing devices are marked with final balance position.

    d. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer.

3. Engineer shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

6. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

    a. All systems shall be retested, new data recorded, new Certified Report submitted, and new inspections tests made at no additional cost to Owner. Request a second final inspection.

    b. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

C. Prepare final test and inspection reports.

3.11 ADDITIONAL TESTS

A. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

B. The TAB Firm shall perform an inspection of the HVAC systems during the opposite season from that which the initial adjustments were made. The TAB Firm shall make any necessary modifications to the initial adjustments to produce optimum system operation.

END OF SECTION 23 05 93

SECTION 23 07 13

DUCTWORK INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

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 ductwork insulation and jackets 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 C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
4. ASTM C553 - Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
5. ASTM C612 - Mineral Fiber Block and Board Thermal Insulation.
6. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
7. ASTM C1104 - Standard Test Method for Determining the Water Vapor Sorption of Unfaced Mineral Fiber Insulation.
8. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
9. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
10. ASTM C1338 - Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings.
11. ASTM E84 - Surface Burning Characteristics of Building Materials.

12. ASTM E96 - Water Vapor Transmission of Materials.
13. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
14. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
15. NFPA 255 - Surface Burning Characteristics of Building Materials.
16. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
17. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors.
18. UL 723 - Surface Burning Characteristics of Building Materials.
19. ASTM E2336 - Standard for Grease Ducts.
20. 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 QUALITY ASSURANCE

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

B. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement. Certificates to this effect shall be submitted along with Contractor's submittal data for this Section of the Specifications. No material may be used that, when tested by the ASTM E84-89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

C. Application Company Qualifications: Company performing the Work of this Section must have 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.

1.5 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.

B. Record Documents:

1. Submit under provisions of Division 01.

C. Operation and Maintenance Data:

1. Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type.

2. Manufacturer’s Installation Instructions: Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

1.6 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect, and handle products to the Project Site under provisions of Division 01 and Division 20.

B. Deliver materials to Site in original factory packaging, labeled with manufacturer’s identification including product thermal ratings and thickness.

C. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.

D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.

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. CertainTeed Corporation.

B. Johns Manville Corporation.

C. Knauf Corporation.

D. Owens-Corning.

E. Armacell North America.

F. Unifrax 1 LLC. (FyreWrap)

G. 3M Fire Protection Products (Fire Barrier Duct Wrap 615+)

2.3 INSULATION MATERIALS

A. Type D1: Flexible glass fiber; ASTM C553 and ASTM C1290; commercial grade; 'k' value of 0.25 at 75 degrees F; 1.5 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.

B. Type D2: Rigid glass fiber; ASTM C612, Class 1; 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; 0.002 inch foil scrim kraft facing for air ducts.

C. Type D3: Ductliner (FOR ACOUSTICAL PURPOSES ONLY - FIRST 4 FEET OF SUPPLY AND RETURN DUCT FROM AIR HANDLER), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable acrylic surface coating specifically formulated to:

1. Be no more corrosive than sterile cotton when tested in accordance with the test method for corrosiveness in ASTM C665.
2. Absorb no more than 3 percent by weight when tested in accordance with the test method for moisture vapor sorption in ASTM C1104.
3. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM C1071, ASTM C1338, ASTM G21, and ASTM G22.
4. Show no signs of warpage, cracking, delaminating, flaming, smoking, glowing, or any other visibly negative changes when tested in accordance with the test method for temperature resistance in ASTM C411.
5. Have a flame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.C
6. Meet the sound absorption requirements when tested in accordance with the test method for sound absorption in ASTM C423.
7. Show no evidence of continued erosion, cracking, flaking, peeling, or delamination when tested in accordance with the test method for erosion resistance in UL181.

D. Type D4: Fire Rated Grease Duct Insulation (High Temperature Flexible Blanket); 1-1/2-inch thick refractory grade fibrous fire barrier material with minimum service temperature design of 2,000 degrees F; aluminum foil laminated on both sides; with a minimum 'k' value of 0.25 and a minimum density of 6 lbs/cu ft; containing no asbestos. Listed by a nationally recognized testing laboratory (NRTL) UL to meet ASTM E 2336, ASTM E119, and with flame spread/smoke minimum rating of 25 / 50 when tested as per ASTM E84/UL 723.

E. Type D5: Outdoor Duct Insulation (Closed Cell Flexible Elastomeric Insulation); 1 inch thick material that has a service temperature range from –60 degrees F to 180 degrees F. This outdoor duct insulation meets ASTM C 177 or C 518 and shall have minimum 'k' value of 0.27 Btu-in. / hr-ft2- degrees F at minimum density measurement of 3 lb/cu ft. The insulation and outside surface must be protected with a white Thermo Plastic Rubber Membrane formulated to:

1. Be resistant to UV, and ozone, acid rain, and physical elements produced from outdoor weather per ASTM E 96 Procedure A.
2. Have aflame spread rating of 25 or less and a smoke developed rating of 50 or less when tested in accordance with the test method for surface burning in ASTM E 84.
3. Show no evidence of continued erosion, delaminating, cracking, flaking, or peeling when tested in accordance with the test method for erosion resistance in UL181. Be resistant to mold growth resistance, ASTM G 21/C 1338 resistant to fungi, and resistant to bacteria growth per ASTM G 22.

F. Type D6: Ductliner (to be used in return air sound boots only), flexible glass fiber; ASTM C1071; Type II, 'k' value of 0.23 at 75 degrees F; 3.0 lb/cu ft minimum density; coating air side for maximum 4,000 feet per minute air velocity. The airstream surface must be protected with a durable polyacrylate copolymer emulsion specifically formulated to:
1. Not support the growth of fungus or bacteria, when tested in accordance with the test method for fungi resistance in ASTM D 5590 with "0" growth rating.
2. Act as a fungicidal protective coating: water based, VOC < 50 g/l. Fungicidal coating must be EPA registered for use in HVAC duct systems. Manufacturer: H.B. Fuller Construction Products Inc., Foster 40-20 (white) or 40-30 (black) Fungicidal Protective Coating or approved equal. Coatings may also be used to repair damage to duct liner insulation.

2.4 INSULATION ACCESSORIES

A. Adhesives: Waterproof vapor barrier type, meeting requirements of ASTM C916; Childers CP-82 or Foster 85-20.

B. Weather Barrier: Breather Mastic:, Childers CP-10/CP-11 or Foster 46-50 White..

C. Vapor Barrier Coating: Permeance - ASTM E 96, Procedure B, 0.08 perm or less at 45-mil dry film thickness, tested at 100F and 50%RH; Foster 30-65 or Childers CP-34
1. When higher humidity levels may be of concern, only specify the following fungus/mold resistant coating: Foster 30-80 AF (anti fungal). Coating must meet ASTM D 5590 with 0 growth rating**

D. Reinforcing Mesh: 10x10 or 9x8 glass mesh; Foster Mast a Fab or Childers #10

E. Jacket: Pre-sized glass cloth, minimum 7.8 oz/sq yd.

F. Type D4 Insulation Adhesive: Fire resistive to ASTM E84, Childers CP-82 or Foster 85-20.

G. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.

H. Joint Tape: Glass fiber cloth, open mesh.

I. Tie Wire and Wire Mesh: Annealed steel, 16 gage.

J. Stainless Steel Banding: 3/4-inch wide, minimum 22 gage, 304 stainless.

K. Armaflex 520, 520 BLV, or Foster 85-75 contact adhesive.

L. Armatuff 25 white seal seam tape.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that ductwork has been tested before applying insulation materials.

B. Verify that surfaces are clean, foreign material removed, and dry.

C. Maintain required ambient temperature during and after installation for a minimum period of 24 hours.

3.2 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. Extend duct insulation without interruption through walls, floors, and similar penetrations, except where otherwise indicated.

D. Provide external insulation on all round ductwork connectors to ceiling diffusers and on top of diffusers as indicated in the Ductwork Insulation Application and Thickness Schedule and the Drawings. Secure insulation to the top of ceiling diffusers with adhesive that meets NFPA 90A and 90B 25/50 requirements, and vapor barrier or tape to match jacket. Do not insulate top of ceiling diffuser if it is used in ceiling return air plenum or in an open space with no ceiling.

E. Flexible and Rigid fiberglass insulation (Types D1 and D2) application for exterior of duct:

1. Secure insulation jacket joints with vapor barrier adhesive or tape to match jacket.

2. Install without sag on underside of ductwork. Use 4-inch wide strips of adhesive on 8-inch centers and mechanical fasteners where necessary to prevent sagging. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

3. Insulate standing seams and stiffeners that protrude through the insulation with 1-1/2 inch thick, unfaced, flexible blanket insulation. Cover with reinforcing mesh and coat with vapor barrier finish coating.

4. On circumferential joints, the 2-inch flange on the facing shall be secured with 9/16 inch outward clinch steel staples on 2-inch centers, and taped with minimum 3-inch wide strip of glass fabric and finish coating.

5. Vapor seal all seams, joints, pin penetrations and other breaks with vapor barrier coating reinforced with reinforcing mesh.

F. Duct Liner (Type D3 or D6) application for interior of return air sound boots:

1. Secure insulation with 100 percent coverage of duct liner adhesive, pins and clips not more than 18 inches on center.

2. Secure bottom of duct insulation using alternate single and double clips. The first pin will secure the insulation and the second clip will be used to secure the cladding. Isolate the exterior clip from the cladding by using two 1/8 inch closed cell neoprene (Armaflex) washers on either side of the cladding. Predrill holes in cladding and avoid contact with pin during installation.

3. For round duct, secure insulation with 100 percent coverage of duct liner adhesive. Secure cladding with 3/4 inch, 0.020 inch stainless steel bands on 12-inch centers.

4. For joints and overlaps, fold cladding to form a double thickness hem 2 inches minimum. Seal with a non-shrink, non-hardening sealing compound.

5. Type D6: Provide fungicidal coating in air handlers ten feet on either side, first ten feet downstream of cooling coils, ten feet downstream of mix boxes, in mechanical rooms or as otherwise specified in potentially high humidity areas in the duct system shall be coated with an fungicidal coating; EPA registered for use in HVAC duct systems at a coverage rate of 80 ft2/gallon.

G. Insulation (Type D4) application for exterior of grease ducts:

1. External duct wrap system requires two (2) 1.5-inch layers of lightweight, flexible wrap overlapped to provide an effective fire barrier. The barrier is installed in 24-inch or 48-inch wide sections. Insulation pins are welded in certain locations to maintain the fire barrier material up against the duct.

2. Grease duct doors to be installed so the door can be removed and re installed and meet code requirements.

3. Install duct wrap as tested per manufacturer's instructions to assure the duct wrap is mechanically attached per the manufacturer's spacing of bands or weld pins.

4. Vertical and horizontal members of the support hanger system shall be wrapped with one layer of the insulation. Vertical and horizontal portions shall be wrapped independent of one another. The horizontal hanger shall be removed from the vertical support rods and wrapped and then immediately replaced so that an adjacent horizontal support can be removed, wrapped, and reinstalled. The end of the threaded vertical rod shall extend 6-inch past the horizontal member at the beginning of the installation.

