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**DIVISION 15 – MECHANICAL**

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## **SECTION 15050 - BASIC MECHANICAL MATERIALS AND METHODS**

### **PART 1 - GENERAL**

#### 1.1 RELATED DOCUMENTS

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

#### 1.2 SUMMARY

- A. This Section includes the following basic mechanical materials and methods to complement other Division 15 Sections.
  - 1. Piping materials and installation instructions common to most piping systems.
  - 2. Escutcheons.
  - 3. Flexible connectors.
  - 4. Equipment nameplate data requirements.
  - 5. Labeling and identifying mechanical systems and equipment.
  - 6. Field-fabricated metal and wood equipment supports.
  - 7. Installation requirements common to equipment specification sections.
  - 8. Mechanical demolition.
  - 9. Cutting and patching.
  - 10. Touchup painting and finishing.
  - 11. Demolition.
  - 12. Access Doors.
- B. Pipe and pipe fitting materials are specified in Division 15 piping system Sections.

#### 1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.
- E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.
- F. The following are industry abbreviations for plastic materials:
  - 1. ABS: Acrylonitrile-butadiene-styrene plastic.
  - 2. CPVC: Chlorinated polyvinyl chloride plastic.
  - 3. NP: Nylon plastic.

4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

- G. The following are industry abbreviations for rubber materials:
1. CR: Chlorosulfonated polyethylene synthetic rubber.
  2. EPDM: Ethylene propylene diene terpolymer rubber.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.
- B. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.
- C. Protect flanges, fittings, and piping specialties from moisture and dirt.
- D. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

#### 1.5 SEQUENCING AND SCHEDULING

- A. Coordinate mechanical equipment installation with other building components.
- B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.
- C. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.
- D. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.
- E. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.
- F. Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors."
- G. Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

#### 1.6 PERMITS, CODES, INSPECTIONS AND APPROVALS

- A. Permits

1. All permits necessary for the complete heating, air conditioning, ventilating, sprinkler, boilers and plumbing systems shall be obtained by the Contractor from the authorities governing such work. The cost of all permits shall be borne by the Contractor.

B. Mechanical Work

1. Heating and ventilating and air conditioning work shall be performed in accordance with the rules and regulations of the Kentucky Building Code, National Fire Protection Association, the latest standards recognized by the American Society of Heating and Air Conditioning Engineers and IMC-International Mechanical and Energy Codes as adopted by the Commonwealth of Ky. All HVAC work shall be performed by a Licensed Kentucky Master HVAC Contractor.
2. Where the scope of mechanical work includes electrical work, all provisions included in the electrical sections of the work shall apply.

C. Inspection Requirements

1. The inspection work shall be scheduled for rough as well as the finished work. The rough inspection shall be divided into as many inspections as may become necessary to cover all roughing-in. A punch list inspection shall be scheduled with the Architect or his representative present.
2. The Architect shall be notified twenty-four (24) hours in advance when any tests or inspections are to be made and before any work is insulated or concealed. Failing to do so, the Contractor shall uncover and retest lines as directed by the Architect. The Contractor shall notify the Architect when he is ready for final inspection.

1.7 MECHANICAL DRAWINGS AND SPECIFICATIONS

- A. The drawings and specifications are intended to cover all work enumerated under the respective headings. The drawings are diagrammatic only as far as final location of pipes, relative size, is concerned. Any item of work not clearly included, specified and/or shown, any errors or conflict between plans (Mechanical, Architectural, Structural or Electrical), specifications, codes and field conditions, shall be clarified by a written request to the Architect by the Bidder before bidding; otherwise the bidder shall, at his own expense, supply the proper labor and materials to make good any damages or defects in his work caused by such error, omission or conflict.
- B. Piping schematics, risers and details shown on the drawings are for the equipment specified hereinafter. All revisions, modifications or changes in piping, accessories, etc. due to using equipment of a different manufacturer than specified hereinafter, shall be the responsibility of the Bidder and shall be made at no additional cost to the Owner. All modifications or changes shall be submitted to the Architect in writing and meet with his approval before the equipment is released for shipment.
- C. This Contractor shall be responsible for all revisions, modifications or changes necessary in the structural or architectural or electrical systems to accommodate the equipment to be furnished under this Section of the Specifications. This shall be made at no additional cost to the Owner.
- D. The contractor in all areas where his work and/or expense is involved shall verify scale of Drawings and/or details. This may involve all contract drawings: Architectural, Structural, Mechanical, Electrical, etc. due to the advent of computers, copiers, and faxes, which change drawing scales so easily, this is very important. If drawings are scaled to determine quantities

of materials, labor, etc., no allowances will be due the contractor due to inaccurate scales shown on any of the contract drawings or reproductions thereof.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Metal, Flexible Connectors:
    - a. ANAMET Industrial, Inc.
    - b. Central Sprinkler, Inc.
    - c. Flexicraft Industries.
    - d. Flex-Weld, Inc.
    - e. Grinnell Corp.; Grinnell Supply Sales Co.
    - f. Hyspan Precision Products, Inc.
    - g. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
    - h. Mercer Rubber Co.
    - i. Metraflex Co.
    - j. Proco Products, Inc.
    - k. Uniflex, Inc.
  - 2. Rubber, Flexible Connectors:
    - a. General Rubber Corp.
    - b. Mercer Rubber Co.
    - c. Metraflex Co.
    - d. Proco Products, Inc.
    - e. Red Valve Co., Inc.
    - f. Uniflex, Inc.

### **2.2 PIPE AND PIPE FITTINGS**

- A. Refer to individual Division 15 piping Sections for pipe and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

### **2.3 JOINING MATERIALS**

- A. Refer to individual Division 15 piping Sections for special joining materials not listed below.
- B. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32.
  - 1. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
  - 2. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.

3. Alloy HA: Tin-antimony-silver-copper zinc, with 0.10 percent maximum lead content.
  4. Alloy HB: Tin-antimony-silver-copper nickel, with 0.10 percent maximum lead content.
  5. Alloy Sb5: 95 percent tin and 5 percent antimony, with 0.20 percent maximum lead content.
- D. Brazing Filler Metals: AWS A5.8.
1. BCuP Series: Copper-phosphorus alloys.
  2. BAg1: Silver alloy.
- E. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Solvent Cements: Manufacturer's standard solvent cements for the following:
1. ABS Piping: ASTM D 2235.
  2. CPVC Piping: ASTM F 493.
  3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
  4. PVC to ABS Piping Transition: ASTM D 3138.
- G. Plastic Pipe Seals: ASTM F 477, Elastomeric gasket.
- H. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.
- I. Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.
1. Sleeve: ASTM A 126, Class B, gray iron.
  2. Followers: ASTM A 47 malleable iron or ASTM A 536 ductile iron.
  3. Gaskets: Rubber.
  4. Bolts and Nuts: AWWA C111.
  5. Finish: Enamel paint.

## 2.4 PIPING SPECIALTIES

- A. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:
1. Steel Sheet Metal: 0.0239-inch minimum thickness, galvanized, round tube closed with welded longitudinal joint.
  2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
  3. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.
  4. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
    - a. Underdeck Clamp: Clamping ring with set screws.
  5. PVC: Manufactured, permanent, with nailing flange for attaching to wooden forms.
  6. PVC Pipe: ASTM D 1785, Schedule 40.
  7. PE: Manufactured, reusable, tapered, cup shaped, smooth outer surface, with nailing flange for attaching to wooden forms.
- B. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type if required to conceal protruding fittings and sleeves.
1. ID: Closely fit around pipe, tube, and insulation of insulated piping.

2. OD: Completely cover opening.
3. Cast Brass: One piece, with set screw.
  - a. Finish: Rough brass.
  - b. Finish: Polished chrome-plate.
4. Cast Brass: Split casting, with concealed hinge and set screw.
  - a. Finish: Rough brass.
  - b. Finish: Polished chrome-plate.

### **PART 3 - EXECUTION**

#### **3.1 PIPING SYSTEMS - COMMON REQUIREMENTS**

- A. General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 15 piping Sections specify unique piping installation requirements.
- B. General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.
- C. Install piping at indicated slope.
- D. Install components with pressure rating equal to or greater than system operating pressure.
- E. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
- F. Install piping free of sags and bends.
- G. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- H. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.
- I. Install piping to allow application of insulation plus 1-inch clearance around insulation.
- J. Locate groups of pipes parallel to each other, spaced to permit valve servicing.
- K. Install fittings for changes in direction and branch connections.
- L. Install couplings according to manufacturers written instructions.
- M. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wallboard partitions, and suspended ceilings according to the following:
  1. Chrome-Plated Piping: Cast brass, one piece, with set screw, and polished chrome-plated finish. Use split-casting escutcheons if required, for existing piping.
  2. Uninsulated Piping Wall Escutcheons: Cast brass or stamped steel, with setscrew.
  3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.

4. Insulated Piping: Cast brass or stamped steel; with concealed hinge, spring clips, and chrome-plated finish.
  5. Piping in Utility Areas: Cast brass or stamped steel, with setscrew or spring clips.
- N. Sleeves are not required for core-drilled holes.
- O. Install sleeves for pipes passing through concrete and masonry walls, and concrete floor and roof slabs.
- P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  2. Build sleeves into new walls and slabs as work progresses.
  3. Install sleeves large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
    - a. Steel Pipe Sleeves: For pipes smaller than 6-inch NPS.
    - b. PVC Pipe Sleeves: For pipes smaller than 6-inch NPS.
    - c. Steel, Sheet-Metal Sleeves: For pipes 6-inch NPS and larger, penetrating gypsum board partitions.
    - d. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Refer to Division 7 Section "Sheet Metal Flashing and Trim" for flashing.
      - 1) Seal space outside of sleeve fittings with nonshrink, nonmetallic grout.
  4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants. Refer to Division 7 Section "Joint Sealants" for materials.
  5. Use Type S, Grade NS, Class 25, Use O, neutral-curing silicone sealant, unless otherwise indicated.
- Q. Aboveground, Exterior-Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
  2. Install cast-iron "wall pipes" for sleeves 6 inches in diameter and larger.
  3. Assemble and install mechanical sleeve seals according to manufacturer's written instructions. Tighten bolts that cause rubber-sealing elements to expand and make watertight seal.
- R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with Firestopping materials. Refer to Division 7 Section "Firestopping" for materials.
- S. Verify final equipment locations for roughing-in.
- T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.



- U. Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:
1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
  2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
  3. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
  4. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube."
  5. Soldered Joints: Construct joints according to CDA's "Copper Tube Handbook."
  6. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  7. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following:
    - a. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
    - b. ABS Piping: ASTM D 2235 and ASTM D 2661.
    - c. CPVC Piping: ASTM D 2846 and ASTM F 493.
    - d. PVC Pressure Piping: ASTM D 2672.
    - e. PVC Nonpressure Piping: ASTM D 2855.
    - f. PVC to ABS Nonpressure Transition Fittings: Procedure and solvent cement according to ASTM D 3138.
  8. Plastic Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657 procedures and manufacturer's written instructions.
    - a. Plain-End Pipe and Fittings: Use butt fusion.
    - b. Plain-End Pipe and Socket Fittings: Use socket fusion.

### 3.2 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to provide maximum possible headroom, if mounting heights are not indicated.
- B. Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.
- C. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- D. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- E. Install equipment giving right of way to piping installed at required slope.
- F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

### 3.3 LABELING AND IDENTIFYING

- A. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of mechanical equipment.
  - 1. Lettering Size: Minimum 1/4-inch- high lettering for name of unit if viewing distance is less than 24 inches, 1/2-inch- high lettering for distances up to 72 inches, and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
  - 2. Text of Signs: Provide name of identified unit. Include text to distinguish between multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.
- B. Adjusting: Relocate identifying devices as necessary for unobstructed view in finished construction.

### 3.4 PAINTING AND FINISHING

- A. Refer to Division 9 Section "Painting" for paint materials, surface preparation, and application of paint.
- B. Do not paint piping specialties with factory-applied finish.
- C. Cleaning and Painting
  - 1. The Contractor shall remove all temporary stickers, tags, etc. from all items installed under this Contract and shall thoroughly clean all equipment or materials installed under this Contract. Scratched and damaged paint and/or other finishes shall be touched up and/or repainted as required. All equipment shall be cleaned and made ready for painting by the General Contractor.
  - 2. Upon completion of the work, the Contractor shall thoroughly clean and lubricate all equipment; clean and flush all piping as often as necessary to satisfy the Architect that the system is clear of oil, dirt, scale or other foreign matter; clean all strainers after flushing operation and prior to acceptance. Clean ductwork to insure system is clear of dirt or other foreign matter.
  - 3. Surplus material, rubbish and equipment resulting from the Contractor's work shall be removed from the building and premises by the Contractor upon completion of the work in accordance with the Architectural Specifications.
  - 4. All permanent nameplates on equipment shall be kept clean and exposed for easy reading. If field conditions warrant (in the opinion of the Architect), the Contractor may be requested to vacuum clean all equipment and installation materials which are unduly filled or covered with dust, debris, etc.

### 3.5 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

### 3.6 ERECTION OF METAL SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

- B. Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

3.7 ERECTION OF WOOD SUPPORTS AND ANCHORAGE

- A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage to support and anchor mechanical materials and equipment.
- B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.
- C. Attach to substrates as required to support applied loads.

3.8 DEMOLITION

- A. Disconnect, demolish, and remove Work specified in Division 15 Sections.
- B. If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.
- C. Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.
- D. Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches beyond face of adjacent construction. Cap and patch surface to match existing finish.
- E. Removal: Remove indicated equipment from Project site.
- F. Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

3.9 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.
- B. Repair cut surfaces to match adjacent surfaces.
- C. Where concrete surrounding all buildings is cut for installation of piping, piping will be embedded in sand and brought to level of replacement concrete via use of flowable fill.

3.10 FOUNDATIONS AND ANCHOR BOLTS

- A. The Contractor shall be responsible for the location of all concrete pads required for all equipment installed under this Contract. All pads required will be poured at the expense of the Contractor.
- B. The Contractor shall furnish anchor bolts for all equipment installed on concrete slabs and/or bases. Bolts shall be placed in exact positions prior to pouring concrete. Sizes and location of bolts shall be determined by the manufacturer's recommendations for the equipment served.

3.11 PROTECTION

- A. All work, equipment and material shall be protected at all times. All pipe openings shall be closed with caps or plugs during construction. All equipment and accessories shall be tightly covered and protected against dirt, water or other injury during period of construction.
- B. No plumbing or heating piping shall be installed in any part of the building where danger of freezing may exist without adequate protection being given by the Contractor installing the pipe, whether or not insulation is specified for the particular piping. All damages resulting from leaking pipes shall be borne by the Contractor whose work is at fault.
- C. It shall be the responsibility of the Contractor to install and maintain pipe and equipment which is clean and free of rust, dirt, scale, etc. Where roughed-in only, the Contractor shall provide temporary airtight covers at all conduit, duct and equipment openings.

3.12 CONNECTIONS TO EQUIPMENT FURNISHED BY OTHERS

- A. The Architectural, Structural, Electrical, Plumbing and Heating and Ventilating Drawings and Specifications are complementary to one another. Respective Contractors shall rough-in for and furnish all labor and materials necessary to make final connections to all equipment furnished by the Owner or any other Contractor or Sub-Contractor which requires mechanical or electrical connections.
- B. The Contractor making the required connections shall be responsible for making proper connections and shall be responsible for any damages caused by erroneously connected equipment.

3.13 LINTELS

- A. In general, others will provide all lintels. However, the Contractor shall refer to the Architectural Drawings and Specifications and ascertain whether or not lintels are included in the general construction.
- B. If lintels are NOT included in the general construction, then the Contractor is responsible for all lintels where ductwork, louvers and/or equipment furnished by him is installed under this contract.
- C. All lintels shall be subject to the approval of the Architect or his representative.

3.14 ACCESS DOORS

- A. The Contractor shall refer to the Architectural Drawings to ascertain which rooms have removable ceilings. Where removable ceilings are specified, access to equipment may be obtained by removing the ceiling pieces. Where non-removable ceilings are specified, the Contractor shall furnish all required access doors for servicing valves, equipment, etc.
- B. Access doors shall be L.M. Walsh Company "Way-Loctor", Milcor, Miami or approved equal. No. 3 shall be used for concrete block or tile walls having no plaster finish and No. 20 shall be used for plastered walls and ceilings or for acoustical tile ceilings. All doors shall be prime coated and key operated and keys shall be the same for plumbing and heating work.

- C. Installation of doors will be done by the General Contractor. However, the Contractor shall be responsible for the correct location of them for servicing equipment. These access doors shall be sized large enough to service the equipment with a minimum size of 20"x20".

3.15 ELIMINATION OF NOISE AND VIBRATION (CONSTRUCTION EQUIPMENT)

- A. During construction of this project, if any system or piece of equipment produces noise or vibration which is, in the opinion of the Architect, objectionable to the Owner, the Contractor shall, at his own expense, make changes in equipment and do all work necessary to eliminate the objectionable noise or vibration.

END OF SECTION

## **SECTION 15100 - PIPING & VALVES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Pipe, pipe fittings, valves, and connections for piping systems.
  - 1. Sanitary Sewer.
  - 2. Domestic Water.
  - 3. Heat Pump Loop.
  - 4. Condensate Removal.
  - 5. Refrigeration Piping.
  - 6. Geothermal Piping.
  - 7. Natural Gas Piping.

#### **1.2 RELATED SECTIONS**

- A. Division 15 - Mechanical Insulation.
- B. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

#### **1.3 REFERENCES**

- A. ASME B31.9 - Building Service Piping.
- B. Kentucky Building Code.
- C. Kentucky Plumbing Code.
- D. IMC, International Mechanical Code.

#### **1.4 SUBMITTALS FOR REVIEW**

- A. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

#### **1.5 SUBMITTALS AT PROJECT CLOSEOUT**

- A. Project Record Documents: Record actual locations of valves and piping. Provide maintenance data for all valves, which can be rebuilt.

#### **1.6 QUALITY ASSURANCE**

- A. Valves: Manufacturer's name and pressure rating marked on valve body.
- B. Welding Materials and Procedures: Conform to ASME SEC IX and applicable state labor regulations.
- C. Welder's Certification: In accordance with Kentucky standards for trade involved.

- D. Identify pipe with marking including size, ASTM material classification, ASTM specification, water pressure rating.
- E. Pipe is to be stored covered, off the ground, with end caps in place. Pipe installed that is dirty or rusted shall be cleaned and painted.

1.7 REGULATORY REQUIREMENTS

- A. Perform Work in accordance with Codes listed in Paragraph 1.3 references.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- 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.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

**PART 2 - PRODUCTS**

2.1 PIPING SCHEDULE

- A. Furnish and install piping of sizes and locations shown on the drawings. Piping and fitting material shall be as shown in the accompanying table.
- B. Table of Piping Fittings (Interior)

<b>Service</b>	<b>Sizes</b>	<b>Pipe</b>	<b>Fittings</b>
Domestic Water	All Sizes	Type L Hard Copper	Wrought Copper or Cast Brass Solder Joint
Condensate Drain	All Sizes	DWV/PVC	PVC
Refrigerant	All Sizes	ACR Hard/Soft Copper	Long Radius Wrought Copper
Gas	2" and Smaller	Sch. 40 Black Steel	125 lb. Malleable Iron Screwed

SOUTH KENTUCKY RECC, SOMERSET, KENTUCKY

Gas	2-1/2" and Larger	Sch. 40 Black Steel	Std. Wt., Welded
Geothermal	Exterior Interior Loops	SDR11 Polyethylene Type L Copper SDR 9 Polyethylene	SDR 9 Polyethylene Copper SDR 9 Polyethylene

\* The Contractor shall have the option of using Type "L" Hard Copper with wrought copper or cast brass solder joint fittings. See "Geothermal Heat Exchanger" for exterior piping.