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

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

1. Horizontal ductwork located outdoors shall be sloped at a minimum 2-degree angle to prevent the accumulation of water on top of the finished insulated duct. Support members that connect directly to the ductwork are to be insulated with this same material. Keep compression or sharp creases of outdoor insulation to a minimum by distributing the weight of the duct resting on horizontal duct support members.

2. Follow the insulation manufacturer's installation instructions and procedures to assure the ductwork is properly insulated and that the insulation will meet the manufacturer's warranty requirements.

I. All ductwork, accessories, and all plenums including metal and masonry construction, etc., shall be insulated as indicated on the Drawings, as specified herein and as required for a complete system. In each case, the insulation shall be equal to that specified and materials applied and finished as described in these Specifications.

J. Flexible ductwork connections to equipment shall not be insulated.

K. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall all be sealed. Where insulation with a vapor barrier terminates, it shall be sealed off with the vapor barrier being continuous to the surface being insulated. Ends shall not be left raw.

L. Extreme care shall be taken in insulating high and medium pressure ductwork including all ductwork between the fan discharge and all mixing boxes to ensure the duct is not pierced with sheet metal screws or other fasteners. All high and medium pressure ducts in these Specifications are classified as high velocity ductwork.

M. Where canvas finish is specified use lagging adhesive/coating to prevent mildew in securing canvas. Do not use wheat paste. Use only anti fungal lagging adhesive that adheres to ASTM D 5590 with 0 growth rating. (Foster 30-60, Childers CP-137AF). In addition, cover all exterior canvas-covered insulation with a fire retardant weather barrier mastic.

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

O. Flexible round ducts shall be factory insulated.

3.3 INSPECTION

A. Visually inspect the completed insulation installation per manufacturers recommended materials, procedures and repair or replace any improperly sealed joints.

B. Where there is evidence of vapor barrier failure or "wet" insulation after installation, the damaged insulation shall be removed, duct surface shall be cleaned and dried and new insulation shall be installed.

3.4 DUCTWORK INSULATION APPLICATION AND THICKNESS SCHEDULE

Ductwork System	Application	Insulation Type	Insulation Thickness
Outside Air Duct	External Duct Insulation	D1	2"
Supply Air Diffusers	Top of Diffuser	D1	2"
Supply Air Duct	Acoustical Liner	D3	1”
	External Duct Insulation	D1	2"
Return Air Duct	Acoustical Liner	D3	1”
	External Duct Insulation	D3	1"
Supply Air Duct	Outdoor Environment	D5	2”
Return, Exhaust Air Duct	Outdoor Environment	D5	1-1/2"
Kitchen Grease Hood Exhaust Air Duct	All	D4	3"

END OF SECTION 23 07 13

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 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.

D. 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.

E. 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.

F. 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.

G. 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.

H. Install danger signs required by governing regulations and authorities.

I. 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: ≤ 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 licking 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 0^0F-150^0F. 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 - 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 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.

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 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General Provisions of Contract, including General and Supplementary Conditions, apply to Work specified in this Section.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. All other Sections of Division 26

B. All other divisions of Contract Documents. Refer to each Division's Specifications and Drawings for requirements.

1.3 SCOPE OF WORK

A. The purpose and intent of this study is to:

1. Verify that protective equipment and components are applied within their nameplate ratings.

2. Determine settings for the adjustable protective devices to protect system components and maximize system reliability.

3. Identify changes in the utility company protective devices that may be necessary for proper application and protection.

B. The study shall include the electrical distribution system as described as follows:

1. Utility overcurrent devices.

2. The 120/208-volt distribution to include all main protective devices.

C. One-Line Diagrams

1. Prepare a one-line diagram of the power system. This diagram shall identify all components considered in the study, and the ratings of all power devices. (This includes, but is not limited to: transformers, circuit breakers, relays, fuses, busses, and cables). Reference numbers shall be used on the diagram related to key items in the report. ANSI device function numbers shall be used to designate protective relays.

D. Short Circuit Study

1. A Short Circuit Study shall be performed which shows the momentary and interrupting fault duties on each bus shown on the single-line diagram. A computer shall be used to perform calculations for three-phase faults. In addition, an impedance listing shall be prepared showing bus-to-bus impedance values reduced to a common MVA base reference to a single line diagram for ease in reviewing data.

2. Study each fault-interrupting device related to the calculated duty, and verify that devices are applied within published ratings. Recommend changes when appropriate.

E. Coordination Study

1. Perform a comprehensive, protective device coordination study including all devices identified on the single-line diagram. Using a practical compromise between protection of electrical equipment and coordination of devices "downstream", provide setting for all adjustable protective devices shown on the diagram.

2. Study the application of devices versus system needs and verify the new devices that are needed for adequate protection.

3. Prepare hand drafted and/or computer-generated time/current coordination curves to illustrate the protection and coordination achieved with the recommended settings of protective devices. These curves shall reflect the following (where applicable):

   a. Appropriate NEC protection points

   b. Appropriate ANSI protection points for transformers and other equipment.

   c. Magnetizing inrush points of transformers

   d. One-line diagram of the system identifying the device plotted

   e. Short circuit current levels used for coordination.

   f. Motor starting curves

   g. Cable damage curves

1.4 QUALITY ASSURANCE

A. The study shall be conducted by a studies organization with three or more years' experience on this type of study. The studies organization shall have three or more engineers experienced in studies work who are available to share opinions related to significant recommendations. The organization shall have proven computer programs for making three-phase fault duty calculations. A listing of previous study jobs completed and resumes of three studies engineers shall be
available for review. A previous study report shall be available for review to illustrate the type of report that will be supplied.

B. The study work shall be conducted under the applicable standards of the American Nation Standards Institute (ANSI) and the National Electric Code (NEC). Specifically, the following standards shall apply:

ANSI – C37.010 – Latest Revision:	Standard Application Guide for AC High-Voltage Circuit Breakers
ANSI – C37.5 – Latest Revision:	Calculation of Fault Currents for Application of Power Circuit Breakers Rated on a Total Current Basis
ANSI-C37.13 – Latest Revision:	Low-voltage AC Power Circuit Breakers (600 Volt Insulation Class).

IEEE Standard 141 – Latest Revision Also known as the IEEE Red Book.

1.5 SUBMITTALS

A. Provide as required by the General Provisions in Division 1, copies of a draft and final report, which shall contain the following information:

1. An executive summary that identifies any significant problems and recommendations for any corrections.
2. Technical discussion that details the calculation methodology used to develop the one-line diagram and perform the Short Circuit Study and the Coordination Study work. The intent will be to provide the reader with an understanding of the techniques used to develop the study results and the basis for key decisions.
3. A tabulation of all protective devices identified on the one-line diagram, which their ratings compared with respective fault duty as calculated in the study.
4. A tabulation of all the settings recommended on all adjustable protective devices with references to the single-line diagram and to coordination curves.
5. Copies of all time/current coordination curves developed in the study. Curves shall be 11 X 17" format, folded to accommodate the 8 1/2 X 11 Report format.
6. The analysis that leads to specific recommendations included in the executive summary.
7. The single-line diagram of the system studied, including all ratings, identifications described and AutoCAD drawing files.
8. Copies of all short circuit calculations referenced to the single-line diagram and the impedance listings.

B. The Final and Draft Reports shall be prepared using the following format:

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).

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

   ELECTRICAL POWER SYSTEMS STUDY

   Owner's Name

   Project Title

   Space for approval signature of the engineer and approval date

2. Contents: Include at least the following:

   a. Neatly typewritten index near the front of the Manual, giving immediate information as to location within the manual.

C. Such other data as required in pertinent sections of these specifications.

D. Submit as required by the General Provisions in Division 1, copies of a Draft Report to the engineer with the equipment shop drawings. Revise the report as required to accommodate the Engineer's comments.

E. Submit as required by the General Provisions in Division 1, copies of the Final Report within 30 calendar days after approval of the Draft Report.

END OF SECTION 26 05 73

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 - 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:

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

SECTION 28 31 00

FIRE DETECTION AND ALARM SYSTEM
INTELLIGENT FIRE ALARM DETECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. The General Provisions of the Contract, including General and Supplementary Conditions, apply to the Work specified in this Section.

B. Section 21 10 00 – Fire Suppression.

1.2 SUMMARY

A. This section of the specification includes the furnishing, installation, and connection of an intelligent reporting, microprocessor controlled, addressable, fire detection and emergency alarm communication system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, control panels, auxiliary control devices, annunciators, power supplies, and wiring as shown on the drawings and specified herein.

B. The fire alarm shall comply with requirements of NFPA Standard 72 for Fire Alarm Control Unit except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.

C. The system shall be an active/interrogative type system where each addressable device is repetitively scanned, causing a signal to be transmitted to the main Fire Alarm Control Unit (FACU) indicating that the device and its associated circuit wiring is functional. Loss of this signal at the main FACU shall result in a trouble indication as specified hereinafter for the particular input.

D. The system shall support additional, alternate Fire Command Centers, which shall be capable of simultaneous monitoring of all system events. Alternate Fire Command Centers shall also support an approved method of transferring the control functions to an alternate Fire Command Center where necessary.

E. Each designated zone shall transmit separate and different alarm, supervisory and trouble signals to the Fire Command Center (FCC) and designated personnel in other buildings at the site via a multiplex communication network.

F. The fire alarm system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994

G. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and the installation shall comply with the UL listing.

H. The installing company shall employ NICET (minimum Level II Fire Alarm Systems) technicians on site to guide the final checkout and to ensure the systems integrity.

I. System Programming:

1. Ability to program the system via the local user interface.

2. The system shall be capable of off-line/on-line programming by the manufacturers programming utility.

J. Provide a cloud base connected life safety platform with the ability to remotely monitor the buildings fire system and capable of providing system diagnostics with full detail reports on annual test and inspections from a web-based server or mobile device application. The software shall also expand to allow for future offerings and provide dedicated account access to facility users and service personal.

K. The system shall automatically track NFPA 72 installation and testing requirements for all fire system devices to ensure that every device is functionally tested upon installation and then periodically as required by Code. A gateway/hub shall be utilized to retrieve the system information using its native protocol and/or bar codes without the need of additional tools and accessories.

L. This section includes the minimum requirements for the following equipment:

1. Main Fire Alarm Control Unit

2. Signal Line Circuit Control Module

3. Enclosures

4. Digital Voice Command Center

5. Addressable Main Power Supply

6. Auxiliary Addressable Power Supply

7. Power Supply Expander

8. System Circuit Supervision

9. Audio Amplifiers

10. CLSS Gateway

11. Digital Alarm Communicator Transmitter
12. Speaker Notification Devices
13. Audible/Visual Combination Devices
14. Manual Fire Alarm Stations
15. Projected Beam Detectors
16. Waterflow Indicator
17. Annunciator Control Display
18. Network Node Communication
19. ONYX Works Workstation
20. Network Control Display
21. Gateway Communication
22. Addressable Wireless Devices
23. Intelligent Photoelectric Smoke Detectors
24. Intelligent Thermal Detectors
25. Self-testing Photoelectric Smoke Detectors
26. Self-testing Thermal Detectors
27. Self-testing Photo Thermal Detectors
28. High Sensitivity Photo Smoke Detectors
29. Multi-Criteria Smoke Detectors
30. Low Frequency Sounder Base
31. Intelligent Duct Smoke Detectors
32. CO Detectors
33. Photoelectric Smoke and CO Detectors
34. Batteries and External Charger

1.3 APPLICABLE STANDARDS AND SPECIFICATIONS

A. The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards, if applicable.

B. National Fire Protection Association (NFPA) – USA

No. 13	Sprinkler Systems
No. 70	National Electric Code
No. 90A	Air Conditioning Systems
No. 72	National Fire Alarm Code
No. 101	Life Safety Code

C. Underwriters Laboratories Inc. (UL) – USA

No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 217	Smoke Detectors, Single and Multiple Station
No. 228	Door Closers - Holders for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective Signaling Systems
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 1481	Power Supplies for Fire Protective Signaling Systems
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances
No. 2017	Standard for General-Purpose Signaling Devices and Systems

Local and State Building Codes.

Latest Adopted Edition of the International Building Code

Latest Adopted Edition of the International Fire Code

All requirements of the Authority Having Jurisdiction (AHJ)

1.4 APPROVALS

A. The system shall have proper listing and/or approval from the following nationally recognized agencies:

UL	Underwriters Laboratories, Inc.
FM	Factory Mutual
NYFD	New York Fire Department
CSFM	California State Fire Marshal

B. The Fire Alarm Control Unit and all transponders shall meet the modular listing requirements of the tenth edition of UL Standard 864 (Control Units). Each subassembly, including all printed circuits, shall include the appropriate UL modular label. This includes all printed circuit board assemblies, power supplies, and enclosure parts. Systems that do not include modular labels may require return to the factory for system upgrades and are not acceptable.

1.5 SCOPE

A. A new intelligent reporting, microprocessor-controlled fire detection system shall be installed in accordance to the project specifications and drawings.

B. The system shall be designed such that each signaling line circuit (SLC) is limited to only 80% of its total capacity at initial installation.

C. Basic Performance:

1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Class <A, B or X>Signaling Line Circuits (SLC).

2. Initiation Device Circuits (IDC) shall be wired Class <A or B> as part of an addressable device connected by the SLC Circuit.

3. Notification Appliance Circuits (NAC) shall be wired Class <A or B>

4. On Class A configurations a single ground fault or open circuit on the system Signaling Line Circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.

5. Alarm signals arriving at the FACU shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.

6. Speaker circuits may be controlled by NAC outputs built into the amplifiers, which shall function as addressable points on the Digital Audio Loop.

7. Notification Appliance Circuits (NAC) speaker circuits shall be arranged such that there is a minimum of one speaker circuit per floor of the building or smoke zone whichever is greater.

8. Audio amplifiers and tone generating equipment shall be electrically supervised for normal and abnormal conditions.

9. Notification Appliance Circuits (NAC) speaker circuits and control equipment shall be arranged such that loss of any one (1) speaker circuit will not cause the loss of any other speaker circuit in the system.

10. Speaker circuits shall be arranged such that there is a minimum of one speaker circuit per smoke zone.

11. Speaker circuits shall be electrically supervised for open and short circuit conditions. If a short circuit exists on a speaker circuit, it shall not be possible to activate that circuit.

12. Audio amplifiers and tone generating equipment shall be electrically supervised for abnormal conditions. Digital amplifiers shall provide built-in speaker circuits, field configurable as four Class B, two or four Class A circuits where necessary

    a. Speaker circuits shall be <25 or 70V> VRMS Speaker circuits shall have 20% space capacity for future expansion or increased power output requirements.

D. Basic System Functional Operation

When a fire alarm condition is detected and reported by one of the systems initiating devices, the following functions shall immediately occur:

1. The System Alarm shall flash on display.

2. A local piezo electric signal in the control panel shall sound.

3. The touchscreen LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

4. Printing and history storage equipment shall log the information associated each new Fire Alarm Control Unit condition, along with time and date of occurrence.

5. All system output programs assigned via control-by-event interlock programming to be activated by the particular point in alarm shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

6. The audio portion of the system shall sound the proper audio signal to the appropriate zones.

1.6 SYSTEM MAINTENANCE ANALYSIS AND REPORTING

A. The software shall automatically report fire system events during usage and via Push Notifications when the App is not in the foreground on a mobile device. The software shall also record active events during test and inspection mode and capable of silencing alarm/trouble during the test period remotely.

B. The software shall be capable of downloading and uploading such data to approved handheld devices via web portal or bar codes. Systems that rely solely on the use of bar codes shall not be considered as equal. No proprietary software of any kind shall be required for viewing reports online.

C. The software shall have the capability to provide several services with open protocol to allow for future expansion. At minimum the software shall have the following functionalities:

1. Check point access for commissioning.

2. Detail commissioning reports.

3. Facility Management.

4. Service Site Management

5. Check point remote access for service monitoring

6. User Management

D. The software shall be secure and encrypted with user authentication to meet cyber security requirements. Each user shall have a dedicated account with limitations based on designated clearances. Online access to the web-based reporting system shall run 24/7 with no downtime.

E. Allow active control of fire system during test and inspection when connected to the buildings network for authentication. Off premise services shall only allow for monitoring and history of the system.

F. Forwarding of event notifications and reports by utilizing a mobile device or PC.

G. Full capability to monitor an unlimited number of buildings and shall display events customizable to the user.

1.7 SUBMITTALS

A. General

1. Two copies of all submittals shall be submitted to the Architect/Engineer for review.

2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.

3. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.

4. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

B. Shop Drawings

1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.

2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.

3. Show annunciator layout, configurations, and terminations.

C. Manuals

1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.

2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.

3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.

4. Approvals will be based on complete submissions of manuals together with shop drawings.

D. Software Modifications

1. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.

2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.

E. Certifications

1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

1.8 GUARANTY

A. All work performed, and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one-year period shall be included in the submittal bid.

1.9 POST CONTRACT MAINTENANCE

A. Complete maintenance and repair service for the fire detection system shall be available from a factory trained authorized representative of the manufacturer of the major equipment for a period of one (1) years after expiration of the guaranty.

B. As part of the bid/proposal, include a quote for a maintenance contract to provide all maintenance, tests, and repairs described below. Include also a quote for unscheduled maintenance/repairs, including hourly rates for technicians trained on this equipment, and response travel costs for each year of the maintenance period. Submittals that do not identify all post contract maintenance costs will not be accepted. Rates and costs shall be valid for the period of One (1) year after expiration of the guaranty.

C. Maintenance and testing shall be on a semiannual basis or as required by the AHJ. A preventive maintenance schedule shall be provided by the contractor describing the protocol for preventive maintenance. The schedule shall include:

1. Systematic examination, adjustment and cleaning of all detectors, manual fire alarm stations, control panels, power supplies, relays, waterflow switches and all accessories of the fire alarm system.

2. Each circuit in the fire alarm system shall be tested semiannually.

3. Each smoke detector shall be tested in accordance with the requirements of NFPA 72 Chapter 7.

1.10 POST CONTRACT EXPANSIONS

A. The contractor shall have the ability to provide parts and labor to expand the system specified, if so requested, for a period of three (3) years from the date of acceptance.

B. As part of the submittal, include a quotation for all parts and material, and all installation and test labor as needed to increase the number of intelligent or addressable devices by ten percent (10%). This quotation shall include intelligent smoke detectors, intelligent heat detectors, addressable manual stations, addressable monitor modules and addressable modules equal in number to one tenth of the number required to meet this specification (list actual quantity of each type).

C. The quotation shall include installation, test labor, and labor to reprogram the system for this 10% expansion. If additional FACU hardware is required, include the material and labor necessary to install this hardware.

D. Do not include cost of conduit or wire or the cost to install conduit or wire.

E. Submittals that do not include this estimate of post contract expansion cost will not be accepted.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Basis of Design Product: Subject to compliance with requirements, provide product indicated on drawings as manufactured by NOTIFIER; a Honeywell company.

2.2 EQUIPMENT AND MATERIAL, GENERAL

A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protected premises protective signaling (fire alarm) system. The authorized representative of the manufacturer of the major equipment, such as control panels, shall be responsible for the satisfactory installation of the complete system. The materials, equipment, and devices shall be tested to function with manufactures approved FACU via a cloud base life safety services system.

B. The system shall fully comply with commissioning and test and inspect reports as outline in NFPA-72. System test shall automatically retrieve the fire systems connected devices utilizing a gateway. In applications where a gateway is not applicable the systems peripheral devices shall be entered manually and/or by using barcodes.

C. All equipment and components shall be installed in strict compliance with each manufacturer's recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc. before beginning system installation. Refer to the riser/connection diagram for all specific system installation/termination/wiring data.

D. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.

2.3 CONDUIT AND WIRE

A. Conduit

1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.

2. Where possible, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross-sectional area where three or more cables are contained within a single conduit.

3. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, as per NEC Article 760.

4. Wiring for 24-volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the Fire Alarm Control Unit, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACU manufacturer.

6. Conduit shall be 3/4-inch (19.1 mm) minimum.

B. System Wiring

1. All fire alarm system wiring must be new.

2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits, signaling line circuits, and notification appliance circuits.

3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).

5. The system shall permit the use of IDC and NAC wiring in the same conduit with the multiplex communication loop.

6. All field wiring shall be completely supervised. In the event of a primary power failure, disconnected standby battery, removal of any internal modules, or any open circuits in the field wiring; a trouble signal will be activated until the system and its associated field wiring are restored to normal condition.

7. All analog voice speaker and analog telephone circuits shall use twisted/shielded pair to eliminate cross talk.

C. Terminal Boxes, Junction Boxes

1. All boxes and cabinets shall be UL listed for their intended purpose.

D. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

E. The Fire Alarm Control Unit shall be connected to a separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire Alarm Control Unit primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold-water pipe or grounding rod.

2.4 MAIN FIRE ALARM CONTROL UNIT

A. The main FACU Central Console shall be a NOTIFIER INSPIRE N16 Series Model and shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, control circuits, and notification appliance circuits, local and remote operator terminals, printers, annunciators, and other system-controlled devices.

B. The FACU will be based on a licensing model to allow for future expansion. Licensable features shall include but not limited to additional general zones, logic zones, CLIP mode support and network display support. The FACU shall be backwards compatible to support previous Onyx series devices.

C. The FACU shall be fully networkable to support traditional NOTI-Fire-Net standard and high speed networks.

D. The main FACU shall include the capability to function as a master network controller along with its main functions.

E. Functionality of the FACU shall allow for the ability to annunciate and specify commands directly from the LED touchscreen without the need of a external programmer.

F. In conjunction with intelligent Signaling Loop Modules the main FACU shall perform the following functions:

1. Supervise and monitor all intelligent addressable detectors and monitor modules connected to the system for normal, trouble and alarm conditions.

2. Supervise all initiating signaling and notification circuits throughout the facility by way of connection to addressable monitor and control modules.

3. Detect the activation of any initiating device and the location of the alarm condition. Operate all notification appliances and auxiliary devices as programmed. In the event of CPU failure, all SLC loop modules shall fallback to local mode. Such local mode shall treat the corresponding SLC loop control modules and associated detection devices as conventional two-wire operation. Any activation of a detector in this mode shall automatically activate associated Notification Appliance Circuits.

4. Visually and audibly annunciate any trouble, supervisory, security or fire or CO (Carbon Monoxide) alarm condition on operator's terminals, panel display, and annunciators.