1. All pipe nipples shall be of the same material as the lines in which they are installed.
2. All piping not covered in the above table shall be Schedule 40 Black Steel with 125 lb. cast iron fittings.
3. Screwed fittings shall be Midwest, Grinnell, Crane or equal. Welding fittings shall be long radius type, Tube Turns, Midwest, Crane or equal.
4. Solder joint fittings shall be "Nibco", Ohio Brass, Chase or equal. Solder shall be lead-free 95-5 for all applications except DWV, where 50-50 may be used. Acid will not be allowed. Silver solder shall be used for brazing DX lines.

C. Pipe And Fittings - Exterior (Does Not Include Soil, Waste And Vent Piping).

1. Be responsible for contacting the local utility companies and include in the base bid all costs incurred with tap-on fees, service taps, piping to property line, meters, meter pits and pressure reducing equipment as required by the local utility companies.
2. Furnish and install sewer piping from the building to points shown on the Drawings. Piping shall be polyvinyl chloride SDR of 35. Piping shall be suitable for forced main service.
3. Furnish and install a new water service from the building to the point shown on the Drawings. Piping shall be Type K copper with wrought copper solder joint fittings or Class 200 PVC pressure piping with an S.D.R. of 21.
4. Furnish and install all water main piping from the building to the points shown on the Drawings. Piping shall be cement lined, Class 250 cast iron pipe with Tyton joints or Johns-Manville "Blue-Brute", PVC water main with ring-tite joints, Class 150 made to cast iron pipe outside diameter and meeting the requirements of SDR 17 with fitting the same as cast iron pipe.
5. Furnish and install other piping as indicated on the drawings.

D. Soil, Waste And Vent Piping.

1. Pipe and Fittings (Above Slab)
  - a. All soil, waste and vent piping 3" and larger shall be standard weight cast iron and shall conform to the latest ASTM Standard Specifications for standard weight fittings. All joints shall be neoprene joints. All plumbing "trees" and piping made with neoprene joints shall be supported in a "plumb" and properly graded manner.
  - b. Waste and vent piping 2½" and smaller shall be DWV hard copper, hubless cast iron or galvanized piping. Fittings for copper vent piping shall be wrought copper and for copper waste piping shall be cast brass drainage type. If cast iron piping is installed, all joints may be leaded or neoprene.



- c. Where allowed by building and plumbing code polyvinyl chloride piping (PVC) or ABS may be used. PVC or ABS is not allowed in return plenums unless fire protected.
- 2. Pipe and Fittings (Below Slab or Grade)
  - a. All sanitary waste and vent piping below slab shall be standard weight cast iron pipe with neoprene joints, polyvinyl chloride or ABS.

## 2.2 FLANGES, UNIONS, AND COUPLINGS

- A. Pipe Size 3 inches and Under:
  - 1. Ferrous pipe: Class 150 malleable iron threaded unions.
  - 2. Copper tube and pipe: Class 150 bronze unions with soldered joints.
- B. Pipe Size Over 1 inch:
  - 1. Ferrous pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.
  - 2. Copper tube and pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.
- C. Grooved and Shouldered Pipe End Couplings:
  - 1. Housing: Malleable iron clamps to engage and lock, designed to permit some angular deflection, contraction, and expansion; steel bolts, nuts, and washers; galvanized for galvanized pipe.
  - 2. Sealing gasket: "C" shape composition-sealing gasket.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.

## 2.3 GATE VALVES

- A. Sizes 2" and smaller shall be Nibco Bronze No. T-134, Crane Brass, No. 431UB, Milwaukee 1151 or approved equal, screwed, solid wedge disc, tapered seat, rising brass stem, union bonnet working pressure 150 PSI steam.
- B. Sizes 2½" and larger shall be Nibco No. F-617-0, Crane IBBM, No. 465 1/2, Milwaukee F2885 or approved equal, iron body bronze mounted, flanged with flanged bonnet and yoke, rising bronze stem, brass seat and disc, working pressure 125 PSI steam.

## 2.4 GLOBE VALVES

- A. Sizes 2" and smaller shall be Nibco Bronze No. T-235-Y, Crane Brass, No. 7, Milwaukee 590 or approved equal, screwed renewable composition disc, rising brass stem, working pressure 150 PSI steam.
- B. Sizes 2½" and larger shall be Nibco Bronze, No. F-918-B, Crane IBBM, No. 351, Milwaukee F2981 or approved equal flanged with flanged bonnet and yoke, rising bronze stem, brass seat and disc, working pressure 125 PSI steam.

## 2.5 CHECK VALVES (HORIZONTAL)

- A. Sizes 2" and smaller shall be Nibco Bronze, No. T-433-B, Crane Brass No. 137, Milwaukee 510 or approved equal, screwed with screwed cap, swing check, renewable bronze disc, working pressure 150 PSI steam.
- B. Sizes 2½" and larger shall be Nibco, No. F-918-B, Crane IBBM, No. 373, Milwaukee F2974 or approved equal, swing check, flanged with flanged cap, bronze seat and disc, working pressure 125 PSI steam.

#### 2.6 BALANCING VALVES

- A. Sizes 2" and smaller shall be Powell, Figure 2200 or approved equal, 175 PSI WOG, screwed, lubricated plug cock.
- B. Size 2½" and larger shall be Powell, Figure 2201 or approved equal, 175 PSIG WOG flanged, lubricated plug cock.
- C. Valves, as manufactured by Crane, Keystone, Homestead or equal will be acceptable.

#### 2.7 RELIEF VALVES

- A. Refer to individual articles on heaters or boilers.

#### 2.8 BUTTERFLY VALVES

- A. Dezurik, Figure No. 632-LD, Crane, Milwaukee, Keystone, Nibco or approved equal, lug style, semi-steel body, bronzed discs with stainless steel shafts, bronze bushings and infinite position adjustment lever on valves 4" and smaller and enclosed handwheel actuators on all valves 6" and larger.

#### 2.9 BALL VALVES (WATER)

- A. Milwaukee Model BA-100 Apollo, Nibco or equal bronze body and bonnet, chrome plated brass ball, glass-reinforced teflon seat, blowout proof stem, 600 PSI WOG, 150 PSI WSP, screwed, lever operated with extended neck to match insulation thickness, CV of 24 for ¾" size, 34 for 1" size.

#### 2.10 EXTERIOR VALVES AND ACCESSORIES

- A. Valve - Mueller, Cat. No. A-2480-20, mechanical joint of sizes as required on Drawings.
- B. Valve Boxes - Mueller, Cat. No. H-10365, flange base. Provide extension piece as required.
- C. Furnish a valve-operating wrench with socket to fit valves above. Length of wrench to be as required and shall be equal to Mueller, No. A-24610.
- D. Valves, as manufactured by Milwaukee, Kennedy, Traverse City or equal will be accepted.

#### 2.11 CHECK VALVES (VERTICAL)

- A. Mueller, Fig. No. 107M-A-P, Williams-Hager, Nibco or approved equal, 250 PSI ANSI B16.1 globe type, silent check valve, flanged ends, cast iron body with bronze trim.

## 2.12 UNIONS

- A. Unions shall be installed at all locations shown on the Drawings and as required for the isolation of all screwed valves and connections to screwed equipment.
- B. Unions in steel piping 2" and smaller shall be ground joint, malleable iron, screwed; 250 PSI working pressure for high pressure steam and return lines and chilled water lines, and 125 PSI working pressure for all other applications.
- C. Unions in piping 2½" and larger shall be flanged type with gaskets designed for the working pressure of the unions.

## **PART 3 - EXECUTION**

### 3.1 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

### 3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain maximum headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access doors where valves and fittings are not exposed.

- I. Establish elevations of buried piping outside the building to ensure not less than 3 feet of cover.
- J. Install vent piping penetrating roofed areas to maintain integrity of roof assembly.
- K. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- L. Provide support for utility meters in accordance with requirements of utility companies.
- M. Prepare exposed, unfinished pipe, fittings, supports, and accessories ready for finish painting.
- N. Install bell and spigot pipe with bell end upstream.
- O. Install valves with stems upright or horizontal, not inverted.
- P. Pipe vents from gas pressure reducing valves to outdoors and terminate in weatherproof hood.
- Q. Sleeve pipes passing through partitions, walls and floors.

#### 3.4 INSTALLATION PROCEDURES

- A. All piping furnished and installed under this Contract and shown on the Drawings shall be new and conform to the applicable specifications of ASA, as applied to the class, weight and type of piping installed.
- B. All underground piping shall be installed at the elevations given on the Drawings or on details pertaining to the installation in question. All piping shall be installed with an even grade between elevations given and in accordance with articles in these Specifications, which apply to this work.
- C. All piping located in pipe chases, furred walls, and ceilings shall be tested for leaks before being concealed or covered in any manner.
- D. All waste and vent piping and roof leaders, condensate drain piping, shall pitch minimum of 1/8" per foot.
- E. Where construction does not permit pitching, all piping other than waste, vent and roof leader piping may be installed dead level. Provide drain valves at low point.
- F. No pressure piping shall be installed in or under concrete floor slab. No "Bull Head" Tees will be allowed.
- G. High point in all recirculated water systems shall be provided with manual air vent valves and/or automatic air vents. Automatic air vents shall be piped to the outside of the building or to an approved drain.
- H. Use dielectric insulating unions wherever adjoining materials being connected are of dissimilar material such as connections between copper and steel piping.

3.5 PIPE LAYING AND BEDDING

- A. Provide firm bed for each pipe so that pipe is supported uniformly along barrel and does not rest on bell or joint when brought to grade. Set each length to grade and line before making joint.
- B. Thoroughly inspect and fit pipes before lowering into trenches. Clean interior of joints before joint material is placed.
- C. Lay to uniform grade between elevations shown or to pitch indicated. Use Engineer's level and transit along with adequately spaced and supported batter boards to establish horizontal and vertical control. Lay bell and spigot pipe with bells upstream.
- D. For each pipe which passes under a footing or grade beam, provide steel pipe sleeve, with at least two (2) inches clearance around pipe and extending eighteen (18) inches beyond each side of footing or grade beam. Before backfilling, pack space between pipe and sleeve for a depth of two (2) inches at each end of sleeve with oakum or yarn to prevent the entrance of dirt. If pipe is installed before footing or grade is constructed, place compacted backfill around sleeve. If pipe is installed after building work is constructed, backfill with concrete to a thickness of at least six (6) inches around sleeve and up to the footing or grade beam.
- E. Close open ends of piping during construction to prevent earth entering lines. Close ends of lines and unused openings in fittings.
- F. Provide concrete thrust blocks for water piping as indicated or required to resist any thrust that may be encountered.

3.6 APPLICATION

- A. Use grooved mechanical couplings and fasteners only in accessible locations.
- B. Install unions downstream of valves and at equipment or apparatus connections.
- C. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- D. Install gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- E. Install globe ball or butterfly valves for throttling, bypass, or manual flow control services.
- F. Provide lug end butterfly valves adjacent to equipment when provided to isolate equipment.
- G. Provide spring loaded check valves on discharge of water pumps.
- H. Provide plug valves in natural gas systems for shut-off service.
- I. Provide flow controls in water recirculating systems where indicated.

3.7 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed and clean.
- B. Ensure Ph of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residuals.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.8 PIPE IN RETURN AIR PLENUMS

- A. Insulate existing and new piping in return air plenums with 25/50, 3/4" insulation.

3.9 SERVICE CONNECTIONS

- A. Provide sanitary and service as indicated. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.
- B. Connect to existing water service.

END OF SECTION

**SECTION 15140 - SUPPORTS AND ANCHORS**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Pipe and equipment hangers and supports.
- B. Equipment bases and supports.
- C. Sleeves and seals.
- D. Flashing and sealing equipment and pipe stacks.

1.2 RELATED SECTIONS

- A. Division 3 - Cast-In-Place Concrete: Equipment bases.
- B. Division 7 - Firestopping: Joint seals for piping and duct penetration of fire rated assemblies.
- C. Division 9 - Painting.
- D. Division 15 - Piping & Valves.
- E. Division 15 - Mechanical Insulation.
- F. Division 15 - Sprinkler Piping.
- G. Division 15 - Sprinkler Systems.

1.3 REFERENCES

- A. ASME B31.5 - Refrigeration Piping
- B. ASME B31.9 - Building Services Piping
- C. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- D. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
- E. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- F. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- G. UL 203 - Pipe Hanger Equipment for Fire Protection Service

1.4 SUBMITTALS

- A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- B. Product Data: Provide manufacturers catalog data including load capacity.
- C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- D. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

## 1.5 REGULATORY REQUIREMENTS

- A. Supports for Sprinkler Piping: In conformance with NFPA 13.

## **PART 2 - PRODUCTS**

### 2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
  - 1. Grinnell.
  - 2. Elcen.
  - 3. B-Line.
- B. Plumbing Piping - DWV:
  - 1. Hangers for Pipe Sizes 1/2 inch to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
  - 2. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
  - 3. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - 4. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
  - 5. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
  - 6. Vertical Support: Steel riser clamp.
  - 7. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  - 8. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- C. Plumbing Piping (Water) and Hydronic Piping:
  - 1. Hangers for Pipe Sizes 1/2 inch to 1-1/2 inch: Malleable iron or Carbon steel], adjustable swivel, split ring.
  - 2. Hangers for Cold Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.
  - 3. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
  - 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  - 5. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
  - 6. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
  - 7. Vertical Support: Steel riser clamp.
  - 8. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.



9. Floor Support for Hot Pipe Sizes to 4 inches: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
10. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

D. Refrigerant Piping:

1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.
2. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
3. Vertical Support: Steel riser clamp.
4. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
5. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.3 INSERTS IN PRE CAST PLANKS

- A. Inserts: Hilti HDI-P drop in anchor with lip.

2.4 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counter flashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
  1. Waterproofing: 5 lb/sq ft sheet lead
  2. Soundproofing: 1 lb/sq ft sheet lead.
- D. Flexible Flashing: 47-mil thick sheet compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 EQUIPMENT CURBS

- A. Manufacturers:
  1. Thy Curb.
  2. Equipment manufacturer.
- B. Fabrication: Welded 18 gage galvanized steel shell and base, mitered 3 inch cant, variable step to match roof insulation, 1-1/2 inch thick insulation, factory installed wood nailer.

2.6 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed, refer to Section on Fire Stopping.
- D. Sleeves for Round Ductwork: Galvanized steel.
- E. Sleeves for Rectangular Ductwork: Galvanized steel or wood.
- F. Firestopping Insulation: Glass fiber type, non-combustible; refer to Section on Fire Stopping.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

#### 3.2 INSERTS

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.

#### 3.3 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as scheduled.
- B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
- C. Place hangers within 12 inches of each horizontal elbow.
- D. Use hangers with 1-1/2 inch minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.

- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

### 3.4 EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads 3000 lb concrete, minimum 4 inches thick and extending 6 inches beyond supported equipment, chamfer edges 1" x 45°.
- B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.
- C. Provide rigid anchors for pipes after vibration isolation components are installed.

### 3.5 FLASHING

- A. Provide flexible flashing and metal counter flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 12 inches minimum above finished roof surface with lead worked 1-inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inch sheet size. For pipes through outside walls, turn flanges back into wall and calk, metal counter flash, and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor drains and mop sink drains watertight to adjacent materials.
- E. Provide curbs for mechanical roof installations 12 inches minimum high above roofing surface. Flash and counter flash with sheet metal; seal watertight. Attach counter flashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- F. Adjust storm collars tight to pipe with bolts; calk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

### 3.6 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors 1 inch above finished floor level. Calk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing (or fire stopping is rated wall) insulation and calk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.

- E. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

3.7 SCHEDULES

PIPE SIZE	HANGER ROD MAX. HANGER SPACING	DIAMETER
Inches	Feet	Inches
1/2 to 1-1/4	6.5	3/8
1-1/2 to 2	10	3/8
2-1/2 to 3	10	1/2
4 to 8	10	5/8
Polyethylene and PVC (All sizes)	6	3/8

END OF SECTION

## **SECTION 15170 - MOTORS**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

- A. Common requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.

#### 1.2 RELATED SECTIONS

- A. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

#### 1.3 REFERENCES

- A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. NEMA MG 1 - Motors and Generators.
- D. NFPA 70 - National Electrical Code.
- E. UL 674 - UL Standard for Safety Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
- F. UL 1836 - UL Standard for Safety for Electric Motors for Use in Class I, Division 2 and Class II, Division 2 Hazardous (Classified) Locations.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to UL Component Recognition for appropriate sizes.
- B. Conform to NFPA 70.

#### 1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

### **PART 2 - PRODUCTS**

#### 2.1 GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these specifications.
- B. Single Phase Motors: PSC where available.

- C. Electrical Service:
  - 1. Electric service to building is 120/208/460 volt, three phase, “Y” connected.
- D. Open drip-proof type except where specifically noted otherwise.
- E. Design for continuous operation in 40 degrees C environment.
- F. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- G. Explosion-Proof Motors: UL approved for hazard classification.
- H. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.
- I. Wiring Terminations:
  - 1. Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70, threaded for conduit.
  - 2. For fractional horsepower motors where connection is made directly, provide threaded conduit connection in end frame.
- J. Motors shall not be rated for 208, 230 or 240 volts. Motors in this voltage range shall accept operating voltages ranging from 190 volts to 250 volts.

## 2.2 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.

## 2.3 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 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.

#### 2.4 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; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
- F. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
- G. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.

#### 2.5 THREE PHASE POWER - SQUIRREL-CAGE MOTORS

- A. Starting Torque: Between 1 and 1-1/2 times full load torque.
- B. Starting Current: Six times full load current.
- C. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
- D. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B energy efficient motors.
- E. Insulation System: NEMA Class B or better.
- F. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
- G. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid-state control relay with wiring to terminal box.
- H. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt centerline at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

- I. Sound Power Levels: To NEMA MG 1.
- J. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
- K. Weatherproof Epoxy Sealed or Treated Motors: Epoxy seal windings using vacuum and pressure or coat windings with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- L. All three phase motors shall be rated for 208 or 460-volt service. Motors may be dual rated for 208/230-volt service. Motors rated for 230-volt service are not acceptable and will be replaced.

### **PART 3 - EXECUTION**

#### 3.1 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- B. Check line voltage and phase and ensure agreement with nameplate.

END OF SECTION



SECTION 15185 - HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
  - 1. Separately coupled, base-mounted, end-suction centrifugal pumps.

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

- A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.
- B. Store pumps in dry location.
- C. Retain protective covers for flanges and protective coatings during storage.
- D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.
- E. Comply with pump manufacturer's written rigging instructions.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.

1.8 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

2.2 SEPARATELY COUPLED, BASE-MOUNTED, END-SUCTION CENTRIFUGAL PUMPS

- A. Available Manufacturers:
  - 1. Armstrong Pumps Inc.
  - 2. Bell & Gossett; Div. of ITT Industries.
  - 3. Deming Pumps; Div. of Crane Pumps & Systems.
  - 4. PACO Pumps.
  - 5. Taco, Inc.
  - 6. Thrush Company Inc.

- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately coupled, end-suction pump as defined in HI 1.1-1.2 and HI 1.3; designed for base mounting, with pump and motor shafts horizontal. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.
- C. Pump Construction:
  - 1. Casing: Cast iron, with threaded gage tappings at inlet and outlet, drain plug at bottom and air vent at top of volute, and flanged connections. Provide integral mount on volute to support the casing, and attached piping to allow removal and replacement of impeller without disconnecting piping or requiring the realignment of pump and motor shaft.
  - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw.
  - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
  - 4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket.
  - 5. Packing Seal: Stuffing box, with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
  - 6. Pump Bearings: Grease-lubricated ball bearings contained in cast-iron housing with grease fittings.
- D. Shaft Coupling: Molded rubber insert and interlocking spider capable of absorbing vibration. Couplings shall be drop-out type to allow disassembly and removal without removing pump shaft or motor EPDM coupling sleeve for variable-speed applications.
- E. Coupling Guard: Dual rated; ANSIB15.1, Section 8; OSHA 1910.219 approved; steel; removable; attached to mounting frame.
- F. Mounting Frame: Welded-steel frame and cross members, factory fabricated from ASTM A 36/A 36M channels and angles. Fabricate to mount pump casing, coupling guard, and motor.
- G. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; secured to mounting frame, with adjustable alignment. Comply with requirements in Division 15 Section "Motors."