5. When a fire alarm condition is detected and reported by one of the systems initiating devices or appliances, the following functions shall immediately occur:

    a. The system alarm shall flash on the display.

    b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

    c. The touchscreen LCD display shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.

    d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.

f. When a trouble condition is detected and reported by one of the systems initiating devices or appliances, the following functions shall immediately occur:

g. The system trouble shall flash on the display.

h. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

i. The touchscreen LCD display shall indicate all information associated with the trouble condition, including the type of trouble point and its location within the protected premises.

j. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

k. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (trouble notification appliances and/or relays) shall be activated.

6. When a supervisory, security alarm or pre-alarm condition is detected by an initiating devices or appliance, the following functions shall immediately occur:

a. The system trouble shall flash on the display.

b. A local piezo-electric audible device in the control panel shall sound a distinctive signal.

c. The touchscreen LCD display shall indicate all information associated with the supervisory condition, including the type of trouble point and its location within the protected premises.

d. Printing and history storage equipment shall log and print the event information along with a time and date stamp.

e. All system outputs assigned via preprogrammed equations for a particular point in trouble shall be executed, and the associated system outputs (notification appliances and/or relays) shall be activated.

G. Operator Control

1. Acknowledge

   a. Activation of the control panel acknowledge selection in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble indicators from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, selection of acknowledge shall advance the LCD display to the next alarm or trouble condition. In addition, the FACU shall support Block Acknowledge to allow multiple trouble conditions to be acknowledged with a single tap on the touchscreen button

   b. Tapping on the Acknowledge button shall also silence all remote annunciator piezo sounders.

2. Signal Silence

   a. Tapping of the Signal Silence button shall cause all programmed alarm notification appliances and relays to return to the normal condition. The selection of notification circuits and relays that are silenceable by this switch shall be fully field programmable within the confines of all applicable standards. The FACU software shall include silence inhibit and auto-silence timers.

3. Drill Switch

   a. Selection of the Drill mode shall activate all programmed notification appliance circuits. The drill function shall latch until the panel is silenced or reset.

4. System Reset

   a. Tapping the System Reset button shall cause all electronically latched initiating devices to return to their normal condition. Initiating devices shall re-report if active. Active notification appliance circuits shall not silence upon Reset. Systems that de-activate and subsequently re-activate notification appliance circuits shall not be considered equal. All programmed Control-By-Event equations shall be re-evaluated after the reset sequence is complete if the initiating condition has cleared. Non-latching trouble conditions shall not clear and re-report upon reset.

5. Lamp Test

   a. Tapping the Lamp Test button shall activate all local system LED’s as well as illuminate the LCD display.

6. About Screen

    a. The system shall provide an “About Screen” that offers panel software and hardware version as well as provide a means to upgrade the software for service personnel.

7. Scrolling

    a. Provide a programmable Alert bar such that Tapping on an active events category in the Alert Bar shall vector the display to those categorized events including but not limited to, Fire Alarm, Supervisory, Trouble, CO Alarm and Disable. Tapping on the display and dragging in a upward or downward motion shall scroll through active events

8. Printing

    a. When connected to a supported printer the panel shall print live events. History may also be exported to USB drive.

H. System Capacity and General Operations

1. The control panel shall be scalable up to 10 SLC modules without the need of replacing the CPU. Each SLM module shall support a maximum of 318 analog/addressable devices for a system capacity of 3,180 points. The system shall be capable of up to 2,400 annunciation points per system regardless of the number of addressable devices.

2. The Fire Alarm Control Unit shall include a full featured high definition 10 inch color 1024x600 resolution LCD with capacitive touch display, including audible and visible feedback, adjustable brightness solid-state LCD. It shall also include a graphical QWERTY-style keypad on the color, touchscreen display. The display shall have the

3. ability to scroll events by type (i.e. Fire Alarm, Supervisory Alarm, Trouble, etc) using the touchscreen.

4. The touchscreen LCD shall be intuitive and allow for custom configuration of actionable events to be program as a selectable icon on the screen.

5. The touchscreen LCD shall have the ability to display up to 3,000 events in order of priority and time of occurrence. Counters shall be provided to indicate the total number of events by type

6. The panel display may be converted to a Network control display through licensing

7. The touchscreen LCD shall include indication of Fire Alarm, CO Alarm, Trouble, Supervisory, Signals Silenced, Disabled Points, and other (non-fire) events. The LCD will also include LEDs to indicate primary power status and any off-normal event

8. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the Fire Alarm Control Unit.

9. The FACU shall be able to provide the following software and hardware features:

    a. Pre-signal and Alarm Delay: The system shall provide means to cause alarm signals to only sound in specific areas with a delay of the alarm from 60 to up to 180 seconds after start of alarm processing. In addition, an Alarm Delay selection shall be available that allows a 15-second time period for acknowledging an alarm signal from a fire detection/initiating device. If the alarm is not acknowledged within 15 seconds, all local and remote outputs shall automatically activate immediately.

    b. Smoke Detector Pre-alarm Indication at Control Panel: To obtain early warning of incipient or potential fire conditions, the system shall support a programmable option to determine system response to real-time detector sensing values above the programmed setting. Two levels of Pre-alarm indication shall be available at the control panel: alert and action.

    c. Alert: It shall be possible to set individual smoke detectors for pre-programmed pre-alarm thresholds. If the individual threshold is reached, the pre-alarm condition shall be activated.

    d. Action: If programmed for Action and the detector reaches a level exceeding the pre-programmed level, the control panel shall indicate an action condition. Sounder bases installed with either heat or smoke detectors shall automatically activate on action Pre-Alarm level, with general evacuation on Alarm level.

    e. The system shall support a detector response time to meet world annunciation requirements of less than 3 seconds.

    f. Device Blink Control: Provide a means to enable or disable detector/module LED indicators for special areas.

    g. NFPA 72 Smoke Detector Sensitivity Test: The system shall provide an automatic smoke detector test function that meet the requirements of NFPA 72.

    h. Programmable Trouble Reminder: The system shall provide means to automatically initiate a reminder that a Fire Alarm or CO Alarm or supervisory event or troubles exist in the system. The reminder will appear on the system display and (if enabled) will sound a piezo alarm.

i. On-line or Off-line or Remote programming: The system shall provide means to allow panel programming either through an off-line software utility program away from the panel or while connected online or remotely connected to the panel via a secured gateway. The system shall also support upload and download of programmed database to a Personal Computer/cloud.

j. History Events: The panel shall be capable maintaining a history file up to the last 10,000 events, each with a time and date stamp and shall allow to scroll through all stored events. History events shall include all alarms, troubles, operator actions, and programming entries. The control panels shall be able to export the history to a USB drive.

k. The system shall provide means for all SLC devices on any SLC loop to be auto programmed into the system by specific address. The system shall recognize specific device type ID's and associate that ID with the corresponding address of the device.

l. Drill: The system shall support means to activate all silence able fire output circuits in the event of a practice evacuation or "drill". If enabled for local control, the front panel switch shall be held for a minimum of 2 seconds prior to activating the drill function.

m. Passwords and Users: The system shall support 5 access levels System Operator, Building Maintenance User, Technician User, Admin User, Master User. and up to 50 usernames and passwords. Each role has default permissions that can be customized. Only the master password shall allow access to password change screens.

n. Two Wire Detection: The system shall support standard two wire detection devices specifically from the following manufacturer; System Sensor.

o. Block Acknowledge: The system shall support a block Acknowledge for Trouble and Disable conditions

p. Service mode: Panel shall support a Service Mode in which state, the panel can be accessed remotely for programming, testing and control. Service mode shall have a time out feature that can be customized. While in Service Mode the panel shall display a trouble condition.

q. Magnet test – Panel shall support A/V magnet test with compatible A/V appliances which allows to test individual A/V appliances on the NAC circuit by applying the magnet to appliance shortly without activating the entire circuit minimizing disruptions during testing and inspection

r. Sensitivity Adjust: The system shall provide Automatic Detector Sensitivity Adjust based on Occupancy schedules including a Holiday list of up to 15 days.

s. Environmental Drift Control: The system shall provide means for setting Environmental Drift Compensation by device. When a detector accumulates dust in the chamber and reaches an unacceptable level but yet still below the allowed limit, the control panel shall indicate a maintenance alert warning. When the detector accumulates dust in the chamber above the allowed limit, the control panel shall indicate a maintenance urgent warning.

t. Custom Action Messages: The system shall provide means to enter up to 100 custom action messages of up to 160 characters each. It shall be possible to assign any of the 100 messages to any point.

u. Custom Action Button: Panel will support up to 32 programmable custom action buttons on the LCD touchscreen display to enable/disable or control panel outputs without the use of additional hardware

v. Print Functions: When connected to a supported printer the panel shall print live events. History may also be exported to USB drive

w. Local Mode: If communication is lost to the central processor the system shall provide added survivability through the intelligent loop control modules. Inputs from devices connected to the SLC and loop control modules shall activate outputs on the same loop when the inputs and outputs have been set with point programming to participate in local mode or when the type codes are of the same type: that is, an input with a fire alarm type code shall activate an output with a fire alarm type code.

x. Resound based on type for security or supervisory: The system shall indicate a Security alarm when a monitor module point programmed with a security Type Code activates. If silenced alarms exist, a Security alarm will Resound the panel sounder. The system shall indicate a Supervisory alarm when a monitor module point programmed with a supervisory Type Code activates. If there are silenced alarms, a Supervisory alarm will Resound the panel sounder.

y. Read status preview - enabled and disabled points: Prior to re-enabling points, the system shall inform the user that a disabled device is in the alarm state. This shall provide notice that the device must be reset before the device is enabled thereby avoiding activation of the notification circuits.

z. Custom Wallpaper: The panel display shall permit uploading of a custom background wallpaper.

aa. Multi-Detector and Cooperating Detectors: The system shall provide means to link one detector to up to two detectors at other addresses on the same loop in cooperative multi-detector sensing. There shall be no requirement for sequential addresses on the detectors and the alarm event shall be a result or product of all cooperating detectors chamber readings.

bb. Tracking/Latching Ductdetector : The system shall support both tracking and latching duct detectors photo types.

cc. Alarm Verification, by device, with timer and tally: The system shall provide a user-defined global software timer function that can be set for a specific detector or indicating panel module input. The timer function shall delay an alarm signal for a user-specified time period and the control panel shall ignore the alarm verification timer if another alarm is detected during the verification period. It shall also be possible to set a maximum verification count between 0 and 20 with the "0" setting producing no alarm verification. When the counter exceeds the threshold value entered, a trouble shall be generated to the panel.

I. Central Processing Unit

1. The Central Processing Unit shall be the same component with the ability to expand to a larger system as required by the project without the need to be replaced.

2. The Central Processing Unit shall communicate with, monitor, and control all other modules within the control panel. Removal, disconnection or failure of any control panel module shall be detected and reported to the system display by the Central Processing Unit.

3. The Central Processing Unit shall contain and execute all control-by-event (including Boolean functions including but not limited to AND, OR, NOT, ANYX, and CROSSZONE) programs for specific action to be taken if an alarm condition is detected by the system. Such control-by-event programs shall be held in non-volatile programmable memory and shall not be lost with system primary and secondary power failure.