### 2.3 PUMP SPECIALTY FITTINGS

- A. Suction Diffuser: Angle pattern, 175-psig pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 15 Section "Basic Mechanical Materials and Methods."
  - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  - 2. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - 3. Install anchor bolts to elevations required for proper attachment to supported equipment.

3.3 PUMP INSTALLATION

- A. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- B. Set base-mounted pumps on concrete foundation. Disconnect coupling before setting. Do not reconnect couplings until alignment procedure is complete.
  - 1. Support pump baseplate on rectangular metal blocks and shims, or on metal wedges with small taper, at points near foundation bolts to provide a gap of 3/4 to 1-1/2 inches between pump base and foundation for grouting.

3.4 ALIGNMENT

- A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
- B. Comply with pump and coupling manufacturers' written instructions.

3.5 CONNECTIONS

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.
- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check valve on discharge side of pumps.
- F. Install suction diffuser and shutoff valve on suction side of pumps.
- G. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.
- H. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.
- I. Connect wiring according to Division 16.

3.6 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Check piping connections for tightness.
  - 3. Clean strainers on suction piping.
  - 4. Perform the following startup checks for each pump before starting:
    - a. Verify bearing lubrication.
    - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
    - c. Verify that pump is rotating in the correct direction.
  - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
  - 6. Start motor.
  - 7. Open discharge valve slowly.

END OF SECTION 15185

**SECTION 15190 - MECHANICAL IDENTIFICATION**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Pipe Markers.

1.2 REFERENCES

- A. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS FOR REVIEW

- A. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Product Data: Provide manufacturers catalog literature for each product required.

**PART 2 - PRODUCTS**

2.1 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
  - 1. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Underground Pipe Markers:
  - 1. Factory fabricated, flexible, Magnetic Tape.

2.5 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
  - 1. HVAC equipment: Yellow.
  - 2. Fire dampers/smoke dampers: Red.
  - 3. Plumbing valves: Green.
  - 4. Heating/cooling valves: Blue.

**PART 3 - EXECUTION**

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.

3.2 INSTALLATION

- A. Install identifying devices after completion of coverings and painting.
- B. Identify piping, concealed or exposed, with plastic pipe markers. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- C. Provide ceiling tacks to locate valves or dampers above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

**SECTION 15260 - MECHANICAL INSULATION**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.
- C. Equipment insulation.
- D. Covering.
- E. Exterior ductwork insulation.
- F. Lined ductwork insulation.

1.2 RELATED SECTIONS

- A. Division 07 - Firestopping.
- B. Division 09 - Painting: Painting insulation jacket.
- C. Division 15 - Piping & Valves
- D. Division 15 – Ductwork.

1.3 REFERENCES

- A. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
- B. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
- C. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type).
- D. ASTM D1056 - Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
- E. ASTM D1667 - Standard Specification for Flexible Cellular Materials--Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
- F. ASTM D1784 - Standard Specification for Rigid Poly (Vinyl Chloride) PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.



- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
- H. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.
- J. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- K. IMC – International Mechanical Code.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.5 QUALITY ASSURANCE

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

1.6 REGULATORY REQUIREMENTS

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Maintain ambient conditions required by manufacturers of each product.

1.9 SUBMITTALS FOR REVIEW

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.
- B. Samples: Submit one sample of any representative size illustrating each insulation type.

**PART 2 - PRODUCTS**

2.1 MANUFACTURER:

- A. Armstrong.
- B. Knauf.

- C. Johns Manville.
- D. Owens Corning
- E. Rubatex.

2.2 GLASS FIBER

- A. Insulation: ASTM C547; rigid molded, noncombustible.
  - 1. K value: ASTM C177, 0.24 at 75 degrees F.
  - 2. Maximum service temperature: 850 degrees F.
  - 3. Maximum moisture absorption: 0.2 percent by volume.
- B. Vapor Barrier Jacket:
  - 1. ASTM C921, White Kraft paper with glass fiber yarn, bonded to aluminized film.
  - 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
- C. Tie Wire: 0.048-inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Vapor Barrier Lap Adhesive shall be compatible with insulation.
- E. Insulating Cement/Mastic:
  - 1. ASTM C195; hydraulic setting on mineral wool.
- F. Fibrous Glass Fabric:
  - 1. Cloth: Untreated; 9 oz/sq yard weight.
  - 2. Blanket: 1.0 lb/cu foot density.
  - 3. Weave: 10x10.
- G. Outdoor Breather Mastic:
  - 1. Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- H. Insulating Cement:
  - 1. ASTM C449/C449M.

2.3 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible.
  - 1. K Value: ASTM C177 or ASTM C518 0.24 at 75 degrees F.
  - 2. Maximum Service Temperature: 450 degrees F.
  - 3. Maximum Moisture Absorption: 0.2 percent by volume.
  - 4. Density: 1.5 lb/sq ft
- B. Vapor Barrier Jacket:
  - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture vapor transmission: ASTM E96; 0.04 perm.
  - 3. Secure with self-sealing longitudinal laps and butt strips.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Vapor Barrier Lap Adhesive:
  - 1. Compatible with insulation.

- E. Insulating Cement/Mastic:
  - 1. ASTM C195; hydraulic setting on mineral wool.

2.4 GLASS FIBER, RIGID

- A. Insulation: ASTM C612 [or ASTM C592]; rigid, noncombustible.
  - 1. K Value: ASTM C177 or ASTM C518, 0.024 at 75 degrees F.
  - 2. Maximum Service Temperature: 450 degrees F.
  - 3. Maximum Moisture Absorption: 0.1 percent by volume.
  - 4. Density: 3.0 lb/sq ft.
- B. Vapor Barrier Jacket:
  - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
  - 2. Moisture vapor transmission: ASTM E96; 0.04 perm.
  - 3. Secure with self-sealing longitudinal laps and butt strips.
- C. Vapor Barrier Lap Adhesive:
  - 1. Compatible with insulation.
- D. Insulating Cement/Mastic:
  - 1. ASTM C195; hydraulic setting on mineral wool.

2.5 CELLULAR FOAM

- A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
  - 1. K value: ASTM C177; 0.28 at 75 degrees F.
  - 2. Minimum service temperature: -40 degrees F.
  - 3. Maximum service temperature: 220 degrees F.
  - 4. Maximum moisture absorption: ASTM D1056; 5.0 percent (pipe) by volume, 6.0 percent (sheet) by volume.
  - 5. Moisture vapor transmission: ASTM E96; 0.20 perm-inches.
  - 6. Connection: Waterproof vapor barrier adhesive.
- B. Elastomeric Foam Adhesive:
  - 1. Air dried, contact adhesive, compatible with insulation.

2.6 CELLULAR FOAM SHEET

- A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
  - 1. K Value: ASTM C177; 0.25 at 75 degrees F.
  - 2. Minimum Service Temperature: -40 degrees F.
  - 3. Maximum Service Temperature: 220 degrees F.
  - 4. Maximum Moisture Absorption: ASTM D1056; 1.0 percent by volume.
  - 5. Moisture Vapor Transmission: ASTM E96; 0.05 perm-inches.
  - 6. Connection: Waterproof vapor barrier adhesive.
- B. Elastomeric Foam Adhesive:
  - 1. Air dried, contact adhesive, compatible with insulation.

2.7 JACKETS

- A. PVC Plastic.
  - 1. Jacket: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color.
    - a. Minimum service temperature: 0 degrees F.
    - b. Maximum service temperature: 150 degrees F.
    - c. Moisture vapor transmission: ASTM E96; 0.002 perm-inches.
    - d. Thickness: 15 mil.
    - e. Connections: Brush on welding adhesive or pressure sensitive color matching vinyl tape.
  - 2. Covering Adhesive Mastic:
    - a. Compatible with insulation.

### **PART 3 - EXECUTION**

#### 3.1 EXAMINATION

- A. Verification of existing conditions before starting work.
- B. Verify that piping has been tested before applying insulation materials.
- C. Verify that surfaces are clean and dry, with foreign material removed.

#### 3.2 INSTALLATION

- A. Exposed Piping: Locate insulation and cover seams in least visible locations. Cover exposed piping with Fabric.
- B. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- C. Glass fiber insulated pipes conveying fluids below ambient temperature:
  - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
  - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- D. Glass fiber insulated pipes conveying fluids above ambient temperature:
  - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
  - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- E. Inserts and Shields:
  - 1. Application: Piping 1-1/2 inches diameter or larger.

2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  3. Insert location: Between support shield and piping and under the finish jacket.
  4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
  5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- F. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions.
- G. Insulated ductwork:
1. Provide insulation with vapor barrier jackets.
  2. Finish with tape and vapor barrier jacket.
  3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
  4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

### 3.3 SCHEDULES

- A. Plumbing Systems:
1. Domestic Hot Water Supply Mains and Recirculating Pipe:
    - a) Glass Fiber Insulation:
      - 1) Pipe Size Range: All sizes.
      - 2) Thickness: 1 inch.
    - b) Cellular Foam Insulation:
      - 1) Pipe Size Range: All sizes.
      - 2) Thickness: 1 inch.
  2. Domestic Hot and Cold Water Branches-All Sizes and cold water mains:
    - a) Glass Fiber Insulation:  
Thickness: 1/2 inch.
    - b) Cellular Foam Insulation:  
Thickness: 1/2 inch.
  3. Geothermal Piping and Condensate Piping:
    - a) Same as Cold Domestic Water. Plastic Pipe in Plenum must be totally covered.
- B. Ductwork:
1. Concealed Supply and Outside Air:
    - a) 2" thick 1.5 lb./sq.ft., glass fiber, flexible.
  2. Exposed Supply and Outside Air in a non-conditioned space:
    - a) 2" thick 1.5 lb./sq.ft. glass fiber, rigid with canvas jacket.
  3. Concealed Return Air and Exhaust air to heat recovery unit:
    - a) 1-1/2" thick 1.5 lb./ft.sq. glass fiber, flexible.
  4. Exposed Return Air and Exhaust air to heat recovery unit:
    - a) 1-1/2" thick 1.5 lb./ft.sq. glass fiber, rigid with canvas jacket.
  5. Supply air ductwork exposed in a conditioned space:
    - a) Duct shall be lined with 1/2" thick cellular foam.

6. Return air ductwork exposed in a conditioned space:
    - a) Duct shall be lined with 1/2" thick cellular foam.
  7. Exhaust ductwork from inlet to exterior shall not be insulated.
  8. Sound attenuating air transfer ducts shall be insulated with 1/2" cellular foam.
- C. Refrigerant Piping:
1. Suction, 1" Elastomeric.
  2. If exterior, 2 coats manufacturers enamel, gray.

END OF SECTION

**SECTION 15310 - FIRE PROTECTION PIPING**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Pipe, fittings, valves, and connections for sprinkler systems.

1.2 RELATED SECTIONS

- A. Division 15 - Mechanical Identification: Piping identification.
- B. Division 15 - Sprinkler Systems: Sprinkler systems design.
- C. Division 16 – Wiring methods.

1.3 REFERENCES

- A. ASME Boiler and Pressure Vessel Code Section IX - Welding and Brazing Qualifications.
- B. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
- C. ASME B16.3 - Malleable Iron Threaded Fittings, Class 150 and 300.
- D. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
- E. ASME B16.5 - Pipe Flanges and Flanged Fittings.
- F. ASME B16.9 - Factory-made Wrought Steel Butt welding Fittings.
- G. ASME B16.11 - Forged Steel Fittings, Socket-welding and Threaded.
- H. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- I. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- J. ASME B16.25 - Butt welding Ends.
- K. ASME B36.10 - Welded and Seamless Wrought Steel Pipe.
- L. ASTM A135 - Electric-Resistance-Welded Steel Pipe.
- M. ASTM A47 - Malleable Iron Castings.
- N. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-coated Welded and Seamless.
- O. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

- P. ASTM A795 - Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
- Q. ASTM B32 - Solder Metal.
- R. ASTM B75 - Seamless Copper Tube.
- S. ASTM B88 - Seamless Copper Water Tube.
- T. ASTM B251 - General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
- U. AWS A5.8 - Brazing Filler Metal.
- V. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- W. AWWA C110 - Ductile Iron and Gray Iron Fittings.
- X. AWWA C151 - Ductile Iron Pipe, Centrifugally Cast.
- Y. NFPA 13 - Installation of Sprinkler Systems.
- Z. UL - Fire Resistance Directory.

#### 1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide manufacturers catalogue information. Indicate valve data and ratings.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

#### 1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Project Record Documents: Record actual locations of components and tag numbering.
- B. Operation and Maintenance Data: Include installation instructions and spare parts lists.

#### 1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 3 years experience

#### 1.7 REGULATORY REQUIREMENTS

- A. Conform to UL, FM, and/or Warnock Hersey as applicable.



- B. Sprinkler Systems: Conform work to NFPA 13.
- C. Welding Materials and Procedures: Conform to ASME Code.
- D. Valves: Bear UL, FM, or Warnock Hersey as applicable label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- E. Products Requiring Electrical Connection: Listed and classified as suitable for the purpose specified and indicated.

#### 1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Deliver and store valves in shipping containers, with labeling in place.
- 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.

### **PART 2 - PRODUCTS**

#### 2.1 BURIED PIPING

- A. Steel Pipe: ASTM A53, ASTM A135, ASTM A795, or ASME B36.10, Schedule 40 black, with ASME C105 polyethylene jacket, or double layer, half-lapped 10 mil polyethylene tape.
  - 1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ASME B16.25, butt weld ends; ASTM A234, wrought carbon steel and alloy steel; ASME B16.5, steel flanges and fittings; ASME B16.11, forged steel socket welded and threaded; with double layer, half-lapped 10 mil polyethylene tape.
  - 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
  - 3. Joints: AWS D1.1, welded.
  - 4. Casing: Closed glass cell insulation. Polyurethane insulation with high-density polyethylene jacket and heat shrink sleeves.
- B. Cast Iron Pipe: AWWA C151.
  - 1. Fittings: AWWA C110, standard thickness.
  - 2. Joints: AWWA C111, rubber gasket.
  - 3. Mechanical Couplings: Shaped composition sealing gasket, steel bolts, nuts, and washers.

#### 2.2 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A53; ASTM A135; ASTM A135 UL listed, threadable, light wall; ASTM A795; or ASME B36.10; Schedule 5, 10, 40 black or galvanized.
  - 1. Steel Fittings: ASME B16.9, wrought steel, butt welded; ASME B16.25, butt weld ends; ASTM A234, wrought carbon steel and alloy steel; ASME B16.5, steel flanges and fittings; ASME B16.11, forged steel socket welded and threaded.
  - 2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings; ASME B16.4, threaded fittings.

3. Malleable Iron Fittings: ASME B16.3, threaded fittings or ASTM A47.
4. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped elastomeric sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.
5. Mechanical Formed Fittings: Carbon steel housing with integral pipe stop and O-ring pocked and O-ring, uniformly compressed into permanent mechanical engagement onto pipe.

B. Cast Iron Pipe: AWWA C151.

1. Fittings: AWWA C110, standard thickness.
2. Joints: AWWA C111, rubber gasket.
3. Mechanical Grooved Couplings: Malleable iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

2.3 PIPE HANGERS AND SUPPORTS

A. Conform to NFPA 13.

B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron or Carbon steel, adjustable swivel, split ring.

C. Hangers for Pipe Sizes 2 inches and Over: Carbon steel, adjustable, clevis.

D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.

E. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.

F. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.

G. Vertical Support: Steel riser clamp or Angle ring.

H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

2.4 GATE VALVES

A. Up to and including 2 inches:

1. Bronze body, bronze trim, rising stem, handwheel, solid wedge or disc, threaded ends.

B. Over 2 inches:

1. Iron body, bronze trim, rising stem pre-grooved for mounting tamper switch, handwheel, OS&Y, solid rubber covered bronze or cast iron wedge, flanged or grooved ends.

C. Over 4 inches:

1. Iron body, bronze trim, non-rising stem with bolted bonnet, solid bronze wedge, flanged ends, iron body indicator post assembly.

2.5 GLOBE VALVES

- A. Up to and including 2 inches:
  - 1. Bronze body, bronze trim, rising stem and handwheel, inside screw, renewable rubber disc, threaded ends, with backseating capacity.
- B. Over 2 inches:
  - 1. Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

## 2.6 BALL VALVES

- A. Up to and including 2 inches:
  - 1. Bronze or Stainless steel two piece body, brass, chrome plated bronze, or stainless steel ball, teflon seats and stuffing box ring, lever handle, threaded ends.
- B. Over 2 inches:
  - 1. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle or gear drive handwheel for sizes 10 inches and over, flanged.

## 2.7 BUTTERFLY VALVES

- A. Bronze Body:
  - 1. Stainless steel disc, resilient replaceable seat, threaded or grooved ends, extended neck, handwheel and gear drive and integral indicating device, and built-in tamper proof switch rated 10 amp at 115 volt AC.
- B. Cast or Ductile Iron Body
  - 1. Cast or ductile iron, chrome or nickel plated ductile iron or aluminum bronze disc, resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck, handwheel and gear drive and integral indicating device, and external tamper switch rated 10 amp at 115 volt AC.

## 2.8 CHECK VALVES

- A. Up to and including 2 inches:
  - 1. Bronze body and swing disc, rubber seat, threaded ends.
- B. Over 2 inches:
  - 1. Iron body, bronze trim, swing check with rubber disc, renewable disc and seat, flanged ends with automatic ball check.
- C. 4 inches and Over:
  - 1. Iron body, bronze disc, stainless steel spring, resilient seal, threaded, wafer, or flanged ends.

## 2.9 DRAIN VALVES

- A. Compression Stop:
  - 1. Bronze with hose thread nipple and cap.

- B. Ball Valve:
  - 1. Brass with cap and chain, 3/4 inch hose thread.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

#### **3.2 INSTALLATION**

- A. Install piping in accordance with NFPA 13 for sprinkler systems.
- B. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- C. Install piping to conserve building space, to not interfere with use of space and other work.
- D. Group piping whenever practical at common elevations.
- E. Sleeve pipes passing through partitions, walls, and floors.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- G. Inserts:
  - 1. Provide inserts for placement in concrete formwork.
  - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
  - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- H. Pipe Hangers and Supports:
  - 1. Install in accordance with NFPA 13 and NFPA 14.
  - 2. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
  - 3. Place hangers within 12 inches of each horizontal elbow.
  - 4. Use hangers with 1-1/2" minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - 5. Support vertical piping at every floor. Support riser piping independently of connected horizontal piping.
  - 6. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
  - 7. Provide copper plated hangers and supports for copper piping.

8. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- I. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- J. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Do not penetrate building structural members unless indicated.
- L. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- M. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- N. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- O. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- P. Provide gate ball or butterfly valves for shut-off or isolating service.
- Q. Provide drain valves at main shut-off valves, low points of piping and apparatus.

END OF SECTION

## **SECTION 15325 - SPRINKLER SYSTEMS**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

- A. Wet-pipe sprinkler system.
- B. Dry-Pipe sprinkler system.
- C. Conversion of existing wet system to dry system
- D. System design, installation, and certification.

#### 1.2 RELATED SECTIONS

- A. Division 15 - Mechanical Identification and Supports and Anchors.
- B. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

#### 1.3 REFERENCES

- A. NFPA 13 - Installation of Sprinkler Systems.
- B. FM - Factory Mutual Approval Guide.
- C. NFPA 70 - National Electrical Code.
- D. UL - Fire Resistance Directory.
- E. Warnock Hersey - Certification Listings.
- F. Kentucky Building Code.

#### 1.4 SYSTEM DESCRIPTION

- A. System to provide coverage for buildings as indicated on the plans.
- B. Provide system to NFPA 13 light hazard or ordinary hazard occupancy requirements in offices and other occupancies in the plant as deemed necessary.
- C. Use water flow data provided if it is within the past six months or conduct independent flow test. Flows recorded on the 21<sup>st</sup> of April, 2015 at the two hydrants in front of the building to be removed show a flow of 1,250 gallons per minute with static pressure of 120 psi and residual pressure of 58 psi.
- D. Interface system with building fire and smoke alarm system.
- E. Connect to existing building sprinklers as necessary for a fully sprinklered building.

- F. Coordinate with building alarm contractor and provide method of sprinkler system supervision through an approved proprietary supervision supplier.
- G. System shall also include a new riser and service from the exterior main for the new office building "A". A new riser and service from the exterior main shall be provided for part of the dry system in building "B". An existing riser shall be converted to dry for the remaining part of the dry system in building "B". Sprinkler heads shall be replaced if required to convert the wet system to two dry systems.
- H. Work in Building D is included in this section. Existing system will be inspected and placed back in service.

#### 1.5 SUBMITTALS FOR REVIEW

- A. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- B. Shop Drawings:
  - 1. Submit preliminary layout of finished ceiling areas indicating only sprinkler locations coordinated with ceiling installation.
  - 2. Indicate hydraulic calculations, detailed pipe layout, hangers and supports, sprinklers, components and accessories. Indicate system controls.
  - 3. Submit shop drawings, product data, hydraulic calculations and review fee for review by the Office of Housing, Buildings and Construction. Submit a copy of shop drawings, product data and hydraulic calculations to the engineer of record.

#### 1.6 SUBMITTALS AT PROJECT CLOSEOUT

- A. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- B. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements.
- C. Operation and Maintenance Data: Include components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.
- D. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

#### 1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with NFPA 13
- B. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

- C. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience approved by manufacturer.
- D. Design and install system under direct supervision of a licensed sprinkler contractor and installer.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation. Store piping off the ground or floor. Piping installed with dirt and/or rust will be cleaned and painted!

1.9 EXTRA MATERIALS

- A. Provide extra sprinklers under provisions of NFPA 13.
- B. Provide suitable wrenches for each sprinkler type.
- C. Provide metal storage cabinet located adjacent to alarm valve.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Gem.
- B. Star
- C. Viking.
- D. Reliable.

2.2 SPRINKLERS

- A. Suspended Ceiling:
  - 1. Type: Semi-recessed pendant type with matching clamp on escutcheon plate.
  - 2. Finish: Chrome plated or white enamel.
  - 3. Escutcheon Plate Finish: To match head
  - 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- B. Exposed Area Type:
  - 1. Type: Standard upright type with guard in mechanical rooms and gymnasiums.
  - 2. Finish: Brass.
  - 3. Fusible Link: Fusible solder link type temperature rated for specific area hazard.
- C. Sidewall Type:
  - 1. Type: Semi-recessed horizontal sidewall type with matching clamp on escutcheon plate.
  - 2. Finish: Chrome plated.
  - 3. Escutcheon Plate Finish: Chrome plated.
  - 4. Fusible Link: Fusible solder link type temperature rated for specific area hazard.



- D. Guards: Finish to match sprinkler finish.

### 2.3 PIPING SPECIALTIES

- A. Wet Pipe Sprinkler Riser Valve: A.U.L. approved right check riser valve, with test and drain valve. Add sprinkler risers as necessary for system completion.
- B. Control Valve: Valves sealed in proper position and provided with approved type metal signs indicating purpose of valve and fastened to yoke with brass chain.
  - 1. 2" and smaller: Underwriters approved OS&Y threaded bronze gate valve: 175 WWP Class, 2-1/2" and larger: Underwriters approved OS&Y flanged IBBm gate valve: 175 WWP Class.
  - 2. Butterfly Valves – 2" and larger UL/FM approved valve with gear operator and flag, 250 WWP with internal or external supervisory switches.
- C. Provide all flow valves as shown.
- D. Air compressors.

## **PART 3 - EXECUTION**

### 3.1 INSTALLATION

- A. Install in accordance with NFPA 13.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Locate outside alarm gong on building wall as indicated.
- D. Place pipe runs to minimize obstruction to other work.
- E. Place piping in concealed spaces above finished ceilings.
- F. Center sprinklers in two directions in ceiling tile and provide piping offsets as required.
- G. Apply masking tape or paper cover to ensure concealed sprinklers, cover plates, and sprinkler escutcheons do not receive field paint finish. Remove after painting. Replace painted sprinklers.
- H. Flush entire piping system of foreign matter.
- I. Install guards on sprinklers where exposed.
- J. Hydrostatically test entire system.

### 3.2 INTERFACE WITH OTHER PRODUCTS

- A. Ensure required devices are installed and connected as required to fire alarm system.

END OF SECTION

## **SECTION 15360 - FM-200 FIRE SUPPRESSION SYSTEM**

### **1. GENERAL SPECIFICATION**

- 1.1 A total flooding, ADS FM-200 fire suppression system with separate nitrogen storage used for a propellant shall be installed to meet a minimum design concentration of 20 %, by volume in all designated spaces to be protected.

### **2. CODES/STANDARDS COMPLIANCE**

- 2.1 The design, installation, testing and maintenance of the above stated FM-200 fire suppression system shall be in accordance to the following codes, standards and regulatory bodies:
- A. NFPA 2001 – Standard for Clean Agent Fire Extinguishing Systems – 2004 edition.
  - B. NFPA 12A – Halon 1301 Fire Extinguishing Systems
  - C. UL 2166 – Standard for Halocarbon Clean Agent Extinguishing System Units
  - D. Factory Mutual Approval Guide
  - E. ANSI B1.20.1 – Standard for pipe threads, General Purpose, 1992
  - F. Design and installation practices set forth by system manufacturer
  - G. NFPA 70 - NEC – National Electrical Code
  - H. NFPA 72 – National Fire Alarm Code
  - I. Kentucky Building Code.
- 2.2 The Fire suppression system must have the following listings and approvals:
- A. FM Approved – Factory Mutual Research Center
  - B. UL 2166 Listed – Underwriters Laboratories Inc.
- 2.3 The manufacturer shall meet ISO 9001 requirements for the design, production and distribution of the FM-200 fire suppression systems.

### **3. SYSTEM DESCRIPTION**

- 3.1 All FM-200, fire suppression equipment and accessories must be manufactured by:  
Kidde Fire Systems or Fike FE-25 (ECARO).
- 3.2 The months from date of shipment or one (1) full year from the date of installation.
- 3.3 The system shall be supplied and installed by a factory-authorized, Kidde Fire Systems distributor. The distributor / Installer shall be trained by the manufacturer to calculate / design, install, test and maintain the ADS, FM-200 Fire suppression system and shall be able to produce a certificate stating such on request.

- 3.4 The ADS system shall consist of a Kidde FM-200 Agent Storage Cylinder, Kidde Nitrogen Driver Cylinder, Kidde Nitrogen Transfer hardware, Kidde actuation hardware and Kidde ADS system distribution nozzles attached to a pipe network.
- 3.5 (OPTIONAL EQUIPMENT) The FM-200 Agent Cylinder shall have the option of a Liquid level indicator. This device will provide a reliable means other than weighing for determining the agent weight with the storage container during normal routine servicing.

#### **4. COMPONENTS**

##### 4.1 FM-200 Cylinder and Valve Assembly

- A. FM-200 shall be stored in a Kidde ADS series Cylinders P/N 90-10022X-001 or 90-10039X-001. Operating pressure of the FM-200 shall be at 44 psig @ 70°F.
- B. FM-200 Agent cylinders can be actuated pneumatically with Kidde P/N 878737.
- C. The FM-200 Agent cylinder shall be provided with a safety rupture disc.

##### 4.2 Nitrogen Driver Cylinder and Valve Assembly

- A. Nitrogen shall be stored in a Kidde ADS series Nitrogen driver cylinder P/N 90-102300-001 for use with agent storage cylinder 90-10022X-001
- B. Nitrogen shall be stored in a Kidde ADS series Nitrogen driver cylinder P/N 90-104070-001 for use with agent storage cylinder 90-10039X-001
- C. Operating Pressure for Nitrogen driver cylinders, P/N 90-102300-001 and 90-104070-001 shall be 1800 psig @ 70°F.
- D. Nitrogen driver cylinders shall be equipped with a discharge head, Kidde P/N 872442 and shall be actuated as the primary cylinder using a Kidde electric control head, electric / cable control head or lever operated control head.
- E. (OPTIONAL EQUIPMENT): pneumatic actuation of Nitrogen driver cylinders can be accomplished by using a nitrogen pilot Cylinder Kidde P/N's 877940 or 06-129773-00X
- F. Nitrogen shall be transferred from the Nitrogen Driver Cylinder to the FM-200 Agent cylinder by using a 3/4" Outlet, flexible transfer hose. Kidde P/N 06-118207-00X.
- G. Nitrogen Transfer to the FM-200 Agent cylinder shall be regulated by an Orifice fitting, Kidde P/N 90-194129-XXX. Size of Orifice restrictor plate to be determined using Kidde ADS flow calculation software P/N 90-190002-100.

##### 4.3 Distribution Nozzles

- A. Engineered discharge nozzles for use with the Kidde ADS series system will be made of Brass or Stainless steel, Kidde P/N 90-1944XX-XXX
- B. Each nozzle shall be located in the space per the manufactures guidelines, Nozzles can have

either a 180 or a 360-degree discharge pattern.

- C. Each Nozzle discharge pattern shall be available in sizes ranging from ½” NPT to 2” NPT.
- D. (OPTIONAL EQUIPMENT): Nozzle escutcheon plates can be used to conceal pipe entry through ceiling, Kidde P/N 06-23613X-001

#### 4.4 Pipe Network

- A. Distribution piping, and fittings, shall be installed in accordance with NFPA 2001, approved piping standards and FM-200 system manufacturer’s requirements.

#### 4.5 (OPTIONAL EQUIPMENT) 3-Way Directional Ball Valves

- A. For selector suppression systems where multiple hazard manifold arrangements are used, a Kidde 3-Way directional ball valve for use with the ADS series system shall be used. P/N 90-22003X-00X.
- B. When multiple cylinders are used, each cylinder must have the same orifice fitting and drill size and be of the same cylinder size and fill density to ensure proper regulated flow of agent and nitrogen.
- C. 3-way directional ball valves shall be pneumatically actuated using a Kidde nitrogen pilot cylinder P/N 877940 or 06-129773-00X.
- D. The fire system control panel will energize an electric solenoid P/N 06-118384-001 attached to the actuator, allowing pressure to enter the actuator and turn the selected 3-way ball valve, 90 deg CCW.
- E. The 3-way directional ball valves shall be installed and located in the piping network per the manufacturers guidelines and design manual
- F. 3-Way directional ball valves must be UL system listed with the Kidde ADS.

### 5. WARRANTY

The manufacturer shall warrant all FM-200 fire suppression system products for 36 months from the date of Substantial Completion.

### 6. SUBMITTALS

#### 6.1 Engineered Design Drawings

- A. The factory-authorized Kidde Fire Systems Distributor shall provide all required installation drawings per NFPA 2001.

#### 6.2 Flow Calculation Reports

- A. The contractor shall provide the following information in the flow calculation report.
  - 1. Customer Information and Project Data

2. Enclosure Information – at a minimum, enclosure information is to include Minimum and adjusted design concentrations, Minimum and maximum enclosure temperatures, minimum agent required and volume of enclosures, including non-permeable volume if applicable.
3. Agent information – at a minimum, agent information is to include Cylinder size and part number, quantity of cylinders, main and / or reserve cylinders, pipe take off direction, floor loading for agent cylinder and the nitrogen restrictor plate orifice area.
4. Pipe network information – at a minimum, pipe network information is to include pipe type, pipe diameter, pipe length, change in direction or elevation, pipe equivalent length and any added accessory equivalent length. In addition, the following nozzle information shall be provided; number of nozzles and identification of enclosure location, flow rate of associated nozzle, nozzle nominal size, nozzle type and nozzle orifice area.
5. (OPTIONAL) 3-way ball valve information – A calculation must be completed for each directional valve in the piping network. Modeling of the 3-Way ball valve must be shown in the "opened" and "closed" position.
6. Detailed list of all Pipes and Pipe Fittings designed in the pipe network

### 6.3 Commissioning Equipment List

- A. The contractor shall provide a commissioning equipment list for each installed FM-200 suppression system. The equipment list shall identify all installed equipment and configurations.

### 6.4 Test Plan

- A. The contractor / Installer shall submit a test plan which describes how the system equipment and room integrity shall be tested. This shall include a step-by-step description of all tests and shall indicate type and location of test apparatus to be used. At a minimum, the tests to be conducted shall be per NFPA 2001 and any additional supplemental tests required by the AHJ. Tests shall not be scheduled or conducted until the engineer of record approves the test plan.

### 6.5 Installation Drawings

- A. Four (4) sets of installation drawings for each installed FM-200 suppression system and One (1) set of the calculation report, owners manual and product data sheets shall be submitted to the end-user / owner.
- B. Upon completion of installation and commissioning acceptance, two (2) sets of "As-Built" installation drawings and One (1) set of the calculation report for each installed FM-200 suppression system shall be given to the owner / end-user for use and reference.

### 6.6 Operation and Maintenance Manuals

- A. Two (2) copies of the Kidde ADS FM-200 fire suppression system, Operation and Maintenance

nance Manual shall be submitted after complete installation.

## **7. SYSTEM INSTALLATION AND COMMISSIONING**

### **7.1 FM-200 Fire Suppression System Equipment**

- A. All work shall be completed in a high degree of workmanship and in compliance with the above referenced codes and standards. In addition, the contractor shall install the system in accordance with the manufacturer's installation, operation and maintenance manual.

### **7.2 Training Requirements**

- A. The contractor shall be certified and trained by the manufacturer on installation, design and maintenance of the Kidde ADS, FM-200 fire suppression systems.

### **7.3 Routine Maintenance**

1. Routine maintenance shall be performed as recommended by the manufacturer's installation, operation and maintenance manual. At a minimum, the routine maintenance will include the following:
2. Visual Check of Pipe network and distribution nozzles per the operation and maintenance manual.
3. Weight of FM-200 Agent cylinder and pressure of Nitrogen driver cylinder per the operation and maintenance manual.
4. Inspect all cylinders and equipment for damage per the operation and maintenance manual.
5. Pneumatic operation of 3-way directional valve.

END SECTION 15360

**SECTION 15430 - PLUMBING SPECIALTIES**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Floor drains.
- B. Cleanouts.
- C. Hose bibs.
- D. Hydrants.
- E. Water hammer arrestors.
- F. Trap primers.
- G. Backflow Preventers.
- H. Outlet boxes.

1.2 RELATED SECTIONS

- A. Division 15 - Piping & Valves.
- B. Division 15 - Plumbing Fixtures.
- C. Division 15 - Plumbing Equipment.
- D. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ASME A112.21.1 - Floor Drains.
- B. ASME A112.26.1 - Water Hammer Arrestors.
- C. ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.
- D. ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
- E. DI WH-201 - Water Hammer Arrestors.

1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.
- B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.



1.5 SUBMITTALS FOR INFORMATION

- A. Manufacturer's Instructions: Indicate Manufacturer's Installation Instructions: Indicate assembly and support requirements.

1.6 SUBMITTALS AT PROJECT CLOSEOUT

- A. Project Record Documents: Record actual locations of equipment, cleanouts, backflow preventers, and water hammer arrestors.
- B. Operation Data: Indicate frequency of treatment required for interceptors.
- C. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Accept specialties on site in original factory packaging. Inspect for damage.

1.8 EXTRA MATERIALS

- A. Supply two loose keys for outside hose bibs.

**PART 2 - PRODUCTS**

2.1 WATER HAMMER ARRESTORS

- A. ANSI A112.26.1; stainless steel or copper construction, bellows type sized in accordance with PDI WH-201, pre-charged suitable for operation in temperature range 34 to 250 degrees F and maximum 250 psi working pressure.

2.2 REDUCED PRESSURE BACKFLOW PREVENTER.

- A. Service existing Back Flow Preventer and leave in service..

2.3 FLOOR DRAINS AND CLEANOUTS

- A. Floor drains shall be type and of materials as scheduled manufactured by Josam, Zurn, Mifab, Smith or Watts.

2.4 TRAP PRIMERS

- A. Trap primers shall be supply-type manufactured by Mifab, Sioux Chief, JR Smith, Watts or approved equivalent..

2.5 OUTLET BOXES

- A. Outlet boxes shall be by Guy Gray, Acorn, Oatey, Plastic Oddities or approved equivalent.

2.6 WALL HYDRANTS

- A. Wall hydrants shall be type and of materials as scheduled manufactured by Josam, Zurn, Mifab, Smith, Woodford or Watts.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibs.
- F. Pipe relief from backflow preventer to nearest drain.
- I. Install water hammer arrestors complete with accessible isolation valve on hot and cold water as indicated.
- J. Install supply-type trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor drain body, trap or inlet fitting.
- K. Install floor drains at low points of surface areas to be drained. Set drains flush with finished floor, unless otherwise indicated.

END OF SECTION

**SECTION 15440 - PLUMBING FIXTURES**

**PART 1 - GENERAL**

1.1 SECTION INCLUDES

- A. Water Closets.
- B. Urinals.
- C. Lavatories.
- D. Sinks.
- E. Service Sinks.
- F. Electric Water Coolers.
- G. Emergency Showers and Eye Washes
- H. Showers

1.2 RELATED SECTIONS

- A. Division 15 - Supports and Anchors.
- B. Division 15 - Piping & Valves.
- C. Division 15 - Plumbing Specialties.
- D. Division 15 - Plumbing Equipment.
- E. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections

1.3 REFERENCES

- A. ARI 1010 - Drinking Fountains and Self-Contained Mechanically Refrigerated Drinking Water Coolers.
- B. ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.
- C. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.
- D. ASME A112.19.2 - Vitreous China Plumbing Fixtures.
- E. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals.
- F. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Maintenance Data: Include fixture trim exploded view and replacement parts lists.
- B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., or a testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 WARRANTY

- A. Provide five year manufacturer warranty for electric water cooler.

1.10 EXTRA MATERIALS

- A. Supply two sets of faucet washers, flush valve service kits, and toilet seats minimum, and two additional for each five fixtures.

**PART 2 - PRODUCTS**

- 2.1 See Schedule on Drawings.

**PART 3 - EXECUTION**

3.1 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Verify that electric power is available and of the correct characteristics.

- C. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

### 3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

### 3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and wall carriers as indicated.
- E. Seal fixtures to wall and floor surfaces with sealant, color to match fixture.
- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended to hold fixture in place.

### 3.4 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

### 3.5 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

### 3.6 CLEANING

- A. Clean plumbing fixtures and equipment.

### 3.7 PROTECTION OF FINISHED WORK

- A. Do not permit use of fixtures until acceptance of project.