4. The Central Processing Unit shall also provide a real-time clock for time annotation, to the second, of all system events.

5. Consistent with UL864 standards, the CPU and associated equipment are to be protected so that voltage surges or line transients will not affect them.

6. Each peripheral device connected to the CPU shall be continuously scanned for proper operation. Data transmissions between the CPU and peripheral devices shall be reliable and error free. The transmission scheme used shall employ dual transmission or other equivalent error checking techniques.

7. The CPU shall provide three EIA-485 ports for the serial connection to annunciation and control subsystem components.

8. The EIA-232 serial output circuit shall be optically isolated to assure protection from earth ground.

9. The CPU shall provide one high-speed serial connection for support of network communication modules.

10. The CPU shall provide a trouble relay.

11. The EIA-232 interface may be used for network connection to a proprietary-receiving unit.

12. An expandable power supply shall be allowed for future system modifications.

J. System Display

1. The system display shall provide all the controls and indicators used by the system operator and may also be used to program operational parameters.

2. The display assembly shall contain, and display as required, custom alphanumeric labels for all intelligent detectors, addressable modules, and software zones. The system display shall provide a full featured high definition 10 inch color LCD with touch capability display, including audible and visible feedback, adjustable brightness solid-state LCD. It shall also include a graphical QWERTY-style keypad when needed on the color, touchscreen display. The display shall have the ability to scroll events by type (i.e. Fire Alarm, Supervisory Alarm, Trouble, etc) using the touchscreen The display shall indicate the status of the following system parameters: AC POWER, FIRE ALARM, PREALARM, SECURITY, SUPERVISORY, SYSTEM TROUBLE, OTHER EVENT, SIGNALS SILENCED, POINT DISABLED, and any off normal conditions.

3. The system display shall provide a graphical QWERTY style keypad when needed with control capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Five access levels System Operator, Building Maintenance User, Technician User, Admin User, Master User. Up to 50 usernames and passwords shall be accessible through the display interface to prevent unauthorized system control or programming.

4. The system display shall include the following operator control selections: ACKNOWLEDGE, SIGNAL SILENCE, RESET, DRILL, and LAMP TEST. Additionally, the display interface shall allow scrolling of active events including,

5. FIRE ALARM, CO ALARM, SECURITY, SUPERVISORY, TROUBLE, DISABLE and OTHER EVENTS. The touchscreen LCD shall be intuitive and allow for custom configuration of actional events to be program as a selectable icon on the screen.

K. Loop (Signaling Line Circuit) Control Module

1. The Loop Control Module shall monitor and control a minimum of 318 intelligent addressable devices. This includes 159 intelligent detectors (Photoelectric, or Thermal) and 159 monitor or control modules.

2. The Loop Control Module shall contain its own microprocessor and shall be capable of operating in a local/ mode (any addressable device input shall be capable of activating any or all addressable device outputs) in the unlikely event of a failure in the main CPU.

3. The Loop Control Module shall provide power and communicate with all intelligent addressable detectors and modules on a single pair of wires. This SLC Loop shall be capable of operating as a NFPA Class A, B or X circuit.

4. The SLC interface board shall be able to drive a twisted unshielded circuit up to 12,500 feet in length. The SLC Interface shall also be capable of driving an NFPA Class A, no twist, no shield circuit for limited distances determined by the manufacturer. In addition, SLC wiring shall meet the listing requirements for it to exit the building or structure. "T"-tapping shall be allowed in either case.

5. The SLC interface board shall receive analog or digital information from all intelligent detectors and shall process this information to determine whether normal, alarm, or trouble conditions exist for that particular device. Each SLC Loop shall be isolated and equipped to annunciate an Earth Fault condition. The SLC interface board software shall include software to automatically maintain the detector's desired sensitivity level by adjusting for the effects of environmental factors, including the accumulation of dust in each detector. The analog information may also be used for automatic detector testing and the automatic determination of detector maintenance requirements.

L. Enclosures

1. The control panel shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.

2. The back box and door shall be constructed of 0.060 steel with provisions for electrical conduit connections into the sides and top.

3. The door shall provide a key lock and include a transparent opening for viewing all indicators. For convenience, the door shall have the ability to be hinged on either the right or left-hand side and dress plates can be installed and removed without requiring any specialized tools.

4. The control unit shall be modular in structure for ease of installation, maintenance, and future expansion.

5. The FACU shall have a modular dress panel and door design with interchangeable door hinge locations.

M. Addressable Main Power Supply

1. The Addressable Main Power Supply shall be universal input and shall accept either 120/240 VAC, 50/60 Hz, without any modifications and shall provide all necessary power for the FACU.

2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.

3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-100 amp-hours within a 48-hour period.

4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.

5. The Addressable Main Power Supply shall be power-limited per UL864 requirements.

6. Up to three addressable main power supplies may be added within the same FACU to expand power capacity

7. Each addressable main power supply shall provide a minimum of 4 programmable Notification appliance circuits (NAC)

8. Power distribution of Each addressable main power supply can be customizable to provide system power, NAC, power, Auxillary power and battery charging

N. Auxiliary Addressable Power Supply

1. The auxiliary addressable power supply is a remote 24 VDC power supply used to power Notification Devices and field devices that require regulated 24VDC power. The power supply shall also include and charge backup batteries.

2. The addressable power supply for the fire alarm system shall provide up a minimum of 6.0 amps of 24-volt DC regulated power for Notification Appliance Circuit (NAC) power or 5 amps of 24-volt DC general power. The power supply shall have an additional .5 amp of 24 VDC auxiliary power for use within the same cabinet as the power supply. It shall include an integral charger designed to charge 7.0 - 25.0-amp hour batteries.

3. The addressable power supply shall provide four individually addressable Notification Appliance Circuits that may be configured as two Class "A" and two Class "B" or four Class "B" only circuits. All circuits shall be power-limited per UL 864 requirements.

4. The addressable power supply shall provide built-in synchronization for certain Notification Appliances on each circuit without the need for additional synchronization modules. The power supply's output circuits shall be individually selected for synchronization. A single addressable power supply shall be capable of supporting both synchronized and non-synchronized Notification Devices at the same time.

5. The addressable power supply shall operate on 120 or 240 VAC, 50/60 Hz.

6. The interface to the power supply from the Fire Alarm Control Unit (FACU) shall be via the Signaling Line Circuit (SLC) or other multiplexed means Power supplies that do not use an intelligent interface are not suitable substitutes. The required wiring from the FACU to the addressable power supply shall be a single unshielded twisted pair wire. Data on the SLC shall be transmitted between 24 VDC, 5 VDC and 0 VDC at approximately 3.33k baud.

7. The addressable power supply shall supervise for battery charging failure, AC power loss, power brownout, battery failure, NAC loss, and optional ground fault detection. In the event of a trouble condition, the addressable power supply shall report the incident and the applicable address to the FACU via the SLC.

8. The addressable power supply shall have an AC Power Loss Delay option. If this option is utilized and the addressable power supply experiences an AC power loss, reporting of the incident to the FACU will be delayed. A delay time of eight or sixteen hours shall be Dip-switch selected.

9. The addressable power supply shall have an option for Canadian Trouble Reporting and this option shall be Dip-switch selectable.

10. The addressable power supply mounts in either the FACU backbox or its own dedicated surface mounted backbox with cover.

11. Each of the power supply's four output circuits shall be DIP-switch selected for Notification Appliance Circuit or General Purpose 24 VDC power. Any output circuit shall be able to provide up to 2.5 amps of 24 VDC power.

12. The addressable power supply's output circuits shall be individually supervised when they are selected to be either a Notification Appliance Circuit when wired Class "A" or by the use of and end-of-line resistor. When the power supply's output circuit is selected as General 24VDC power, the circuit shall be individually supervised when an end-of-line relay is used.

13. When selected for Notification Appliance Circuits, the output circuits shall be individually DIP-switch selectable for Steady, March Time, Dual Stage or Temporal.

14. When selected as a Notification Appliance Circuit, the output circuits of the addressable power supply shall have the option to be coded by the use of a universal zone coder.

15. The addressable power supply shall interface and synchronize with other power supplies of the same type. The required wiring to interface multiple addressable power supplies shall be a single unshielded, twisted pair wire.

16. An individual or multiple interfaced addressable power supplies shall have the option to use an external charger for battery charging. Interfaced power supplies shall have the option to share backup battery power.

O. Power Supply Expander

The PSE is a device designed for use as either a remote 24-volt power supply or used to power Notification Appliances.

1. The PSE shall offer up to 6.0 amps or 10 amps of regulated 24volt power. It shall include an integral charger designed to charge up to 33-amp hour batteries.

2. The Power Supply Expanders shall have two or three fully isolated input triggers configurable, pairing any input with any output. The input trigger shall be a Notification Appliance Circuit (from the Fire Alarm Control Unit) or a control module. Five or Seven outputs shall be available for connection to the Notification devices Class B or Class A (without losing any output using converter card)

3. UL-Listed NAC synchronization using System Sensor, Wheelock, Gentex or AMSECO appliances. Sync signal maybe triggered from FACU NAC or remote sync outputs allowing cascading or daisy chain multiple power supplies.

4. The PSE shall include trouble history modes for diagnostic support. PSE shall include individual NAC power and trouble LEDs for diagnostic efficiency.

5. The Power Supply Expanders shall include the ability to delay the AC fail delay per NFPA requirements.

6. Self-Contained in compact, locking cabinet constructed of heavy gauge steel with a corrosion-resistant powder coat chip and scratch-resistant finish. Cabinet shall consist of 10 double knockouts and a removable door for ease of installation and wiring.

7. The PSE shall be capable of utilizing a wide range of end of line supervision values (normal 2K- 27K ohms).

8. The PSE shall be completely configurable via onboard dip switches, with no extra software required.

P. System Circuit Supervision

1. The FACU shall supervise all circuits to intelligent devices, transponders, annunciators and peripheral equipment and annunciate loss of communication with these devices. The CPU shall continuously scan above devices for proper system operation and upon loss of response from a device shall sound an audible trouble, indicate which device or devices are not responding and print the information in the history buffer and on the printer.

2. Transponders that lose communication with the CPU shall sound an audible trouble and light an LED indicating loss of communications.

3. Sprinkler system valves, standpipe control valves, PIV, and main gate valves shall be supervised for off-normal position.

4. All speaker and emergency phone circuits shall be supervised for opens and shorts. Each transponder speaker and emergency phone circuit shall have an individual ON/OFF indication (green LED).

Q. Field Wiring Terminal Blocks

1. All wiring terminal blocks shall be the plug-in/removable type and shall be capable of terminating up to 12 AWG wire. Terminal blocks that are permanently fixed to the PC board are not acceptable.

2. Adjustment of the correct audio level for the amplifier shall not require any special tools or test equipment.

3. Includes audio input and amplified output supervision, back up input, and automatic switch over function, (if primary amplifier should fail).

4. System shall be capable of backing up digital amplifiers.

5. One-to-one backup shall be provided by either a plug-in amplifier card or a designated backup amplifier of identical model as the primary amplifier.

6. One designated backup amplifier shall be capable of backing up multiple primary amplifiers mounted in the same or adjacent cabinets.

7. Multi-channel operation from a single amplifier shall be supported by the addition of an optional plug-in amplifier card.