### 3.8 SCHEDULES

- A. Fixture Rough-In

SOUTH KENTUCKY RECC. SOMERSET, KENTUCKY

	Hot	Cold	Waste	Vent
Water Closet (Flush Valve)		1 inch	3 inch	See plans
Water Closet (Flush Tank)		1/2 inch	3 inch	See plans
Urinal: (Flush Valve)		3/4 inch	2 inch	See plans
Lavatory:	1/2 inch	1/2 inch	See plans	See plans
Sink:	1/2 inch	1/2 inch	See plans	See plans
Shower:	1/2 inch	1/2 inch	2 inch	See plans
Service Sink:	1/2 inch	1/2 inch	3 inch	See plans
Drinking Fountain		1/2 inch	See plans	See plans

Waste and vent size may vary. See diagrams on drawings.

END OF SECTION

## **SECTION 15485 - ELECTRIC WATER HEATERS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes the following electric water heaters:
  - 1. Household, storage electric water heaters.
  - 2. Compression tanks.
  - 3. Water heater accessories.

#### **1.3 SUBMITTALS**

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For electric water heaters to include in emergency, operation, and maintenance manuals.
- E. Warranty: Special warranty specified in this Section.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain same type of electric water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of electric water heaters and are based on the specific system indicated.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9," for all components that will be in contact with potable water.

1.5 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric water heaters that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Structural failures including storage tank and supports.
    - b. Faulty operation of controls.
    - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
  - 2. Warranty Period(s): From date of Substantial Completion:
    - a. Household Electric Water Heaters:
      - 1) Storage Tank: Five years.
      - 2) Controls and Other Components: Two years.
    - b. Compression Tanks: Five years.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

2.2 HOUSEHOLD ELECTRIC WATER HEATERS

- A. Household, Standard, Storage Electric Water Heaters: Comply with UL 174.
  - 1. Available Manufacturers:
    - a. American Water Heater Company.
    - b. Bradford White Corporation.
    - c. HESco Industries, Inc.
    - d. Lochinvar Corporation.
    - e. Rheem Water Heater Div.; Rheem Manufacturing Company.
    - f. Ruud Water Heater Div.; Rheem Manufacturing Company.
    - g. Smith, A. O. Water Products Company.
    - h. State Industries, Inc.
  - 2. Storage-Tank Construction: Steel.
    - a. Tappings: ASME B1.20.1 pipe thread.
    - b. Pressure Rating: 150 psig.
    - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
  - 3. Factory-Installed Storage-Tank Appurtenances:



- a. Anode Rod: Replaceable magnesium.
  - b. Drain Valve: ASSE 1005.
  - c. Insulation: Comply with ASHRAE/IESNA 90.1 or ASHRAE 90.2.
  - d. Jacket: Steel with enameled finish.
    - 1) Standard: Cylindrical shape.
  - e. Heating Element: One; electric, screw-in immersion type.
  - f. Temperature Control: Adjustable thermostat.
  - g. Safety Control: High-temperature-limit cutoff device or system.
  - h. Relief Valve: ASME rated and stamped and complying with ASME PTC 25.3 for combination temperature and pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
4. Capacity and Characteristics: See schedule on drawings.

### 2.3 COMPRESSION TANKS

- A. Description: Steel pressure-rated tank constructed with welded joints and factory-installed butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
- 1. Available Manufacturers:
    - a. AMTROL Inc.
    - b. Armstrong Pumps, Inc.
    - c. Flexcon Industries.
    - d. Honeywell Sparco.
    - e. Myers, F. E.; Pentair Pump Group (The).
    - f. Smith, A. O.; Aqua-Air Div.
    - g. State Industries, Inc.
    - h. Taco, Inc.
    - i. Watts Regulator Co.
    - j. Wessels Co.
  - 2. Construction:
    - a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1, pipe thread.
    - b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
    - c. Air-Charging Valve: Factory installed.

### 2.4 WATER HEATER ACCESSORIES

- A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.

- B. Water Heater Mounting Brackets: Water heater manufacturer's factory-fabricated steel bracket for wall mounting and capable of supporting water heater and water.
- C. Shock Absorbers: ASSE 1010 or PDI WH 201, Size A water hammer arrester.

### **PART 3 - EXECUTION**

#### **3.1 WATER HEATER INSTALLATION**

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for water heaters that do not have tank drains. Refer to Division 15 Section "Plumbing Specialties" for hose-end drain valves.
- C. Install thermometer on outlet piping of water heaters.
- D. Fill water heaters with water.

#### **3.2 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 16 Section "Grounding and Bonding."
- D. Connect wiring according to Division 16 Section "Conductors and Cables."

#### **3.3 FIELD QUALITY CONTROL**

- 1. Operational Test: After electrical circuitry has been energized, confirm proper operation.
- 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

END OF SECTION 15485

## **SECTION 15515 - HYDRONIC SPECIALTIES**

### **PART 1 - GENERAL**

#### **1.1 SECTION INCLUDES**

- A. Expansion tanks.
- B. Air vents.
- E. Pump suction fittings.
- F. Combination fittings.
- G. Flow indicators, controls, and meters.
- H. Relief valves.

#### **1.2 RELATED SECTIONS**

- A. Division 15 - Plumbing Specialties: Backflow Preventers.
- B. Division 15 - Piping & Valves.
- C. Division 15 - Chemical Water Treatment: Pipe Cleaning.

#### **1.3 SUBMITTALS**

- A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description.
- B. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.
- C. Submit Inspection certificates for pressure vessels from the Kentucky State Boiler Inspection Office.

#### **1.4 OPERATION AND MAINTENANCE DATA**

- A. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

#### **1.5 QUALIFICATIONS**

- A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

#### **1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

- 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.

1.8 MAINTENANCE SERVICE

- A. Furnish service and maintenance of glycol system for two years from date of substantial completion.
- B. Quarterly visits to clean strainers in each heat pump hose kit and to clean suction diffuser strainers for the 1<sup>st</sup> year of operation.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Bell and Gossett.
- B. Amtrol.
- C. Taco.
- D. Armstrong.
- E. Wheatley.

2.2 DIAPHRAGM-TYPE EXPANSION TANKS

- A. Construction: Welded steel, tested and stamped in accordance with ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm sealed into tank, and steel support stand.
- B. Accessories: Pressure gage and air-charging fitting, tank-drain; pre-charge to 12 psi.

2.3 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- B. Float Type:
  - 1. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.4 AIR SEPARATORS

- A. Dip Tube Fitting:

1. For 125 psi operating pressure; to prevent free air collected in boiler from rising into system.
- B. In-line Air Separators:
  1. Cast iron for sizes 1-1/2 inch and smaller, or steel for sizes 2 inch and larger; tested and stamped in accordance with ASME SEC 8-D; for 125 psig operating pressure.
- C. Combination Air Separators/Strainers:
  1. Steel, tested and stamped in accordance with ASME SEC 8-D; for 125 psig operating pressure, with integral bronze strainer, tangential inlet and outlet connections, and internal stainless steel air collector tube.

## 2.5 STRAINERS

- A. Size 2 inch and under:
  1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.

## 2.6 PUMP SUCTION FITTINGS

- A. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psig working pressure, with inlet vanes, cylinder strainer 3/26 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.
- B. Accessories: Adjustable foot support, blowdown tapping in bottom, gage tapping in side.

## 2.7 COMBINATION PUMP DISCHARGE VALVES

- A. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psig operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

## 2.8 FLOW CONTROLS

- A. Construction: Brass or bronze body with union on inlet, temperature and pressure test plug on inlet.
- B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psig.
- C. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.

## 2.9 RELIEF VALVES

- A. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank and as shown on the drawings.
- F. Provide valved drain and hose connection on strainer blow down connection.
- G. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
- I. Support pump fittings with floor-mounted pipe and flange supports.
- J. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
- K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Pipe relief valve outlet to nearest floor drain.
- M. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- N. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION

## **SECTION 15545 - CHEMICAL WATER TREATMENT**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

- A. Cleaning of piping systems.
- B. Chemical feeder equipment.
- C. Chemical treatment.
- D. Filter.

#### 1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Division 15 – Piping and Valves: Placement of water coupon rack, by-pass (pot) feeder.
- B. Division 15 – HVAC Pumps, Solids Separator.

#### 1.3 RELATED SECTIONS

- A. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

#### 1.4 REFERENCES

- A. NFPA 70 - National Electrical Code.

#### 1.5 SUBMITTALS

- A. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.
- D. Manufacturer's Field Reports: Submit as part of Maintenance and Operations Manual.
- E. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- F. Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

#### 1.6 PROJECT RECORD DOCUMENTS

- A. Record actual locations of equipment and piping, including sampling points and location of chemical injectors.

1.7 OPERATION AND MAINTENANCE DATA

- A. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step-by-step instructions on test procedures including target concentrations.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum ten years documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.
- B. Installer: Company specializing in performing the work of this section with minimum five years documented experience and approved by manufacturer.

1.9 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by [UL] [testing firm acceptable to the authority having jurisdiction] as suitable for the purpose specified and indicated.

1.10 MAINTENANCE MATERIALS

- A. Provide sufficient chemicals for treatment and testing during warranty period and for one additional year.

**PART 2 – PRODUCTS**

2.1 MANUFACTURERS

- A. Bluegrass Kesco.
- B. Betz.

2.2 MATERIALS

- A. System Cleaner:
  - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodium tripoly phosphate and sodium molybdate.
  - 2. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.
- B. Closed System Treatment (Water):



1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazone, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
3. Conductivity enhancers; phosphates or phosphonates.

2.3 BY-PASS (POT) FEEDER

A. Manufacturers:

1. 1.8 gallon quick opening cap for working pressure of 175 psig.

2.4 WATER METER

- A. Displacement type cold water meter with sealed, tamper-proof magnetic drive, impulse contact register, single pole, double throw dry contact switch.

2.5 TEST EQUIPMENT

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 - 10 ml zeroing titrating burettes and associated reagents.
- B. Provide testing chemicals suitable for the system.

2.5 FILTER

- A. Provide side stream filter as indicated on the drawings.

**PART 3 - EXECUTION**

3.1 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

A. Concentration:

1. As recommended by manufacturer.
2. One pound per 100 gallons of water contained in the system.
3. One pound per 100 gallons of water for hot systems and one pound for 50 gallons of water for cold systems.
4. Fill steam boilers only with cleaner and water.

B. Geothermal Piping System:

1. Circulate for 48 hours, then drain systems as quickly as possible.

2. Refill with clean water, circulate for 24 hours, then drain.
  3. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
  - D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
  - E. Remove, clean, and replace strainer screens.
  - F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

### 3.4 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 4 inch water coupon rack around circulating pumps with space for 4 test specimens.
- D. Provide water meter on system make-up.
- E. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

END OF SECTION

## **SECTION 15550 - FUEL-FIRED HEATERS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Gas fired unit heaters.
- B. Related Sections:
  - 1. Section 15140 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers for placement by this section.
  - 2. Section 15100 - Piping: Product requirements for natural gas piping connected to gas-fired heaters.
  - 3. Section 15905 - HVAC Instrumentation: Product requirements for thermostats and time clocks for placement by this section.
  - 4. Section 16140 - Wiring Connections: Execution requirements for electrical connections specified by this section.

#### **1.2 REFERENCES**

- A. American National Standards Institute:
  - 1. ANSI Z83.8 - Gas Unit Heaters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- C. National Fire Protection Association:
  - 1. NFPA 54 - National Fuel Gas Code.
  - 2. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.

#### **1.3 SUBMITTALS**

- A. Section 01300 - Submittal Procedures: Submittals procedures.
- B. Shop Drawings: Indicate assembly, required clearances, and locations and sizes of field connections.
- C. Product Data: Submit manufacturer's literature and data indicating rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- D. Manufacturer's Installation Instructions: Submit Indicate rigging and assembly.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01700 - Execution Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of thermostats or other products not mounted on unit.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listing.

1.5 QUALITY ASSURANCE

- A. Gas-Fired Unit Heater Performance Requirements: Conform to minimum efficiency prescribed by ASHRAE 90.1 when tested in accordance with ANSI Z83.8.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Product Requirements: Product storage and handling requirements.
- B. Accept heaters and controls on site in factory packaging. Inspect for damage.

1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.9 WARRANTY

- A. Section 01700 - Execution Requirements: Product warranties and product bonds.
- B. Furnish ten year manufacturer warranty for heat exchanger.
- C. This Contractor shall furnish as part of his bid, an unlimited one year parts and labor warranty on equipment provided in this section. The two year warranty period shall begin at the Date of Substantial Completion.

**PART 2 PRODUCTS**

2.1 CONDENSING GAS FIRED UNIT HEATERS

- A. Manufacturers:

1. Sterling.
  2. Reznor.
  3. The Trane Company
  4. Modine.
- B. Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, heat exchanger, burner, controls, and accessories:
1. Heating fuel: Natural gas fired.
  2. Discharge Louvers: Individually adjustable horizontal louvers to match cabinet finish.
  3. Downturn Nozzle: 30 or 60 degree nozzle (as indicated in the schedule) to match outlet and cabinet finish.
  4. Gas Control: Single stage.
  5. Ignition System: Electric ignition-pilot to main burner.
  6. Control Voltage: 24 volt, 60 hertz.
  7. Location: Suspended overhead.
- C. Cabinet: Galvanized steel, easily removed and secured access panels, insulated or double panel construction.
- D. Supply Fan: Centrifugal forward curved type with belt drive, variable pitch motor pulley.
- E. Heat Exchanger: Aluminized steel welded construction.
- F. Gas Burner: Atmospheric type.
- G. Gas Burner Safety Controls:
1. Thermocouple sensor: Prevents opening of gas valve until pilot flame is proven and stops gas flow on ignition failure.
  2. Flame rollout switch: Installed on burner box and prevents operation.
  3. Vent safety shutoff sensor: Temperature sensor installed on draft hood and prevents operation, manual reset.
  4. Limit Control: Fixed stop at maximum permissible setting, de-energizes burner on excessive bonnet temperature, automatic reset.
- H. Controls:
1. Room Thermostat: Adjustable, low voltage, to control burner operation and supply fan to maintain temperature setting.
- I. Accessories:
- 1) Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through outside wall or roof.
  - 2) Plastic Vent Materials.
    - a) CPVC Plastic, Schedule 40 Pipe: ASTM F 441/F 441M.
      - (1) CPVC Plastic, Schedule 40 Fittings: ASTM F 438, socket type.
      - (2) CPVC Solvent Cement: ASTM F 493.
  - 2.

**PART 3 EXECUTION**

3.1 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify space is ready for installation of units and openings are as indicated on shop drawings.

3.2 INSTALLATION

- A. Install units in accordance with NFPA 54.
- B. Installation - Natural Gas Piping:
  - 1. Connect natural gas piping in accordance with NFPA 54.
  - 2. Connect natural gas piping to unit, full size of unit gas train inlet. Arrange piping with clearances for burner service.
  - 3. Install the following piping accessories on natural gas piping connections. Refer to Section 15100.
    - a. Shutoff valve.
    - b. Pressure reducing valve.
    - c. Gas regulator. Vent regulator to exterior.
- C. Provide hangers and supports for suspended units. Refer to Section 15140.
- D. Provide connection to electrical power systems. Refer to Section 16150.

END OF SECTION

## **SECTION 15623 - DUEL FUEL SPLIT-SYSTEMS (HEAT PUMP + GAS FURNACE)**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Split-system heat pump units.
  - 2. Evaporator (cooling coil)
  - 3. Condensing gas furnaces
- B. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components. Units are designed for exposed or concealed mounting, and may be connected to ducts.

#### **1.3 SUBMITTALS**

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.
- C. Warranty: Special warranty specified in this Section.

#### **1.4 QUALITY ASSURANCE**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1-2007 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 - "Heating, Ventilating, and Air-Conditioning."

1.5 COORDINATION

- A. Where condensing units are located on grade, coordinate size and location of concrete bases for units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS**

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Carrier Air Conditioning; Div. of Carrier Corporation.
  - 2. Lennox Industries Inc.
  - 3. Trane Company (The); Unitary Products Group.
  - 4. York International Corp.
  - 5. Goodman
  - 6. Or approved equivalent.

2.2 AIR-COOLED, 15 SEER HEAT PUMPS (OUTDOOR UNIT)

- A. Casing: Steel, finished with baked enamel in standard color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - 1. Compressor Type: Scroll
  - 2. Refrigerant: R-410A
- C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.
- D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.
- E. Fan: Propeller type, directly connected to motor.



- F. Motor: Permanently lubricated, with integral thermal-overload protection.
- G. Mounting Base: Concrete with cast-in place anchors, or poly ethylene base.
- H. Minimum Energy Efficiency: As scheduled on the drawings.

### **2.3 GAS-FIRED FURNACES, CONDENSING**

- A. General Requirements for Gas-Fired, Condensing Furnaces: Factory assembled, piped, wired, and tested; complying with ANSI Z21.47/CSA 2.3, "Gas-Fired Central Furnaces," and with NFPA 54. Minimum 95% efficiency.
- B. Cabinet: Steel or Galvanized steel.
  - 1. Cabinet interior around heat exchanger shall be factory-installed insulation.
  - 2. Lift-out panels shall expose burners and all other items requiring access for maintenance.
  - 3. Factory paint external cabinets in manufacturer's standard color.
- C. Fan: Centrifugal, factory balanced, resilient mounted, direct drive.
  - 1. Fan Motors: Permanent split-capacitor (PSC).
  - 2. Special Motor Features: Multi-tapped, multispeed with internal thermal protection and permanent lubrication.
- D. Type of Gas: Natural.
- E. Heat Exchanger:
  - 1. Primary: Aluminized steel.
  - 2. Secondary: Stainless steel.
- F. Burner:
  - 1. Gas Valve: 100 percent safety two-stage main gas valve, main shutoff valve, pressure regulator, safety pilot with electronic flame sensor, limit control, transformer, and combination ignition/fan timer control board.
  - 2. Ignition: Electric pilot ignition, with hot-surface igniter or electric spark ignition.
- G. Gas-Burner Safety Controls:
  - 1. Electronic Flame Sensor: Prevents gas valve from opening until pilot flame is proven; stops gas flow on ignition failure.
  - 2. Flame Rollout Switch: Installed on burner box; prevents burner operation.
  - 3. Limit Control: Fixed stop at maximum permissible setting; de-energizes burner on excessive bonnet temperature; automatic reset.
- H. Combustion-Air Inducer: Centrifugal fan with thermally protected motor and sleeve bearings prepurges heat exchanger and vents combustion products; pressure switch prevents furnace operation if combustion-air inlet or flue outlet is blocked.

- I. Furnace Controls: Solid-state board integrates ignition, heat, cooling, and fan speeds; adjustable fan-on and fan-off timing; terminals for connection to accessories.
- J. Accessories:
  - 1. Combination Combustion-Air Intake and Vent: PVC plastic fitting to combine combustion-air inlet and vent through outside wall or roof as indicated on plans.
  - 2. PVC Plastic Vent Materials:
    - a. PVC Plastic Pipe: Schedule 40, complying with ASTM D 1785.
    - b. PVC Plastic Fittings: Schedule 40, complying with ASTM D 2466, socket type.
    - c. PVC Solvent Cement: ASTM D 2564.

## 2.4 COOLING COILS

- A. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with thermal-expansion valve.
  - 1. Coil shall be sized to match outdoor heat pump and indoor fan characteristics.

## 2.5 ACCESSORIES

- A. Thermostat: Low voltage 7-day programmable thermostat.
- B. Automatic-reset timer to prevent rapid cycling of compressor.
- C. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.
  - 1. Minimum Insulation Thickness: 1/2 inch thick.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Where units are noted on the drawings to be installed on concrete pad, install heat pump on 4-inch-thick, reinforced concrete base; 4 inches larger on each side than unit.
- D. Where units are noted to be installed on manufactured mounting base, install heat pumps on polyethylene mounting base.
- E. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

### 3.2 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to unit to allow service and maintenance.
- C. Duct Connections: Duct installation requirements are specified in Division 23 Section "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and/or return ducts to air handler with flexible duct connectors. Flexible duct connectors are specified in Division 23 Section "Air Duct Accessories."
- D. Electrical Connections: Comply with requirements in Division 26 Sections for power wiring, switches, and motor controls.

### 3.3 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION 15623

## **SECTION 15731 - GEOTHERMAL HEAT EXCHANGER**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Geothermal loop heat exchanger piping.
  - 2. Temporary casing pipe.
  - 3. Ball valves.
  - 4. Grout.
  - 5. Water supply.
  - 6. Underground pipe markers.
  - 7. Bedding and cover materials.

#### **1.2 REFERENCES**

- A. ASTM International:
  - 1. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
  - 2. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  - 3. ASTM D2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter.
  - 4. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
  - 5. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
  - 6. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
  - 7. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.
  - 8. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
  - 9. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
- B. International Ground Source Heat Pump Association:
  - 1. IGSHPA Design and Installation Standards.
  - 2. IGSHPA Installation Guide.
  - 3. IGSHPA Grouting Procedures for Ground-Source Heat Pump Systems.
  - 4. IGSHPA Grouting for Vertical Geothermal Heat Pump Systems.
- C. Manufacturers Standardization Society of the Valve and Fittings Industry:
  - 1. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 DEFINITIONS

- A. Geothermal Loop Heat Exchanger: Polyethylene piping, fusion joined into vertical loops and connected with horizontal headers.

1.4 SYSTEM DESCRIPTION

- A. Geothermal loop heat exchanger with the following characteristics:
  - 1. Drill Hole: 6 inch diameter.
  - 2. Grout Seal: 10 feet deep.
  - 3. Total Well Depth: 300 feet deep.
  - 4. Separation Distance: 20 feet.
- B. Provide the following sizes of high density polyethylene piping:
  - 1. 1 inch IPS ASTM D3035, DR 9 for Vertical Heat Exchanger Piping.
  - 2. IPS ASTM D3035, DR 11 (Supply and Return Manifold Piping).

1.5 SUBMITTALS

- A. Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Submit coordination drawing of geothermal loop heat exchanger piping, indicating the following:
  - 1. Dimensioned locations of each bore hole.
  - 2. Locations of site utilities and conduit.
  - 3. Elevations of horizontal geothermal loop heat exchanger piping and site utilities and conduit.
- C. Product Data: Submit data on pipe materials, pipe fittings, valves and accessories.
- D. Test Reports:
  - 1. Submit pressure test results for each loop assembly.
  - 2. Submit written flow test report indicating test flow rate, calculated pressure drop and tested pressure drop. Include separate report for each individual circuit.
- E. Submit copy of installer's certification for polyethylene pipe fusion techniques from IGSHPA or piping manufacturer.
- F. Submit installer's report for Architect/Engineer witnessing of on-site bore hole locations, horizontal and vertical underground piping installation, backfilling of horizontal trenches, final system pressure and flow tests.

1.6 CLOSEOUT SUBMITTALS

- A. Project Record Documents:
  - 1. Accurately record actual locations of well, depth, subsoil strata, and drilling difficulties encountered.

2. Record actual locations of each end of vertical bore circuits and routing of header and distribution piping.
3. Include coordinates for each bore based upon permanent benchmark on site.

B. Submit signed copy of driller's log book statements.

#### 1.7 QUALIFICATIONS

A. Drilling Firm: Company specializing in performing Work of this section with minimum 5 years documented experience and licensed in State of Kentucky.

B. Installer: Driller and pipe installer shall be the same company.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

A. Product Requirements: Requirements for transporting, handling, storing, and protecting products.

B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

C. Protect piping systems from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of completed system.

#### 1.9 SEQUENCING

A. Sequence work to complete well drilling before other site improvements.

#### 1.10 WARRANTY

A. Furnish 50 year manufacturer's warranty for polyethylene piping and fittings.

### **PART 2 PRODUCTS**

#### 2.1 GEOTHERMAL LOOP HEAT EXCHANGER PIPING

A. Manufacturers:

1. Vanguard.
2. Charter Plastics.
3. Colonial.

B. Piping : High Density Polyethylene Piping: ASTM D3035 with DR 11.

1. Fittings: ASTM D3261, butt or sidewall or ASTM D2683, socket or ASTM F1055, electrofusion.
2. Joints: [Heat fused] [Electrofusion].

- C. U-Bend: Provide closure for each vertical geothermal loop heat exchanger using single elbow style U-bend at bottom of loop. Construct U-bend attached to geothermal loop heat exchanger using heat fusion bonding method. No other fusion joints are permitted on vertical heat exchanger piping below level of manifold piping.

## 2.2 TEMPORARY CASING PIPE

- A. Steel Pipe: ASTM A53/A53M, Grade B, with minimum wall thickness of 0.280 inches, with outside diameter of 5-1/2 inches.
- B. PVC Pipe: ASTM D1785, Schedule 40, with outside diameter of 5-3/8 inches.
- C. Length to accommodate site conditions.

## 2.3 BALL VALVES

- A. Manufacturers:
  - 1. Crane Valve, North America.
  - 2. Hammond Valve.
  - 3. Milwaukee Valve Company.
  - 4. NIBCO, Inc.
  - 5. Stockham Valves & Fittings.
- B. 2 inches and Smaller: 150 psi at 100 degrees F water temperature, maximum service temperature 180 degrees F, ASTM D4101 natural polypropylene body and ball, double lever handle, EPDM seals, teflon seats, full port, double union type with socket ends.

## 2.4 GROUT

- A. Mixture of bentonite clay with clean water to facilitate well placement.
- B. Maximum permeability rate of less than  $1.2 \times 10^{-8}$  ml/s in fresh water as determined by using "Falling-Head Method" defined in United States Army Corps of Engineers' Civil Engineering Manual No. EM1110-2-1906, "Laboratory Soils Testing" and as recommended by U.S. Environmental Protection Agency to ensure proper sealing.
- C. Minimum mixture of 15 percent to 20 percent solids.

## 2.5 WATER SUPPLY

- A. Furnish supply of potable water to perform the Work.
- B. Furnish equipment including pumps, water trucks or trailers, storage tanks and other items necessary to supply adequate supply of potable water.
- C. Water source is subject to approval of Architect/Engineer.

2.6 UNDERGROUND PIPE MARKERS

- A. Trace Wire: Magnetic detectable conductor, brightly colored plastic covering, imprinted with “Geothermal Loop Heat Exchanger Piping” in large letters.

**PART 3 EXECUTION**

3.1 EXAMINATION

- A. Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify site conditions are ready for Work of this section.
- C. Verify site conditions are capable of supporting equipment for performing drilling operations.
- D. Verify connection to building piping loop size, location, and invert are as indicated on Drawings.

3.2 PREPARATION

- A. Use placement method that will not cause damage to nearby structures.
- B. Document existing conditions for existing structures susceptible to damage:
  - 1. Before move, inspect existing structure thoroughly and notify Architect/Engineer in writing of visible defects and factors capable of affecting safe movement of structure to final location.
  - 2. Compile list of existing visible defects to building structure, finishes, accessories, and. This list will form basis for determining required repair Work after move.
- C. Notify utility companies to mark location of existing underground services. Do not begin work of this section until existing underground services are marked.
- D. Provide survey benchmarks and control points before beginning construction of piers.
- E. Protect underground utilities and structures near the Work, from damage.
- F. Provide barricades, shields or temporary wall structures to protect adjacent structures] parking lots, roadways, vehicles, and pedestrians from water or debris thrown from drilling or excavating process.
- G. Prior to arrival on-site, clean and repair drilling rig, drill rods, tools and bits removing potential sources of contamination, including leaks, excessive grease, oils, gasoline or other substances.



### 3.3 EQUIPMENT

- A. Combustion Engine Exhaust:
  - 1. Direct engine exhaust fumes away from occupied areas adjacent to work area.
  - 2. Confined Work Areas: Direct engine exhaust fumes to atmosphere with closed, sealed exhaust system.

### 3.4 DRILLING

- A. Perform drilling in accordance with IGSHPA Installation Guide.
- B. Bore vertical holes clean with no permanent casing and of sufficient diameter to facilitate installation of U-tube assembly.
- C. Do not introduce drilling fluids other than potable water or bentonite slurry into boring.
- D. Ensure bore does not contain large, sharp or jagged rocks or debris.
- E. Drill, clean, and purge bore holes to depth as indicated on.
- F. Do not use drill cuttings as part of borehole construction.
- G. Provide protection for vehicles, buildings and roads, adjacent to well drilling, from debris, water, or mud from drilling process.
- H. Dispose of drilling waste and water in accordance Local, State and Federal laws and regulations. Dispose of drilling waste and water in manner acceptable to Architect/Engineer, Owner, state and local regulators.
- I. When required, install temporary casing to keep upper consolidated materials from caving into boring. Install length to accommodate site conditions. Remove temporary casing immediately upon completion of grouting of borehole.
- J. Throughout drilling process take precautions to keep material considered contaminant from entering boreholes. When borehole becomes contaminated perform necessary work to eliminate contamination.

### 3.5 INSTALLATION VERTICAL GEOTHERMAL LOOP HEAT EXCHANGER PIPING

- A. Install vertical piping in accordance with IGSHPA Installation Guide.
- B. Remove dirt from inside of piping before assembly.
- C. Install single elbow or double-elbow style U-bend at bottom of vertical loop. Construct U-bend and attach to geothermal loop heat exchanger piping using heat fusion bonding method.
- D. Install U-bend pipe separator on vertical piping at 10 foot increments starting at bottom of vertical geothermal loop heat exchanger.

- E. Install piping in accordance with manufacturer's written instructions.
- F. Connect vertical piping to horizontal headers.

### 3.6 GROUTING

- A. Grout top 10 feet each vertical geothermal loop heat exchanger borehole with bentonite clay grout in accordance with IGSHPA Grouting Procedures for Ground-Source Heat Pump Systems.
  - 1. Monitor each bore hole for settling of grouting material after initial grouting, and continue adding grout to maintain level.
  - 2. Pressure pump grout material through 1 inch or 1-1/2 inch inside diameter tremie pipe placed in bore column from bottom to top to ensure complete fill of bore column.

### 3.7 INSTALLATION - BURIED HORIZONTAL PIPING

- A. Install buried piping in accordance with IGSHPA Installation Guide.
- B. Establish elevations of buried piping with not less than 4 ft of cover.
- C. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches loose depth.
- D. Install pipe on prepared bedding.
- E. Remove dirt from inside of piping before assembly.
- F. Route pipe in straight line.
- G. Install supply and return piping for each well together. Separate supply and return piping for different wells by 12 inches for ease of identification.
- H. Install piping in accordance with manufacturer's written instructions. Join pipe and fittings using socket, butt or electro-fusion heat fusion process. No other method is acceptable.
- I. For header piping 1 inch and smaller, install regular tee fittings. Install bell reducer fittings, or reducing tees at each pipe size reduction to eliminate trapping of air.
- J. For header piping 1 inch and larger, construct vertical loop take-off tee fittings using saddle fusion process. Exercise caution to completely remove cutout material.
- K. Avoid sharp bends in piping, install elbow fittings, only when necessary to eliminate kinking.
- L. Connect manifold piping to geothermal loop heat exchanger supply and return piping and adapt to building system manifold inside mechanical room as detailed on Drawings.

- M. Install on each geothermal loop heat exchanger circuit shutoff valves, balancing valves, pressure temperature test plugs, and air vents inside of vault.
- N. Core drill and seal pipe penetrations with mechanical sleeve seals where geothermal loop heat exchanger supply and return piping penetrates exterior wall of [mechanical room] building exterior wall and valve vault.
- O. Cover pipe ends during installation to maintain interior of pipe clean.
- P. Install trace wire continuous buried 6 inches below finish grade, above piping. Where multiple pipes occur in common trench, locate warning tape above centerline of trench.

### 3.8 BACKFILLING

- A. Maintain optimum moisture content of fill material to attain required compaction density.
- B. Remove sharp-edged rocks from backfill materials before backfilling.
- C. After hydrostatic test, evenly backfill entire trench width by using methods to prevent damage to pipe.
- D. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
- E. Do not use wheeled or tracked vehicles for tamping.

### 3.9 FIELD QUALITY CONTROL

- A. Field inspecting, testing, adjusting, and balancing.
- B. Pressure test each loop assembly as follows:
  - 1. Prior to installation: Test with water at 100 psi pressure for minimum of 30 minutes.
  - 2. After installation but prior to backfilling trench: Test with water at 100 psi pressure for minimum of 30 minutes.
  - 3. During backfilling: Test with water at 100 psi pressure held for entire backfilling process.
  - 4. Record results of each test for each loop assembly and submit to Architect/Engineer upon completion of testing.
- C. Flushing and Purging:
  - 1. Before backfilling trenches, flush, purge of air and flow test each loop to ensure portions of geothermal loop heat exchanger are properly flowing.
  - 2. Use portable temporary purging unit consisting of the following: purge pump - high volume and high head; open reservoir; metering, valves, connecting piping and connection hoses.
  - 3. Using purging unit, flush and purge each geothermal loop heat exchanger with clean, potable water, until free of air, dirt, and debris. Maintain minimum velocity of 2 feet per second in each pipe section to remove air.

4. Perform flushing and purging operation prior to connection of water source heat pumps. When water source heat pump connections are made prior to this operation, install bypass piping before connection to building portion of system to prevent flushing and purging flows through heat pump units.
5. Ensure geothermal loop heat exchanger piping is isolated from building piping to not allow cleaning solution used to purge and flush indoor piping system and heat pump units to become mixed with solution in geothermal loop heat exchanger.
6. Ensure indoor system cleaning solutions are thoroughly flushed from portion of system prior to opening of valves between systems.

D. Flow Test:

1. Perform on each circuit after backfilling of trench has occurred.
2. Use portable flow testing device consisting of the following: high volume, high head gas powered pump, flow meter, open reservoir, connecting hoses, valves and gauges.
3. Using testing unit, test for flow through each circuit.
4. Prior to testing calculate flow rate to achieve 2 feet per second and apply this flow rate to flow test.
5. Flow test each circuit for minimum of 30 minutes at predetermined flow rate. Check for blockages by observing test pressure drop and comparing to calculated pressure drop. When blockage is indicated, expose piping and inspect for kinking or obstructions. When no blockages are found in manifold piping, test each vertical geothermal loop heat exchanger for blockage.
6. Furnish written flow test report indicating test flow rate, calculated pressure drop and tested pressure drop. Submit separate report for each individual circuit.

E. Filling System: Upon completion of geothermal loop heat exchanger construction and following approvals of testing and flow reports, fill geothermal loop heat exchanger piping with water-propylene glycol solution. Verify solution matches manufacturer and solution strength furnished for internal heat pump piping system.

F. Verify by written report the following:

1. Witness pressure testing of horizontal and vertical underground piping, in presence of Architect/Engineer.
2. Witness back-filling of horizontal trenches.
3. Witness final system pressure and flow tests, then certify system is installed in accordance with Contract Documents and is operating properly.

### 3.10 PROTECTION OF FINISHED WORK

A. Protection: During system testing, protect controls, gauges, and accessories that are not designed to withstand test procedures. Do not use permanently installed gauges for field testing of systems.

END OF SECTION

## **SECTION 15733 - PACKAGED TERMINAL AIR CONDITIONING UNITS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Packaged terminal air conditioning units.
- B. Related Sections:
  - 1. Section 16150 - Wiring Connections: Execution requirements for electrical connection to units specified in this section.

#### **1.2 REFERENCES**

- A. Air-Conditioning and Refrigeration Institute:
  - 1. ARI 310/380 - Packaged Terminal Air-Conditioners and Heat Pumps.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

#### **1.3 SUBMITTALS**

- A. Section 01300 - Submittals.
- B. Product Data: Submit data indicating capacity, dimensions, rough-in connections, and electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Execution Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

#### **1.5 QUALITY ASSURANCE**

- A. Test and rate packaged terminal air conditioners in accordance with ARI 310/380.
- B. Performance Requirements: Conform to minimum cooling mode efficiency prescribed by ASHRAE 90.1 when tested in accordance with ARI 310/380.

- C. Maintain one copy of document on site.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01600 - Product Requirements: Product storage and handling requirements.
- B. Accept units on site in factory packaging. Inspect for damage.
- C. Protect units from damage by providing temporary covers until construction is complete.
- D. Protect items shipped loose with units in original packaging and store in secured area.

#### 1.8 FIELD MEASUREMENTS

- A. Verify by field measurements size and configuration are compatible with wall construction and layout.

#### 1.9 COORDINATION

- A. Section 01300 - Administrative Requirements: Requirements for coordination.
- B. Coordinate wall sleeve installation and electrical rough-in locations to accommodate Work of this Section.

#### 1.10 WARRANTY

- A. Section 01700 - Execution Requirements: Product warranties and product bonds.

### **PART 2 PRODUCTS**

#### 2.1 PACKAGED TERMINAL AIR CONDITIONING UNITS

- A. Manufacturers:
  1. Amana Refrigeration Inc.
  2. American Standard Air Conditioning.
  3. Carrier Corp.
  4. McQuay Air Conditioning.
  5. The Trane Company.
  6. York International.
  7. Or Approved Equivalent.

- B. Product Description: Packaged, terminal air conditioning units, with wall sleeve, room cabinet, electric refrigeration system, electric heating, outside air louvers, and built-in temperature controls.
- C. Cabinet:
1. Cabinet: Wall mounted; 18 gauge galvanized steel with baked enamel finish, removable front panel or access doors with concealed latches, standard color.
  2. Insulation: Furnish insulated with 1/2 inch thick glass fiber insulation.
  3. Discharge Grille and Access Door: Integral, extruded aluminum discharge grilles with hinged door in top of cabinet for access to controls.
  4. Subbase: Closure piece for unit front and sides to fit between unit chassis and floor. Furnish with adjustable legs electrical.
- D. Wall Sleeves and Louvers:
1. Wall Sleeves: 16 gauge galvanized steel with polyester finish.
  2. Louvers: Flush, extruded aluminum construction factory enamel finish, color as selected.
- E. Chassis:
1. Refrigeration System:
    - a. Direct expansion cooling coil. Constructed of copper tubing with aluminum fins mechanically bonded to tubes.
    - b. Hermetically sealed compressor with internal spring isolation, external isolation, permanent split capacitor motor and overload protection.
    - c. Fully charged with refrigerant and filled with oil.
    - d. Accumulator.
    - e. Condenser coil and fan. Construct of copper tubing and aluminum fins.
    - f. Capillary restrictor.
  2. Air System: Centrifugal forward curved evaporator fan with two speed permanent split capacitor motor, positive pressure ventilation damper with concealed manual powered operator.
  3. Filters: Permanent washable type.
  4. Electric Heating Coil: Nichrome coiled elements each protected by fusible link and overheat limit control.
  5. Condensate Drain: Drain pan to direct condensate to condenser coil for re-evaporation.
  6. Condenser Fan: Propeller type with separate permanent split capacitor motor.
  7. Electrical Connection: Furnish with cord and plug kit.
- F. Controls:
1. Thermostat: Unit mounted adjustable thermostat with heat anticipator, heat-off-cool switch, high-low fan switch.
- G. Capacity: See schedule on drawings.

**PART 3 EXECUTION**

3.1 EXAMINATION

- A. Section 01300 - Administrative Requirements: Coordination and project conditions.
- B. Verify wall opening is ready for wall sleeve installation.
- C. Verify wall construction is ready for unit installation.
- D. Verify electrical rough-in uses correct receptacle type.

3.2 PREPARATION

- A. Coordinate to assure correct opening size for wall sleeve and louver.

3.3 INSTALLATION

- A. Install units level.
- B. Install unit with wall sleeve, subbase, and outside air louver.