R. Audio Message Generator (Prerecorded Voice)/Speaker Control:

1. Each initiating zone or intelligent device shall interface with an emergency voice communication system capable of transmitting a prerecorded voice message to all speakers in the building.

2. Actuation of any alarm initiating device shall cause a prerecorded message to sound over the speakers. The message shall be repeated four (4) times. Pre- and post-message tones shall be supported.

3. A built-in microphone shall be provided to allow paging through speaker circuits.

4. System paging from emergency telephone circuits shall be supported.

5. The audio message generator shall have the following indicators and controls to allow for proper operator understanding and control:

    a. Lamp Test

    b. Trouble

    c. Off-Line Trouble

    d. Microphone Trouble

    e. Phone Trouble

    f. Busy/Wait

    g. Page Inhibited

    h. Post Announcement Tone

6. Emergency Two-Way Telephone Control Switches/Indicators:

    a. The emergency telephone circuit control panel shall include visual indication of active and trouble status for each telephone circuit in the system.

    b. The telephone circuit control panel shall include switches to manually activate or deactivate each telephone circuit in the system.

S. Controls with associated LED Indicators

1. Speaker Switches/Indicators

    a. The speaker circuit control switches/indicators shall include visual indication of active and trouble status for each speaker circuit in the system.

    b. The speaker circuit control panel shall include switches to manually activate or deactivate each speaker circuit in the system.

T. Remote Transmissions

1. Provide local energy or polarity reversal or trip circuits as required.

2. The system shall be capable of operating a polarity reversal or local energy or fire alarm transmitter for automatically transmitting fire information to the fire department.

3. Provide capability and equipment for transmission of zone alarm and trouble signals to remote operator's terminals, system printers and annunciators.

4. Transmitters shall be compatible with the systems and equipment they are connected to such as timing, operation and other required features.

U. System Expansion

1. Design the main FACU and required components so that the system can be expanded in the future (to include the addition of twenty percent more circuits or zones) without disruption or replacement of the existing control panel. This shall include hardware capacity, software capacity and cabinet space.

V. Field Programming

1. The system shall be programmable, configurable and expandable in the field using the programming utility provided by the manufacturer .

2. All field defined programs shall be stored in non-volatile memory.

3. Five levels of password protection shall be provided in addition to a key-lock cabinet. Building Maintenance User, Technician User, Admin User, Master User and up to 50 usernames and passwords. Each role has default permissions that can be customized. Only the master password shall allow access to password change screens.

4. The system shall enforce the change from factory default password and it shall be a minimum of Eight (8) characters with a maximum of 16

5. The system programming shall be "backed" up via an upload/download program and stored on compatible removable media and also provide means to backup the file to the cloud.

6. A system back-up disk shall be completed and given in duplicate to the building owner and/or operator upon completion of the final inspection. The program that performs this function shall be "non-proprietary", in that, it shall be possible to forward it to the building owner/operator upon his or her request.

7. The installer's field programming and hardware shall be functionally tested on a computer against known parameters/norms which are established by the FACU manufacturer. A software program shall test Input-to-Output correlations, device Type ID associations, point associations, time equations, etc. This test shall be performed on windows-compatible PC with a verification software package. A system generated report of the test results shall be provided to the engineer(s) on record.

W. Specific System Operations

1. Smoke Detector Sensitivity Adjust: Means shall be provided for adjusting the sensitivity of any or all analog intelligent smoke detectors in the system from the system keypad or from the keyboard of the video terminal. Sensitivity range shall be within the allowed UL window.

2. Alarm Verification: Each of the Intelligent Addressable Smoke Detectors in the system may be independently selected and enabled to be an alarm verified detector. The alarm verification function shall be programmable from 5 to 50 seconds and each detector shall be able to be selected for verification during the field programming of the system or any time after system turn-on. Alarm verification shall not require any additional hardware to be added to the control panel. The FACU shall keep a count of the number of times that each detector has entered the verification cycle. These counters may be displayed and reset by the proper operator commands.

X. System Point Operations

1. Any addressable device in the system shall have the capability to be enabled or disabled through the system display.

2. System output points shall be capable of being turned on or off from the system display

3. Point Read: The system shall be able to display the following point status diagnostic functions without the need for peripheral equipment. Each point shall be annunciated for the parameters listed:

    a. Device Status.

    b. Device Type.

    c. Custom Device Label.

    d. Software Zone Label.

    e. Device Zone Assignments.

    f. Analog Detector Sensitivity.

    g. All Program Parameters.

4. System History Recording and Reporting: The Fire Alarm Control Unit shall contain a history buffer that will be capable of storing up to 10000 system events. Each of these events will be stored, with time and date stamp, until an operator requests that the contents be either displayed or printed. The contents of the history buffer may be manually reviewed; one event at a time, and the actual number of activations may also be displayed and or printed. History events shall include all alarms, troubles, operator actions, and programming entries.

5. The history buffer shall use non-volatile memory. Systems which use volatile memory for history storage are not acceptable.

6. Automatic Detector Maintenance Alert: The Fire Alarm Control Unit shall automatically interrogate each intelligent system detector and shall analyze the detector responses over a period of time.

7. If any intelligent detector in the system responds with a reading that is below or above normal limits, then the system will enter the trouble mode, and the particular Intelligent Detector will be annunciated on the system display and printed on the optional system printer. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.

8. The system shall include the ability (programmable) to indicate a "pre-alarm" condition. This will be used to alert maintenance personal when a detector is at 80% of its alarm threshold in a 60 second period.

2.5 CLOUD BASED REPORTING AND MONITORING REQUIREMENTS

A. All equipment, components and software shall be new and meet manufacturer's current model. The materials, equipment, and devices shall be tested to function with manufacture's approved FACU via a cloud-based life safety services system.

B. The system shall fully comply with commissioning and test and inspect reports as outlined in NFPA-72. System test shall automatically retrieve the fire systems connected devices utilizing a gateway. In applications where a gateway is not applicable the systems peripheral devices shall be imported from the panel programming file, entered manually and/or by using barcodes.

C. Connected Life Safety Services Software Platform:

1. The software shall meet all the requirements outline in the System Maintenance and Analysis Reporting section of this specification.

    a. System shall be compatible with IOS and Android mobile functionality and have web-based access with Windows and MAC based platforms without the need to install software on a dedicated network server.

b. Functions through the mobile App and Web access should have all the following features:

1) Device count per building

2) Event log on App and Web access

3) Control and reporting via Mobile App

4) Automatic data input

5) Automatic report generation

6) Cause & Effect testing

7) Ability to change panel device labels

2. The system shall support an IP based gateway to enable the panel or local Noti-Fire-Net to be connected to an ONYX-Works workstation via the Inter-net or Intranet. This gateway shall also support the ability to integrate the system to an interactive firefighter's display.

D. Permanently installed Fixed Gateway: The system shall be capable of being interfaced with a fixed gateway to integrate with 3rd Party Service Management Software.

E. CLSS Gateway:

1. Provide a CLSS gateway for connection to a NOTIFIER fire system panel, serving as an interface between the FACU, Cloud and peripheral devices. The CLSS gateway shall be capable of reading the connected device system data base from a single or network of panels and shall transmit the data to the Connected Life Safety Services (CLSS) cloud.

2. Equipment standard features shall allow Blue Tooth mobile paring for gateway configuration and control capability.

3. Connection to NOTIFIER INSPIRE N16 series fire system panels utilizing Universal Protocol Ports via NUP

4. Provide Nominal Voltage consumption of 12V to 32V DC from the FACU or an external power supply.

5. The CLSS gateway shall allow for alarm transmission to a central station via IP and CELLULAR (LTE).

6. The system shall support the ability to generate automated commissioning reports or test and inspection reports for installation or test & inspection personnel via the Connected Life Safety Service (CLSS) platform. The reports should be stored in cloud, enabling appropriate stakeholders to retrieve test and inspect report immediately after completion of the system commissioning or test and inspection.

7. Inspection report shall indicate the method in which the device disposition was captured. Either by event received from a connected gateway, barcode scan, or manual user entry,

8. The CLSS platform shall support the ability to automatically capture every addressable device connected to the system ensuring that each addressable device is accounted for and properly tested. CLSS shall also support importing any non-addressable devices associated with the system to ensure all system devices are accounted for and properly tested.

9. For self-testing devices CLSS shall identity any issues associated with the integrity or the ability for the smoke detector to properly detect smoke such as a dust cap not being removed or someone tampering with the detector by obstructing the smoke detector chamber.

10. The CLSS Gateway shall support the ability to send events from a single Notifier N16 panel or a network of up to 16 panels using standard BACnet communications protocol

11. The CLSS Gateway shall support the ability to send events from single Notifier N16 panel or a network of up to 10 panels using standard MODbus communications protocol

F. Digital Alarm Communication Transmitter

1. The CLSS gateway shall include an interface to allow for cell communication, per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events.

2. Communication via cellular shall be concluded by utilizing AT&T or Verizon communication services.

3. The CLSS Gateway shall be completely field programmable utilizing the CLSS mobile app. Diagnostic information such as cell signal strength, connection method, and connection status of the communicator should be available to users via the website and mobile app.

4. Communication shall include vital system status such as:

    a. Independent Zone (Alarm, trouble, non-alarm, supervisory)

    b. Independent Addressable Device Status

    c. AC (Mains) Power Loss

    d. Low Battery and Earth Fault

    e. System Off Normal

    f. 6, 12 or 24 Hour Test Signal

    g. Abnormal Test Signal (per UL requirements)

    h. Communications Failure between panel and gateway

5. It shall support independent zone/point reporting when used in the Contact ID format. In this format the communicator shall support transmission of up to 3180 Points. This enables the central station to have exact details concerning the origin of the fire or response emergency.

2.6 SYSTEM COMPONENTS

A. Speakers: Notifier-System Sensor PN SPRL or SPRL Series

1. All speakers/audibles shall operate on 25 VRMS or 70VRMS with field selectable output taps from 0.5 to 2.0 Watts.

2. Speakers/audibles in corridors and public spaces shall produce a nominal sound output of 84 dBA at 10 feet (3m).

3. Frequency response shall be a minimum of 400 HZ to 4000 HZ. Capable of producing 520 HZ low Frequency for hearing impaired, etc.

B. Audible/Visual Combination Devices

1. Shall meet the applicable requirements of Section A listed above for audibility.

2. Shall meet the requirements of Section D listed below for visibility.

3. Visuals shall be installed at a height no less than 90 inches from the floor and no less than 6 inches below the finished ceiling when the greater of the two cannot be achieved as required per NFPA-72.

C. Programmable Electronic Sounders

1. Electronic sounders shall operate on 24 VDC nominal.

2. Electronic sounders shall be field programmable without the use of special tools, at a sound level of at least 80 dBA measured at 10 feet from the device & low frequency 520Hz sounders shall provide sound level at least 75 dBA measured at the pillow per NFPA 72

3. Shall be flush or surface mounted as shown on plans.

D. Strobe lights, such as the Notifier-System Sensor PN SRL series, shall meet the requirements of the ADA, UL Standard 1971, be fully synchronized, and shall meet the following criteria:

1. The maximum pulse duration shall be 20 milliseconds.

2. Strobe intensity shall meet the requirements of UL 1971.

3. The flash rate shall meet the requirements of UL 1971.

E. Manual Fire Alarm Stations

1. Manual fire alarm stations shall be non-code, non-break glass type, equipped with key lock so that they may be tested without operating the handle.

2. Stations must be designed such that after an actual activation, they cannot be restored to normal except by key reset.

3. An operated station shall automatically condition itself so as to be visually detected, as operated, at a minimum distance of 100 feet (30.5 m) front or side.

4. Manual stations shall be constructed of high impact Lexan, with operating instructions provided on the cover. The word FIRE shall appear on the manual station in letters one half inch (12.7 mm) in size or larger.

5. Manual Fire Alarm station shall be located within 5ft of each exit door and mounted between 42-48 inches from the finish floor as required per NFPA-72 and ADA requirements.

6. Add additional manual fire alarm stations when the distance between stations exceeds 200ft.

F. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate an intelligent photoelectric detector that provides continuous analog monitoring and alarm verification from the panel. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system. The Intelligent Duct Smoke Detector shall support the installation of addressable Photoelectric detector capable or being tested remotely. The Intelligent Duct Detector housing shall be model # DNR(W) and the remote test capable photoelectric smoke detector shall be NOTIFIER model # FSP-951R.

G. Projected Beam Detectors

1. The projected beam type shall 24 VDC device.

2. The detector shall be listed to UL 268A

3. The detector shall operate in either a short range (16' - 100') or long range (100' - 330') mode.

4. The temperature range of the device shall be -22 degrees F to 131 degrees F.

5. The detector shall feature a bank of four alignment LEDs on both the receiver and the transmitter that are used to ensure proper alignment of unit without special tools.

6. Beam detectors shall feature automatic gain control which will compensate for gradual signal deterioration from dirt accumulation on lenses.

7. The unit shall be both ceiling and wall mountable.

8. The detector shall have the ability to be tested using calibrated test filters or magnet activated remote test station.

H. Waterflow Monitoring

1. The FACU shall be capable of monitoring any 3rd party water flow devices and annunciating with unique indication for alarm or supervisory condition

2. The FACU addressable monitoring point shall monitor normally open contacts and display status

3. Need to add points around monitoring for opens/shorts, ground faults

I. LED Annunciator Control Display

1. The annunciator shall provide the FACU or NCD with local or remote, serially connected annunciators. Arrays of LED's indicate, at the panel or at the remote location the status of the system.

2. The annunciator shall provide 60 RGB LEDs allowing for multiple programmable color indications

3. The annunciator shall provide 30 capacitive touch programmable control points.

4. The annunciator communicates to the FACU via a two-wire serial interface. Power is provided by the FACU via 24 VDC power and is inherently supervised

5. Up to 80 annunciators can be supported by the FACU., it shall allow up to 10 annunciators to be configured as routers with each router supporting an additional 15 annunciators

J. Remote LCD annunciator

1. The 5inch capacitive full color touchscreen LCD annunciator shall display all system events.

2. An audible indication of alarm shall be integral to the display.

3. The display shall be UL listed for fire alarm application.

4. It shall be possible to connect up to 10 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.

5. Each LCD display shall mimic the main control panel.

2.7 SYSTEM COMPONENTS – ADDRESSABLE DEVICES

A. Addressable Devices – General

1. Addressable devices shall provide an address-setting means using rotary decimal switches. Addressable devices that require the address be programmed using a programming utility are not an allowable substitute.

2. Addressable devices shall use simple to install and maintain decade (numbered 0 to 15) type address switches. Devices which use a binary address or special tools for setting the device address, such as a dip switch are not an allowable substitute.

3. Detectors shall be Analog and Addressable and shall connect to the Fire Alarm Control Unit's Signaling Line Circuits.

4. Addressable smoke and thermal detectors shall provide dual (2) status LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the flashing mode operation of the detector LEDs can be programmed via the fire control panel program.

5. The Fire Alarm Control Unit shall permit detector sensitivity adjustment through field programming of the system. Sensitivity can be automatically adjusted by the panel on a time-of-day basis.

6. Using software in the FACU, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.

7. The detectors shall be ceiling mounted and shall include a separate twist-lock base which includes a tamper proof feature.

8. The following bases and auxiliary functions shall be available:

    a. Sounder base rated at 85 Db(high) and 75 Db (low)

    b. Form-C Relay base

    c. Isolator base

    d. Where required a Low Frequency 520 HZ

9. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.

10. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (example: Duct, PHOTO, THERMAL). Self-testing initiating devices shall be capable of providing both a functional test and smoke entry test using a self-test function. The detector shall transmit a wireless beacon activated only during self-test mode designed to communicate with the CLSS app to prove successful completion of a visual inspection.

    a. Detector Sensitivity Level as required per design.

        1) High = 1.6% obs/m (0.5% obs/ft),

        2) Enhanced = 4% obs/m (1.3% obs/ft)

3) Standard = 8% obs/m (2.5% obs/ft)

b. The detector shall have a test port per detection chamber to facilitate centralized smoke test under user control.

B. Addressable Manual Fire Alarm Box (manual station)

1. Addressable manual fire alarm boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.

2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.

3. Manual fire alarm boxes shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.

C. Addressable Wireless Devices

1. The system shall be capable of supporting intelligent addressable wireless detectors, modules, pull stations and AV devices with similar capabilities as wired addressable intelligent devices.

2. Intelligent wireless devices shall utilize a gateway device to communicate with the intelligent Fire Alarm Control Unit, so that the wireless devices report to the panel using the established SLC protocol.

3. Wireless devices shall be capable of co-existing on the same panel with wired devices, and shall be capable of participating in common control-by-event programming sequences.

4. Wireless devices (excepting the gateway) shall operate on batteries recommended by the manufacturer and shall be UL tested and listed for 2 years of system operation on one set of batteries.

5. Intelligent wireless devices shall use a UL approved Class A mesh communication protocol to provide redundant supervised wireless communication links.

6. Wireless AV systems shall offer synchronization within a single mesh network.

7. Available Wireless devices shall include:

    a. Intelligent wireless smoke detector (photoelectric technology)

    b. Intelligent wireless smoke/heat combo detector

    c. Intelligent wireless fixed temperature heat detector, 135 degrees F.

    d. Intelligent wireless rate of rise heat detector, 135 degrees F.

    e. Wireless monitor module

    f. Wireless relay module

    g. Wireless synchronization module

    h. Wireless AV base for use with wired AV devices

    i. Wireless pull station

    j. Wireless gateway

8. A program that supports qualification of potential wireless applications, configuration and installation, and diagnostics shall be available. This program shall be installed on a Windows® PC, and shall be capable of communicating with wireless devices by use of a USB adapter that plugs into the computer.

D. Intelligent Photoelectric Smoke Detector

1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.

E. Intelligent Thermal Detectors

1. The intelligent thermal detectors shall be NOTIFIER FST- series addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute. A high heat thermal detector rated at 190 degrees Fahrenheit shall also be available. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.

F. Self-Testing Photo Smoke Detector

1. Smoke detectors shall be intelligent addressable devices using photoelectric (light scattering) principal to measure smoke density. It shall connect via two wires to the Fire Alarm Control Unit signaling line circuit.

2. The detector shall comply with UL268 7th edition; operating at 24Vdc, nominal.

3. The self-test sensor shall generate a controlled amount of smoke into the chamber which will test the optics in response to a real smoke simulation.

4. The detector shall also measure the dilution of smoke within a set time frame to determine if there is masking that will prevent smoke from entering the chamber.

5. An alarm condition shall be generated upon smoke entering the chamber.

6. A trouble condition shall be generated if the testing chamber reveals it is being blocked.

G. Self-Testing Thermal Detector

1. Thermal detectors shall be intelligent addressable devices rated at 135°F (57.2°C) Fixed Temperature. It shall connect via two wires to the Fire Alarm Control Unit signaling line circuit.

2. The detector shall comply with UL521 and operating at 24VDC, nominal.

3. The self-test sensor shall generate energy into an internal thermistor to allow register heat to be identified.

4. The detector shall also measure the cooling of the heating element after it's cycle has been completed.

5. An alarm condition shall be generated upon the introduction of heat from the thermistor.

6. A trouble condition shall be generated if the thermistor does not detect heat.

H. Self-Testing Photo Thermal Detector

1. 1. Photo Thermal detectors shall be intelligent addressable devices using photoelectric (light-scattering) principal to measure smoke density and rated at 135°F (57.2°C) Fixed Temperature. It shall connect via two wires to the Fire Alarm Control Unit signaling line circuit.

2. The detector shall comply with UL268 7th edition and UL521; operating at 24VDC, nominal.

3. The self-test sensor shall generate a controlled amount of smoke into the chamber which will test the optics in response to a real smoke simulation and shall generate energy into an internal thermistor to allow register heat to be identified.

4. The detector shall also measure the dilution of smoke within a set time frame to determine if there is masking that will prevent smoke from entering the chamber.

5. The detector shall also measure the cooling of the heating element after its cycle has been completed.

6. An alarm condition shall be generated upon smoke entering the chamber. and heat from the thermistor.

7. A trouble condition shall be generated if the testing chamber reveals its being blocked, or if the thermistor does not detect heat.

I. High Sensitivity Photo Smoke Detector

1. The intelligent high sensitivity photoelectric smoke detector shall include a smoke sensing chamber and patented optic block designed to amplify signals from smoke.

2. The intelligent LED photo detector shall have nine sensitivity levels and be sensitive to a minimum obscuration of 0.02 percent per foot.

3. The detector shall be listed to meet UL 268 requirements and UL268A for duct applications.

4. The intelligent High sensitivity photo detector shall support standard, relay, isolator and sounder detector bases.

5. The High sensitivity photo detector shall not require other cleaning requirements than those listed in NFPA 72. Replacement, refurbishment or specialized cleaning of the detector head shall not be required.

J. Multi-Criteria Smoke Detectors

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control unit.

3. Automatically adjusts its sensitivity by means of drift compensation and smoothing algorithms. The detector shall send trouble alarm if it is incapable of compensating for existing conditions.

4. An operator at fire alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

a. Primary status.

b. Device type.

c. Present sensitivity selected.

d. Sensor range (normal, dirty, etc.).

5. Categories of multicriteria detector should offer the following variants for different applications:

a. Fire / CO

b. PTIR (Photo, Thermal, Infrared)

c. Photo/Thermal

d. Photo/CO

e. Each sensor shall be separately listed according to requirements for its detector type (Except IR).

K. Low Frequency Sounder Base

1. Low frequency sounder base shall be listed to UL 268 and UL 464. The low frequency sounder shall have an option to switch between a temporal three-pattern, temporal four pattern, non-temporal (continuous) or march time pattern.

2. The low frequency sounder base shall offer two volume levels. The alarm current shall not exceed 140 mA at 16 VDC and operate between 10% and 93% relative humidity.

3. The low frequency sounder base shall have the ability to synchronize with notification devices without the use of added accessories. A manual locking feature shall be available to prevent removal of the attached sensor head.

L. Intelligent Duct Smoke Detector

1. The smoke detector housing shall accommodate intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.

2. When sufficient smoke is sensed, an alarm signal is initiated at the FACU, and

appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.