3.4 CLEANING

- A. Section 01700 - Execution Requirements: Requirements for cleaning.
- B. After construction is completed, including painting, clean exposed surfaces of units.
- C. Vacuum clean coils and inside of cabinets.
- D. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.

3.5 DEMONSTRATION

- A. Section 01700 - Execution Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.

3.6 PROTECTION OF FINISHED WORK

- A. Section 01700 - Execution Requirements: Requirements for starting and adjusting.
- B. Protect finished surfaces of cabinets with protective covers during remainder of construction.

END OF SECTION



## **SECTION 15745 - WATER SOURCE HEAT PUMPS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Horizontally mounted water source heat pumps.
  - 2. Vertically mounted water source heat pumps.
- B. Related Sections:
  - 1. Division 15 - Duct Accessories: Flexible connections.
  - 2. Division 15 - Direct Digital Controls.
  - 3. Division 15 - Sequence of Operation.
  - 4. Division 16 - Wiring Connections: Electrical connection to units.

#### **1.2 REFERENCES**

- A. Air-Conditioning and Refrigeration Institute:
  - 1. ARI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment.
  - 2. ARI 320 - Water Source Heat Pump Equipment.
  - 3. ARI 330 - Ground Source Closed-Loop Heat Pump Equipment.
  - 4. ARI 325 - Ground Water Source Heat Pump Equipment.
  - 5. ARI 350 - Sound Rating of Non-Ducted Indoor Air Conditioning Equipment.
- B. Air Movement and Control Association International, Inc.:
  - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 52.1 - Gravimetric and Dust-Spot Procedures for Testing Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.
  - 2. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
- D. ASTM International:
  - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
- E. National Electrical Manufacturers Association:
  - 1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
  - 2. International Building Code: International Mechanical Code.
- F. Underwriters Laboratories, Inc.:
  - 1. UL 1995 - Heating and Cooling Equipment.

### 1.3 DEFINITIONS

- A. Coefficient of Performance (COP), heat pump, heating - Ratio of rate of heat delivered to rate of energy input, in consistent units, for complete heat pump system, including compressor and, if applicable, auxiliary heat, under designated operating conditions.
- B. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.

### 1.4 SUBMITTALS

- A. Product Data: Submit data indicating:
  - 1. Cooling and heating capacities.
  - 2. Dimensions.
  - 3. Rough-in connections and connection requirements.
  - 4. Duct connections.
  - 5. Controls.
  - 6. Accessories.
  - 7. Installation, operation and service clearances. Indicate lift points and recommendations and center of gravity.
  - 8. Indicate unit shipping, installation and operating weights.
  - 9. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or maximum circuit ampacity.
- B. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions.
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- D. Manufacturer's Field Reports: Submit start-up report for each unit.

### 1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of controls installed remotely from units.
- B. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data. Include parts list and wiring diagrams.

### 1.6 QUALITY ASSURANCE

- A. Cooling Performance Requirements: Conform to minimum EER prescribed by ASHRAE 90.1 when tested in accordance with ISO 13256-1 and UL 1995.
- B. Heating Performance Requirements: Conform to minimum COP prescribed by ASHRAE 90.1 when tested in accordance with ISO 13256-1 and UL 1995.
- C. Insulation and adhesives: Meet requirements of NFPA 90A.

1.7 QUALIFICATIONS

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

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Accept units on site. Inspect for damage.
- B. Comply with manufacturers installation instructions for rigging, unloading and transporting units.
- C. Protect units from damage by storing in manufacturer's packaging until ready for installation.

1.9 COORDINATION

- A. Coordinate unit installation with roof structure, piping systems, and ceiling for unit access.

1.10 WARRANTY

- A. Furnish five year manufacturer's warranty for compressors.

1.11 MAINTENANCE SERVICE

- A. Furnish service and maintenance of equipment for two years from Date of Substantial Completion. Provide maintenance items shown in manufacturer's operating and maintenance data, including filter replacements, fan belt replacement, and controls checkout and adjustments.
- B. Furnish 24-hour emergency service on breakdowns and malfunctions for this maintenance period.

**PART 2 PRODUCTS**

2.1 HORIZONTAL AND VERTICAL WATER SOURCE HEAT PUMPS

- A. Manufacturers:
  - 1. FHP Manufacturing, Inc.
  - 2. McQuay International.
  - 3. The Trane Company.
  - 4. Water Furnace International.
  - 5. Climate Master.
  - 6. Mammoth.

7. Daikin.
- B. Configuration: Horizontal and Vertical configuration as indicated on Drawings.
  - C. Cabinet: Factory assembled and wired consisting of galvanized steel cabinet with 1/2 inch thick glass fiber insulation on interior, discharge duct collar and return collar with filter rack.
    1. Hanging Brackets: Located at each corner, and capable of receiving vibration isolation.
  - D. Supply Motor and Fan Assembly:
    1. The standard fan assembly shall be a DWDI forward curved fan assembly mounted on spring vibration isolation. The shaft is belt driven with adjustable drive sheave connected to a nominal 1725 RPM open drip proof motor with sealed ball bearings. Adjustable V-belt drives shall be provided with a minimum rating of 140% of the motor nameplate brake horsepower when the adjustable pulley is at the minimum RPM.
    2. The motor shall be a high efficiency ODP Evaporator fan motor for 1 HP and larger and be externally protected (manual reset).
    3. Factory installed multi-speed motor.
  - E. Air-to-Refrigerant Coil:
    1. Constructed of copper tubes mechanically expanded into aluminum fins; leak tested at 450 psi operating pressure; tubes completely evacuated of air prior to shipment.
    2. Refrigerant coil distributor assembly: orifice style with round copper distributor tubes sized consistent with capacity of coil; suction headers fabricated from rounded copper pipe.
  - F. Drain Pan: Constructed of corrosion resistant material and insulated to prevent sweating. Bottom sloped in two directions.
  - G. Water-to-Refrigerant Heat Exchanger:
    1. Co-axial type; constructed of copper or cupro-nickel; fluted to enhance heat transfer and minimize fouling and scaling.
    2. Working pressure: 450 psi on refrigerant side and 400 psi on water side.
    3. Furnish with insulation for extended temperature ranges.
  - H. Refrigeration System:
    1. Compressor: Rotary, reciprocating, or scroll type. Furnish with:
      - a. External vibration isolation.
      - b. Thermal overload protection.
    2. Reversing Valve: Pilot operating sliding piston type with replaceable encapsulated magnetic coil. Valve energized in cooling mode.
    3. Refrigerant Tubing: Constructed of copper; free from contaminants and conditions such as drilling fragments, dirt, and oil.
    4. Insulation: Refrigerant and water piping internal to unit insulated with 3/8 inch thick elastomeric insulation.

5. Refrigerant Metering: Furnish with thermal expansion valve (TXV) to allow operation of unit with entering fluid temperatures from 25 degrees F to 115 degrees F. Capillary tubes are not acceptable.
  6. Refrigerant Access Ports: Factory supplied on high and low pressure sides for easy refrigerant pressure or temperature testing.
- I. Filters: 2 inch thick throwaway type 25 to 30 percent efficiency based on ASHRAE 52.1.
- J. Control Panel: Factory tested and installed containing devices to allow heating and cooling operation to occur from remote device. Furnish the following:
1. 24 volt AC contactor for compressor control.
  2. Terminal strip.
  3. Safety lockout relay to prevent cycling of compressor during adverse conditions of operation. Capable of being reset at remote thermostat or zone sensor or by cycling power to unit.
  4. High pressure switch.
  5. Low pressure switch.
- K. Controls: BacNet installed per requirements of Section 15905 Instrumentation and Controls and Section 15910 Instrumentation. Each water source heat pump controlled by communicating microprocessor based controller with resident control logic. Controllers shall have the following features:
1. 24 volt AC control transformer with integral circuit breaker.
  2. Random start.
  3. Anti-short cycle protection.
  4. Condensate overflow safeties.
  5. Brownout protection.
  6. Furnish status for the following:
    - a. Heating or cooling.
    - b. Occupied or unoccupied cycle.
    - c. Fan.
    - d. Filter.
  7. Low water temperature sensor.
  8. Ability to control to four set points: occupied, occupied standby, occupied bypass (timed-override), and unoccupied.
  9. Capability of receiving the following commands from Building Management System: mode - occupied and unoccupied, demand limiting sequence, emergency shutdown, and time-of-day scheduling.
  10. Field service interface for diagnostic and troubleshooting purposes.
  11. Capability of communicating specific diagnostics, not general alarm, to Building Management System:
    - a. Space set point.
    - b. Discharge air temperature.
    - c. Leaving water temperature.
    - d. Unit alarms with manual reset include: high pressure, low pressure, and condensate overflow.
    - e. Unit alarms with automatic reset include: fan and filter status and low water temperature.

12. Building Management System: Interface control module to Building Management System furnished and factory mounted by manufacturer. Through this interface module, perform Building Management functions. Refer to Division. Furnish controls and sensors factory mounted. Limit field connection to Building Management System to single communication link.
  13. Zone thermostat with one set point and override button.
- L. Hydronic Piping Specialties: Furnish unit with the following:
1. Ball Valves: Brass body, memory, memory stop, and pressure temperature ports.
  2. Strainers: Bronze body, Y type configuration with stainless steel strainer screen.
  3. Hoses: For supply and return connections. Constructed of stainless steel outer braid with inner core of tube made of nontoxic synthetic polymer material. Suitable for water temperatures ranging between 33 degrees F and 211 degrees F.
  4. Supply and Return Hose Kit Assembly: For supply and return connections. Hose constructed of stainless steel outer braid with inner core of tube made of nontoxic synthetic polymer material. Suitable for water temperatures ranging between 33 degrees F and 211 degrees F. Includes ball valve with pressure temperature plug ports, flexible stainless steel hose with swivel and nipple.
- M. Automatic Flow Devices: Automatic self-balancing device to limit flow rate within 10 percent of scheduled flow rate, over 40 to 1 differential pressure operating range of 2 psi to 80 psi differential. Operating temperature range: from freezing to 225 degrees F. Furnish with dual pressure-temperature test ports.
- N. Motorized Water Valve: Opens when compressor is energized, and closes as compressor shuts down. Furnish valve with fast opening and slow closing characteristics.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. Verify concrete housekeeping pad is sized and located correctly.
- B. Verify piping rough-in is at correct location.
- C. Verify electrical rough-in is at correct location.

#### **3.2 INSTALLATION**

- A. Locate units as indicated, level and shim units, and anchor to structure.
- B. Install units on vibration isolators.
- C. Connect units to supply and return ductwork with flexible connections. Refer to Division 15.
- D. Make connections to coils with unions or flanges.

- E. Install hydronic piping accessories on condenser water piping furnished with unit, as scheduled.
- F. Install valves and piping specialties in accordance with details as indicated on Drawings.
- G. Install manual air vents at high points complete with shutoff valve. Refer to Section 15180.
- H. Install condensate piping with trap and route from drain pan to as indicated on the drawings.
- I. Install components furnished loose for field mounting.
- J. Install electrical devices furnished loose for field mounting.
- K. Install control wiring between unit and field installed accessories.
- L. Leave required electrical clearances for servicing electrical components.

### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Furnish initial start-up and provide start-up report for each unit.
- B. By technician with current factory training capable of start up responsibilities.

### 3.4 CLEANING

- A. Vacuum clean coils and inside of unit cabinet.
- B. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.
- C. Install new throwaway filters in units at Substantial Completion.

### 3.5 DEMONSTRATION

- A. Demonstrate unit operation and maintenance.
- B. Furnish services of manufacturer's technical representative for 4 hours to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner. Provide minimum 7 days notice to Architect/Engineer of training date.

### 3.6 PROTECTION OF FINISHED WORK

- A. Protect finished surfaces of cabinets with protective covers during remainder of construction.

END OF SECTION

## **SECTION 15760 – ELECTRIC HEATERS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Unit heaters.
- B. Related Sections:
  - 1. Division 16 - Wiring Connections: Execution requirements for electric connection to units specified by this section.

#### **1.2 SUBMITTALS**

- A. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.
- B. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.

#### **1.3 CLOSEOUT SUBMITTALS**

- A. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.
- B. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

#### **1.4 FIELD MEASUREMENTS**

- A. Verify field measurements prior to fabrication.

### **PART 2 PRODUCTS**

#### **2.1 ELECTRIC UNIT HEATERS**

- A. Assembly: UL listed and labeled assembly with terminal box and cover, and built-in controls.
- B. Heating Elements: Enclosed copper tube, aluminum finned element of coiled nickel-chrome resistance wire centered in tubes and embedded in refractory material. Exposed helical coil of nickel-chrome resistance wire with refractory ceramic support bushings.



- C. Cabinet: 0.0478-inch thick steel with easily removed front panel with integral air outlet and inlet grilles.
- D. Fan: Direct-drive propeller type, statically and dynamically balanced, with fan guard.
- E. Motor: Permanently lubricated, sleeve bearings for horizontal models; ball bearings for vertical models.
- F. Control: Separate fan speed switch and thermostat heat selector switch, factory wired, with switches built-in behind cover. Furnish thermal overload.
- G. NEC approved means of integral disconnect.

### **PART 3 EXECUTION**

#### **3.1 EXAMINATION**

- A. For recessed units, verify recess dimensions are correct size.
- B. Verify wall construction is ready for installation.

#### **3.2 INSTALLATION**

- A. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- B. Make connections to coils with unions and flanges.
- C. Install electric heating equipment including devices furnished by manufacturer but not factory-mounted. Furnish copy of manufacturer's wiring diagram submittal. Install electrical wiring in accordance with manufacturer's submittals and Section 16150.

#### **3.3 CLEANING**

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION

## **SECTION 15785 - AIR-TO-AIR ENERGY RECOVERY UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Packaged energy recovery units.
- B. Related Sections include the following:
  - 1. Division 15 Section "HVAC Instrumentation and Controls" for control wiring and control devices connected to energy recovery units.

#### **1.3 SUBMITTALS**

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain air-to-air energy recovery units through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-to-air energy recovery units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASHRAE Compliance: Capacity ratings for energy recovery devices shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

1.5 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. Filters: Furnish one set of each type of filter specified.

**PART 2 - PRODUCTS**

2.1 PACKAGED ENERGY RECOVERY UNITS

A. **Available** Manufacturers:

- 1. Advanced Thermal Technologies.
- 2. Applied Air; Mestek, Inc.
- 3. American Energy Exchange.
- 4. Gaylord Industries, Inc.
- 5. Gouvernaire.
- 6. Greenheck.
- 7. SEMCO Incorporated.
- 8. Trane Company (The); Worldwide Applied Systems Group.
- 9. Venmar Ventilation Inc.

B. Housing: Manufacturer's standard construction, gasketed and calked, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.

C. Heat Recovery Device: Fixed-plate heat exchanger.

D. Supply and Exhaust Fans: Forward-curved centrifugal fan with spring isolators and flexible duct connections.

- 1. Motor and Drive: Direct driven, or, Belt driven with adjustable sheaves, motor mounted on adjustable base.
- 2. Comply with requirements in Division 15 Section "Motors."

E. Filters: 2-inch- thick disposable type, in galvanized steel frame, mounted upstream of unit in both supply and exhaust airstreams.

F. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
  - 1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Division 15 Section "Duct Accessories."
- B. Support suspended units from structure; use threaded steel rods.
- C. Install units with clearances for service and maintenance.
- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.2 CONNECTIONS

- A. Duct and fan installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts, fittings, and specialties.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. FIELD QUALITY CONTROL
- E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Adjust seals and purge.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 4. Set initial temperature and humidity set points.
  - 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- F. Remove malfunctioning units, replace with new units, and retest as specified above.

3.3 DEMONSTRATION

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

END OF SECTION 15785

## SECTION 15810 – HVAC DUCTS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Duct Materials.
  - 2. Insulated flexible ducts.
  - 3. Single wall spiral round ducts.
  - 4. Transverse duct connection system.
  - 5. Ductwork fabrication.
  
- B. Related Sections:
  - 1. Division 09 - Paints and Coatings: Execution requirements for Weld priming, weather resistant, paint or coating specified by this section.
  - 2. Division 15 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
  - 3. Division 15 - Duct Accessories: Product requirements for duct accessories for placement by this section.

#### 1.2 REFERENCES

- A. ASTM International:
  - 1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
  - 2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
  - 3. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
  - 4. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  - 5. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
  - 6. ASTM A1011/A1011M - Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
  - 7. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
  
- B. Sheet Metal and Air Conditioning Contractors:
  - 1. SMACNA - HVAC Air Duct Leakage Test Manual.
  - 2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
  
- C. Underwriters Laboratories Inc.:
  - 1. UL 181 - Factory-Made Air Ducts and Connectors.

1.3 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.4 SUBMITTALS

- A. Product Data: Submit data for duct materials.
- B. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.5 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures during and after installation of duct sealant.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

**PART 2 PRODUCTS**

**2.1 DUCT MATERIALS**

- A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G60] zinc coating of in conformance with ASTM A90/A90M.
- B. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.
- C. Fasteners: Rivets, bolts, or sheet metal screws.
- D. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.

**2.2 INSULATED FLEXIBLE DUCTS**

- A. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical wound spring steel wire; fiberglass insulation; aluminized vapor barrier film.
  - 1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
  - 2. Maximum Velocity: 4000 fpm.
  - 3. Temperature Range: -20 degrees F to 210 degrees F.
  - 4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.
  - 5. Furnish each flexible duct section with integral clamping devices for connection to round or oval fittings.
  - 6. Join each flexible duct section to main trunk duct through sheet metal fittings. Construct fittings of galvanized steel and equip with factory installed volume damper having positive locking regulator. Provide fittings installed in lined ductwork with insulation guard.

**2.3 SINGLE WALL SPIRAL ROUND DUCTS**

- A. Manufacturers:
  - 1. McGill AirFlow Corporation.
  - 2. Semco Incorporated.
  - 3. Tangent Air Corp.
  - 4. Spiral Mfg. Co.
  - 5. Lindab.
- B. Product Description: UL 181, Class 1, round spiral lockseam duct constructed of galvanized steel.
- C. Construct duct with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	26
15 inches to 26 inches	24

- D. Construct fittings with the following minimum gages:

Diameter	Gauge
3 inches to 14 inches	24
15 inches to 26 inches	22
28 inches to 36 inches	20

## 2.4 DUCTWORK FABRICATION

- A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards). Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify sizes of equipment connections before fabricating transitions.

### 3.2 INSTALLATION

- A. Install and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.



- B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inch and smaller.
- D. Install duct hangers and supports in accordance with Division 15.
- E. Use double nuts and lock washers on threaded rod supports.

3.3 INTERFACE WITH OTHER PRODUCTS

- A. Install openings in ductwork where required to accommodate thermometers and controllers. Install pitot tube openings for testing of systems. Install pitot tube complete with metal can with spring device or screw to prevent air leakage. Where openings are provided in insulated ductwork, install insulation material inside metal ring.
- B. Connect diffusers boots to low pressure ducts with 5 feet maximum length of flexible duct held in place with strap or clamp.
- C. Connect air terminal units and air outlets and inlets to supply ducts with five foot maximum length of flexible duct. Do not use flexible duct to change direction.

3.4 SCHEDULES

- A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply (Heating Systems)	Steel
Supply (System with Cooling Coils)	Steel
Locker Room System	Welded Aluminum
Return and Relief	Steel, Aluminum
General Exhaust	Steel, Aluminum
Outside Air Intake	Steel
Intake and Exhaust	Steel

END OF SECTION

## **SECTION 15820 - DUCT ACCESSORIES**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Duct access doors.
  - 2. Volume control dampers.
  - 3. Flexible duct connections.
  - 4. Duct test holes.
  - 5. Dial thermometers.
  - 6. Static pressure gages.
  