M. Addressable Control Module

1. Addressable control modules shall provide supervised monitoring of wiring to load devices that require an external power supply to operate, such as horns, strobes, or bells. It shall be capable of Class B (Style Y) and Class A (Style Z) supervision. Upon command from the control panel, the control module shall be able to disconnect the supervision and connect the external power supply across the load device. The

disconnection of the supervision shall provide verification to the panel that the control relay state changed. The external power supply shall always be relay isolated from the communication loop. The control module shall transmit full analog measurement of the supervised wiring back to the panel and can be used to detect impedance changes or other special test functions.

2. The modules shall provide address-setting means on the module using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or DIP switches to set the module address are not acceptable. The modules shall also store an internal identifying code that the control panel shall use to identify the type of detector. Systems that require a special programmer to set the module address (including temporary connection at the panel) are labor intensive and not acceptable. Each module occupies any one-off at least 99 possible addresses on the signaling line circuit (SLC) loop. It responds to regular polls from the system and reports its type and status. The module shall have an LED that is controlled by the panel to indicate module status. Coded signals, transmitted from the panel, can cause the LED to blink, latch on, or latch off. Refer to the control panel technical documentation for module LED status operation.

3. The module shall mount in a standard 4-inch square, 2-1/8" deep electrical box, surface mounted backbox listed, or compatible duct smoke detector housing. The notification appliance circuit (NAC) shall wire in a Class B (Style Y) or Class A (Style Z) fashion. Each control module shall support up to 1 amp of inductive or 2 amps of resistive audible/visual signals. Audio/visual power shall be provided by a separate supervised power loop from the main fire alarm control panel or from a supervised, UL listed remote power supply. The module shall use SEMS screws for easy wiring. Wiring terminals shall be easily accessible for troubleshooting while installed.

N. Addressable Relay Module

1. Addressable relay modules shall allow a compatible control panel to switch discrete contacts by code command. The relay module shall provide two isolated sets of Form-C contacts, which operate as a double pole double throw switch. The module shall allow the control panel to switch these contacts on command. The module shall not provide supervision for the notification appliance circuit (NAC). Module shall have both normally open and normally closed connections available for field wiring.

2. The modules shall provide address-setting means on the module using rotary switches. Because of the possibility of installation error, systems that use binary jumpers or dipswitches to set the module address are not acceptable. The modules shall also store an internal identifying code that the control panel shall use to identify the type of module. Systems that require a special programmer to set the module address (including temporary connection at the panel) are labor intensive and not acceptable. Each module occupies any one of at least 99 possible addresses on the SLC loop. It responds to regular polls from the system and reports its type and status. The module shall have an

LED that is controlled by the panel to indicate module status. Coded signals, transmitted from the panel, can cause the LED to blink, latch on, or latch off.

3. The module shall mount in a standard 4-inch square, 2-1/8" deep electrical box or to a surface mounted backbox. The relay module contact ratings shall support up to 1 amp/30 VDC of inductive load or 2 amps/30VDC (coded) of resistive load (up to 3 amps in non-coded applications). The relay coil shall be magnetically latched to minimize wiring connection requirements and to ensure that 100% of all auxiliary relays may be energized simultaneously on the same pair of wires. The module will use SEMS screws for easy wiring. Wiring terminals shall be easily accessible for troubleshooting while installed.

O. Addressable Releasing Control Module

1. An addressable Flash-Scan releasing module shall be available to supervise and control compatible releasing agent solenoids.

2. The module shall operate on a redundant protocol for added protection.

3. The module shall be configurable for Class <A or B> and support one 24 volt or two 12-volt solenoids.

P. Isolator Module

1. Isolator modules shall automatically isolate wire-to-wire short circuits on a signaling line circuit (SLC) loop. The isolator module shall limit the number of modules or detectors that may be rendered inoperative by a short circuit fault on the SLC Loop.

2. If a wire-to-wire short occurs, the isolator module shall automatically open-circuit (disconnect) the SLC loop. When the short circuit condition is corrected, the isolator module shall automatically reconnect the isolated section of the SLC loop.

3. The isolator module shall not require any address-setting, and its operations shall be fully automatic. It shall not be necessary to replace or reset an isolator module after its normal operation. The module shall have an LED that is controlled by the panel to indicate module status.

4. Coded signals, transmitted from the panel, can cause the LED to blink, latch on, or latch off. Refer to the control panel technical documentation for module LED status operation.

5. The module shall mount in a standard 4-inch square, 2-1/8" deep electrical box, in a surface mounted backbox, or in the Fire Alarm Control Unit. The module shall use SEMS screws for easy wiring. Wiring terminals shall be easily accessible for troubleshooting while installed.

6. Meets Agency Standards:

    a. ANSI/ UL 864- Control Units and Accessories for Fire Alarm Systems

    b. ULC S527- Control Units for Fire Alarm Systems

    c. FM- ANSI/NFPA 72- National Fire Alarm Code.

Q. Serially Connected Annunciator Requirements

1. The annunciator shall communicate to the Fire Alarm Control Unit via an EIA 485 (multidrop) two-wire communications loop. The system shall support two 6,000 ft. EIA-485 wire runs. Up to 32 annunciators, each configured up to 96 points, may be connected to the connection, for a system capacity of 3,072 points of annunciation.

2. An EIA-485 repeater shall be available to extend the EIA-485 wire distance in 3,000 ft. increments. An optional version shall allow the EIA-485 circuit to be transmitted over Fiber optics. The repeater shall be UL864 approved.

3. Each annunciator shall provide up to 96 alarm and 97 trouble indications using a long-life programmable color LED's. Up to 96 control switches shall also be available for the control of Fire Alarm Control Unit functions. The annunciator will also have an "ONLINE" LED, local piezo sounder, local acknowledge and lamp test switch, and custom zone/function identification labels.

4. The annunciator may be field configured to operate as a "Fan Control Annunciator". When configured as "Fan Control," the annunciator may be used to manually control fan or damper operation and can be set to override automatic commands to all fans/dampers programmed to the annunciator.

5. Annunciator switches may be programmed for System control such as, Global Acknowledge, Global Signal Silence, Global System Reset, and on/off control of any control point in the system.

6. An optional module shall be available to utilize annunciator points to drive EIA-485 driven relays. This shall extend the system point capacity by 3,072 remote contacts.

7. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

R. CO Detectors

1. The detector shall have the ability to detect Carbon Monoxide gases in compliance with UL 2075.

2. The detector shall automatically include drift compensation of CO cell.

3. If sounder base is used with the CO Detector, it should be capable of producing Temp 4 pattern for CO Alarm indication.

4. The sounder bases shall synchronize with it's native system.

S. Photoelectric CO detectors

1. The detector shall have dual functionality to detect Carbon Monoxide gases in compliance with UL 2075 use photoelectric principle to measure smoke density in accordance with UL268 7TH edition.

2. The detector shall automatically include drift compensation of CO cell.

3. Provide a 24 Volt with Integral Sounder base connected to the SLC Addressable Circuit. Sounder shall be capable of providing a Temp 4 pattern for CO Alarm indication and a Temp 3 for Fire conditions.

4. The sounder bases shall synchronize with its native system.

2.8 BATTERIES AND EXTERNAL CHARGER

A. Battery

1. Shall be 12 volt, Gel-Cell type.

2. Battery shall have sufficient capacity to power the fire alarm system for not less than <four/twenty-four> hours plus <five/fifteen> minutes of alarm upon a normal AC power failure.

3. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks refilling, spills and leakage shall not be required.

B. External Battery Charger

1. Shall be completely automatic, with constant potential charger maintaining the battery fully charged under all service conditions. Charger shall operate from a 120/240-volt 50/60 hertz source.

2. Shall be rated for fully charging a completely discharged battery within 48 hours while simultaneously supplying any loads connected to the battery.

3. Shall have protection to prevent discharge through the charger.

4. Shall have protection for overloads and short circuits on both AC and DC sides.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.

B. All conduit, junction boxes, conduit supports, and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the

C. system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.

D. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when located in unfinished areas.

E. Manual Pull Stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.

3.2 TYPICAL OPERATION

A. Actuation of any manual station, smoke detector heat detector or water flow switch shall cause the following operations to occur unless otherwise specified:

1. Activate all programmed speaker circuits.

2. Actuate all strobe units until the panel is reset.

3. Light the associated indicators corresponding to active speaker circuits.

4. Release all magnetic door holders to doors to adjacent zones on the floor from that the alarm was initiated.

5. Return all elevators to the primary or alternate floor of egress.

6. A smoke detector in any elevator lobby shall, in addition to the above functions, return all elevators to the primary or alternate floor of egress.

7. Smoke detectors in the elevator machine room or top of hoist-way shall return all elevators in to the <primary/ alternate> floor. Smoke detectors or heat detectors installed to shut down elevator power shall do so in accordance with ANSI A17.1 requirements and be coordinated with the electrical contractor.

8. Duct type smoke detectors shall, in addition to the above functions shut down the ventilation system or close associated control dampers as appropriate.

9. Activation of any sprinkler system low pressure switch or valve tamper switch shall cause a system supervisory alarm indication.

3.3 TEST AND INSPECTION REPORT

A. Only a factory-authorized service representative trained shall be allowed to test and inspect components, assemblies, and equipment installations, including connections.

B. All test and inspection shall be completed by using the CLSS platform.

C. Perform the following tests and inspections via the mobile app:

1. Visual Inspection: Conduct visual inspection prior to testing.

   a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Documentation" chapter in NFPA 72.

   b. Comply with the "Visual Inspection" table in the "Inspection" section of the "Inspection, Testing, and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. Verification shall take place carrying out an automated self-testing process (without need of manual intervention or a smoke/ heat pole). The detectors shall be able to carry out the following;

   a. Functional test on heat or smoke

   b. Smoke entry test for smoke alarms

   c. Determine that the dust cover is in place during construction.

   d. Determine that the dust cover has been removed when the building becomes ready for occupation.

   e. Provide an automated summary report of above points.

3. The system will register real events from all initiating devices not in test mode after each test. Upon an alarm condition during the self-test process the system will be overwritten and initiate an alarm at the FACU.

4. System Testing: Comply with the "Testing" table in the "Testing" section of the "Inspection, Testing, and Maintenance" chapter in NFPA 72.

5. During inspection the software shall automatically comply and generate "Fire Alarm System Record of Completion" in the "Documentation" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing, and Maintenance" chapter in NFPA 72.

D. Annual Test and Inspection: One year after date of Substantial Completion, test fire alarm system complying with visual and testing inspection requirements in NFPA 72. A report shall be automatically be generated from the mobile app upon completion and provide to applicable parties.

3.4 SYSTEM TEST

A. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

B. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.

C. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACU.

D. Open initiating device circuits and verify that the trouble signal actuates.

E. Open signaling line circuits and verify that the trouble signal actuates.

F. Open and short notification appliance circuits and verify that trouble signal actuates.

G. Ground initiating & Signaling device circuits and verify response of trouble signals.

H. Ground notification appliance circuits and verify response of trouble signals.

I. Check presence and audibility of tone at all alarm notification devices.

J. Check installation, supervision, &operation of intelligent smoke detectors during a walk test.

K. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACU and the correct activation of the control points.

L. When the system is equipped with optional features, the manufacturer's manual should be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.

3.5 FINAL INSPECTION

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.6 INSTRUCTION

A. Provide instruction as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation."

END OF SECTION