- B. Related Sections:
  - 1. Division 15 - Ducts: Requirements for duct construction and pressure classifications.

#### **1.2 REFERENCES**

- A. Air Movement and Control Association International, Inc.:
  - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
  
- B. ASTM International:
  - 1. ASTM E1 - Standard Specification for ASTM Thermometers.
  
- C. National Fire Protection Association:
  - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
  
- D. Sheet Metal and Air Conditioning Contractors:
  - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

#### **1.3 SUBMITTALS**

- A. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
  - 1. Backdraft dampers.
  - 2. Flexible duct connections.
  - 3. Volume control dampers.
  - 4. Duct access doors.
  - 5. Duct test holes.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.
- B. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- C. Storage: Store materials in a dry area indoor, protected from damage.
- D. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.6 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.7 COORDINATION

- A. Coordinate Work where appropriate with building control Work.

**PART 2 PRODUCTS**

2.1 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with sheet metal cover.
  - 1. Less than 12 inches square, secure with sash locks.
  - 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
  - 3. Up to 24 x 48 inches: Three hinges and two compression latches [with outside and inside handles].
  - 4. Larger Sizes: Furnish additional hinge.
  - 5. Access panels with sheet metal screw fasteners are not acceptable.

2.2 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Splitter Dampers:

1. Material: Same gage as duct to 24 inches size in both dimensions, and two gages heavier for sizes over 24 inches.
  2. Blade: Fabricate of double thickness sheet metal to streamline shape, secured with continuous hinge or rod.
  3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw.
- C. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 72 inch. Assemble center and edge crimped blades in prime coated or galvanized frame channel with suitable hardware.
- D. End Bearings: Except in round ductwork 12 inches and smaller, furnish end bearings. On multiple blade dampers, furnish oil-impregnated nylon or sintered bronze bearings. Furnish closed end bearings on ducts having pressure classification over 2 inches wg.
- E. Quadrants:
1. Furnish locking, indicating quadrant regulators on single and multi-blade dampers.
  2. On insulated ducts mount quadrant regulators on standoff mounting brackets, bases, or adapters.
  3. Where rod lengths exceed 30 inches furnish regulator at both ends.

### 2.3 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Connector: Fabric crimped into metal edging strip.
1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric conforming to NFPA 90A, minimum density 30 oz per sq yd.
  2. Net Fabric Width: Approximately 6 inches wide.
  3. Metal: 3 inch galvanized steel.

### 2.4 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

### 2.5 DIAL THERMOMETERS

- A. Thermometer: ASTM E1, stainless steel case, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem.
1. Size: 3 inch diameter dial.
  2. Lens: Clear glass.
  3. Accuracy: 1 percent.
  4. Calibration: Degrees F.

**PART 3 EXECUTION**

3.1 EXAMINATION

- A. Verify rated walls are ready for fire damper installation.
- B. Verify ducts and equipment installation are ready for accessories.
- C. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

3.2 INSTALLATION.

- A. Install in accordance with International Mechanical Code, SMACNA HVAC Duct Construction Standards - Metal and Flexible
- B. Access Doors: Install access doors at the following locations and as indicated on Drawings:
  - 1. Spaced every 50 feet of straight duct.
  - 2. Upstream of each elbow.
  - 3. Before and after each automatic control damper.
- C. Access Door Sizes: Install minimum 8 x 8 inch size for hand access, and 18 x 18 inch size for shoulder access. Review locations prior to fabrication.
- D. Install temporary duct test holes where required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- E. Adjust thermometers to final angle, clean windows and lenses, and calibrate to zero.

END OF SECTION

## **SECTION 15850 - AIR OUTLETS AND INLETS**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Diffusers.
  - 2. Registers
  - 3. Grilles.
  - 4. Louvers.
  - 5. Roof hoods.
  
- B. Related Sections:
  - 1. Division 9 - Paints and Coatings: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
  - 2. Division 15 - Wall Louvers: Wall Louvers.
  - 3. Division 15 - Duct Accessories: Volume dampers for inlets and outlets.
  - 4. Division 15 - HVAC Instrumentation: Operators for adjustable louvers.
  - 5. Division 15 - Direct Digital Controls: Operators for adjustable louvers.

#### **1.2 REFERENCES**

- A. Air Movement and Control Association International, Inc.:
  - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
  
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
  
- C. Sheet Metal and Air Conditioning Contractors:
  - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

#### **1.3 SUBMITTALS**

- A. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
  
- B. Test Reports: Rating of air outlet and inlet performance.
  
- C. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

#### **1.4 CLOSEOUT SUBMITTALS**

- A. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

- A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.

**PART 2 PRODUCTS**

2.1 DIFFUSERS REGISTERS GRILLES

- A. Manufacturers:
  - 1. Anemostat Air Products.
  - 2. E. H Price Company.
  - 3. Krueger.
  - 4. Nailor Industries, Inc.
  - 5. Titus.
  - 6. Tuttle and Bailey.

2.2 LOUVERS AND ROOF HOODS

- A. Manufacturers:
  - 1. Airline Products Co.
  - 2. Arrow United Industries.
  - 3. Construction Specialties Inc.
  - 4. Greenheck Corp.
  - 5. Industrial Louvers Inc.
  - 6. Ruskin Manufacturing.
  - 7. United Enertech.

**PART 3 EXECUTION**

3.1 EXAMINATION

- A. Verify inlet and outlet locations.
- B. Verify ceiling and wall systems are ready for installation.

3.2 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black.

3.3 SCHEDULES

- A. See drawings for schedules.

3.4 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION



## **SECTION 15870 - POWER VENTILATORS**

### **PART 1 - GENERAL**

#### 1.1 SECTION INCLUDES

- A. Ceiling exhaust fans.

#### 1.2 RELATED SECTIONS

- A. Division 15 - Motors.
- B. Division 15 - Vibration Isolators.
- C. Division 15 - Ductwork.
- D. Division 15 - Duct Accessories: Backdraft dampers.
- E. Division 16 - Equipment Wiring Systems: Electrical characteristics and wiring connections.

#### 1.3 REFERENCES

- A. AMCA 99 - Standards Handbook.
- B. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes.
- C. AMCA 261 - Directory of Products Licensed to Bear the AMCA Certified Ratings Seal.
- D. AMCA 300 - Test Code for Sound Rating Air Moving Devices.
- E. AMCA 301 - Method of Publishing Sound Ratings for Air Moving Devices.
- F. NEMA MG1 - Motors and Generators.
- G. UL 705 - Power Ventilators.

#### 1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.

#### 1.5 SUBMITTALS FOR INFORMATION

- A. Manufacturer's Instructions: Indicate installation instructions.

#### 1.6 SUBMITTALS AT PROJECT CLOSEOUT

- A. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.
- B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years experience.

**PART 2 - PRODUCTS**

2.1 CABINET AND CEILING EXHAUST FANS

- A. Manufacturer
  - 1. Cook.
  - 2. Acme.
  - 3. Penn Ventilator.
  - 4. Greenheck.
- B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with ½ inch acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- C. Disconnect Switch: Cord and plug in housing for thermal overload protected motor and wall mounted switch with solid state speed controller.
- D. Grille: Aluminum with baked white enamel finish.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Hung Cabinet Fans:
  - 1. Install fans with resilient mountings and flexible electrical leads.
- B. Provide backdraft dampers on outlet from cabinet and ceiling exhausters fans and as indicated.
- C. Do not operate fans until ductwork is clean, filters are in place, and bearings are lubricated.

END OF SECTION

## **SECTION 15785 - AIR-TO-AIR ENERGY RECOVERY UNITS**

### **PART 1 - GENERAL**

#### **1.1 RELATED DOCUMENTS**

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

#### **1.2 SUMMARY**

- A. This Section includes the following:
  - 1. Packaged energy recovery units.
- B. Related Sections include the following:
  - 1. Division 15 Section "HVAC Instrumentation and Controls" for control wiring and control devices connected to energy recovery units.

#### **1.3 SUBMITTALS**

- A. Product Data: Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.

#### **1.4 QUALITY ASSURANCE**

- A. Source Limitations: Obtain air-to-air energy recovery units through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of air-to-air energy recovery units and are based on the specific system indicated. Refer to Division 1 Section "Product Requirements."
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASHRAE Compliance: Capacity ratings for energy recovery devices shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

1.5 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. Filters: Furnish one set of each type of filter specified.

**PART 2 - PRODUCTS**

2.1 PACKAGED ENERGY RECOVERY UNITS

- A. **Available Manufacturers:**
  - 1. Advanced Thermal Technologies.
  - 2. Applied Air; Mestek, Inc.
  - 3. American Energy Exchange.
  - 4. Gaylord Industries, Inc.
  - 5. Gouvernaire.
  - 6. Greenheck.
  - 7. SEMCO Incorporated.
  - 8. Trane Company (The); Worldwide Applied Systems Group.
  - 9. Venmar Ventilation Inc.
  
- B. Housing: Manufacturer's standard construction, gasketed and calked, hinged access doors with neoprene gaskets for inspection and access to internal parts, minimum 1-inch- thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection, and lifting lugs.
  
- C. Heat Recovery Device: Fixed-plate heat exchanger.
  
- D. Supply and Exhaust Fans: Forward-curved centrifugal fan with spring isolators and flexible duct connections.
  - 1. Motor and Drive: Direct driven, or, Belt driven with adjustable sheaves, motor mounted on adjustable base.
  - 2. Comply with requirements in Division 15 Section "Motors."
  
- E. Filters: 2-inch- thick disposable type, in galvanized steel frame, mounted upstream of unit in both supply and exhaust airstreams.
  
- F. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

**PART 3 - EXECUTION**

3.1 INSTALLATION

- A. Install fixed-plate heat exchangers so supply and exhaust airstreams flow in opposite directions.
  - 1. Install duct access doors in both supply and exhaust ducts, both upstream and downstream, for access to heat exchanger. Access doors and panels are specified in Division 15 Section "Duct Accessories."
- B. Support suspended units from structure; use threaded steel rods.
- C. Install units with clearances for service and maintenance.
- D. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.2 CONNECTIONS

- A. Duct and fan installation requirements are specified in other Division 15 Sections. Drawings indicate general arrangement of ducts, fittings, and specialties.
- B. Ground equipment according to Division 16 Section "Grounding and Bonding."
- C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- D. FIELD QUALITY CONTROL
- E. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Adjust seals and purge.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 4. Set initial temperature and humidity set points.
  - 5. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- F. Remove malfunctioning units, replace with new units, and retest as specified above.

3.3 DEMONSTRATION

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

END OF SECTION 15785

SECTION 15905 - INSTRUMENTATION AND CONTROLS FOR BUILDING AUTOMATION SYSTEM

PART 1 - GENERAL

1.0 GENERAL AND SPECIAL CONDITIONS

- A. The Temperature controls for this project consists of new DDC controls for all new and existing equipment specified. All controllers, control interface hardware, services, installation, warranty, training, etc., shall be included as hereinafter specified. All material and equipment used shall be standard components, regularly manufactured locally available and not custom designed especially for this project. All systems and components, except site specific databases, shall have previously been tested and proven in use prior to installation on this project.
- B. Temperature Controls Contractor (TCC) to furnish totally native BACnet-based system based on a distributed control system in accordance with this specification. Building controllers, supplication specific controllers and I/O devices, unitary controllers shall communicate using protocols and network standards as defined in ANSI/ASHRAE Standard 135-2004, BACnet. Do not use gateways for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed with other contractors. No LON-Based systems.
- C. All building automation, generator and digital control systems shall adhere to the latest ASHRAE BACnet Standard 135 and EIA 709.1
- D. TCC shall be responsible for connecting to any mechanical equipment furnished with a control interface device and contacting the equipment suppliers and/or manufacturers for information for the proper interface to the equipment being furnished.
- E. The system shall be a complete electronic DDC temperature control system utilizing unitary type controllers. Including such minor details not specifically mentioned or shown, as may be necessary for the complete operation of the system. This shall consist of, but not limited to, all necessary thermostats, sensing devices, valves, automatic dampers, damper motors, actuators, and with the necessary accessories for the complete control of all equipment hereinafter specified.
- F. Provide all power wiring necessary for the operation of panels, etc., is to be included as work of this section refer to division 16 specifications.
- G. Existing Agency LAN: This is a shared, routed system extended to each building by the Computer Services Department. The new BAS will be connected to the LAN, via VLAN. Communication shall be accomplished by an Ethernet port. Coordinate communication protocol, network addresses, LAN wiring topology, routers and HUB's with the Agency's Computer Services Department.
- H. TCC to provide any configuration tools, interface cables, software, licenses, and/or updates required to configure all controllers installed on this project. Functionally it shall include but not be limited to uploading/downloading or databases, configuration and monitoring of all communications, monitoring and overrides of all controller physical input/output points and editing of controller occupied time schedules. There shall be no renewal charges to the Owner for data base updates.

1.1 QUALITY ASSURANCE - CODES AND STANDARDS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering controls that may be incorporated into the work are limited to, the following:
  - a. Siemens
  - b. Johnson
  - c. Trane
  - d. Innerspace
- B. Manufacturer shall be responsible for the installation and checkout of control systems.
- C. The installation shall be by the manufacturer. The general contractor shall be ultimately responsible for the installation and the warranty.
- D. The TCC contractor shall be the primary manufacturer-owned branch office that is regularly engaged in the engineering, programming, installation and service of total integrated Building Management System. The TCC contractor shall be a recognized national manufacturer, installer and service provider of BMS.
- E. The TCC shall have a branch facility within a 150-mile radius of the job site supplying complete maintenance and support service on a 24 hour, 7-day a week basis.
- F. All work, materials, and equipment shall comply with the rules and regulation of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids for the following codes
  - 1. National Electric Code (NEC)
  - 2. International Building Code (IBC)
  - 3. Underwriters Laboratories (UL)
  - 4. UL-916; Energy Management Systems.
  - 5. UL-873; temperature Indication and Regulating Equipment
  - 6. UL-864; Subcategories UUKL, OUXX, UDTZ; Fire Signaling and Smoke Control Systems.
  - 7. National Electric Manufacturer's Association (NEMA)
  - 8. National Fire Prevention Association (NFPA)
  - 9. American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE)
  - 10. Instrument Society of America (ISA)
  - 11. National Institute of Standards and Technology (NIST)
  - 12. ANSI/ASHRAE Standard 195 (BACnet)
  - 13. ASHRAE BACnet standard 135
  - 14. City, county, state, and federal regulations and codes in effect as of contract date.
  - 15. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, NEC, Local and National Codes
- G. Reference Section 15745 WATER SOURCE HEAT PUMPS, Part 2, Paragraph K list items that would be included if Manufactures Controls were specified. This contractor is to install controls that match Manufactures Controls and report all trouble events as though Manufactures Controls were factory installed.

1.2 MECHANICAL EQUIPMENT INTERFACE AND THIRD PARTY INTEGRATIONS

- A. The BMS shall include appropriate hardware equipment and software to allow bi-directional data communications between BMS system and 3<sup>rd</sup> party manufacturers control panels. The BMS shall receive, react and return information from multiple building systems.
- B. Point I/O from 3<sup>rd</sup> party devices shall have real time interoperability with BMS software features.
- C. The TCC shall be responsible for connecting and interfacing all sub-systems to BMS Network via BACnet MS/TP or Modbus. Sub-systems include VFD's and electrical system monitoring. No third party gateways, "field servers", "micro servers", "translators" or custom integrations are allowed. Sub-systems shall be controlled, monitored and graphically programmed through the Graphical User Interface software of the BMS.
- D. All direct digital controllers for this project shall be provided by the TCC and of the same manufacturer. Packaged and unitary mechanical equipment shall be provided with conventional low voltage electrical terminal strip for interface to allow digital controls provided by the TCC to perform all sequences of operation, monitoring and control indicated. Equipment may provide communication interfaces for additional beneficial information. –OR–Equipment will be supplied with BACnet controllers and control will be directed by this section.

1.3 SUBMITTALS

- A. Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance, characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
  - a. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
  - b. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third party applications.
  - c. Controlled Systems: Instrumentation list with the element name, type of device, manufacturer, model number and product data. Include written description of sequence of operation including schematic diagram.
- B. Submittal must include manufacturers published wiring and networking practices guide
- C. All network and device numbering shall be submitted and approved by Agency Computer Services Department before implementation. IP Addressing convention shall follow the existing Agency numbering structure.
- D. Submittals must include a complete points list of all necessary points and point types that will be needed to complete the temperature control system. (This will include any pseudo type points as well as all hard-wired points.) The TCC shall coordinate with the equipment manufacturers for necessary points lists, protocol documentation, and factory



support information for systems provided in their respective division but integrated into the BMS. All points not provided by the equipment manufacturer are the responsibility of the TCC.

- E. Submittals shall include a written operating sequence, unitary control wiring, building floor plans showing communicating cabling and labels, as well as logic flow diagrams.
- F. Submittals will include part numbers and manufacturer of all cabling that will be used, indicate size and intended use.
- G. Data Submittals: Include Protocol Certificates, Qualification Data, Software Upgrade Kit, Field Quality-Control Test Reports.
- H. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required, clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
  - 2. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
  - 3. Wiring Diagrams: Power, signal and control wiring. Label each control device with setting or adjustable range of control.
  - 4. Details of control panel faces, including controls, instruments, and labeling.
  - 5. Written description of sequence of operation.
  - 6. Schedule of dampers including size, leakage, and flow characteristics
  - 7. Schedule of valves including flow characteristics.
  - 8. DDC System Hardware:
    - a. Wiring diagrams for control units with termination numbers.
    - b. Schematic diagrams and floor plans for field sensors and control hardware.
    - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
  - 9. System configuration showing peripheral devices, batteries, power supplies, diagrams, modems and interconnections.
  - 10. Control System software, List of color graphics indicating monitored systems, data point addresses, output schedule, and operator notations.
  - 11. Controlled Systems:
    - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    - b. Scaled drawings showing mounting, routing and wiring of elements including bases and special construction.
    - c. Written description of sequence of operation including schematic diagram.
- I. Control Valve Schedules including a separate line for each valve provided under this section and a column for each of the valve attributes: Code Number, Configuration, Fail Position, Pipe Size, Valve Size, Body Configuration, Close off pressure, capacity, Valve CV, Design Pressure, and Actuator Type.

- J. Room Schedule including a separate line for each controlled device indicating location and address.
- K. Control Damper Schedule including a separate line for each damper including: Code Number, Fail Position, Damper Type, Duct Size, Damper Size, Damper Operator, Mounting and Actuator Type.
- L. TCC Contractor to specify and label signal transducer ranges and outputs if used.

1.4 OPERATION AND MAINTENANCE MANUAL

- A. Operator and Maintenance Instructions: Prepare three ring, heavy duty, vinyl-covered binder. Binders shall be properly indexed.
- B. Operation and Maintenance Manual shall include:
  - 1. Name and address of Consulting Engineer, Contractor, and index of equipment, including vendor's name and address
  - 2. Complete and descriptive data and material list, etc., on each piece of equipment and system.
  - 3. Complete maintenance and operating instructions, prepared by the manufacturer on each major piece of equipment.
  - 4. Complete As-Built drawings shall include point to point wiring details and shall show all field devices, start-stop arrangements for each piece of equipment, equipment interlocks, controllers, panel devices, wiring terminal numbers and any special information for properly controlling equipment and implementing the required sequence. As-Built documentation in AutoCad, and PDF format with three CD copies
  - 5. TCC to mount laminated copy of the as-built control drawings in individual control panels.
- C. Engineered Shop Drawing / Permit Submittals "BMS subsystems integration flow charts, Network Architecture"; "Interoperability Sequencing", "Functional Performance Testing":
  - 1. Three copies of shop drawings of the entire BMS shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings.
  - 2. Submittal shall also include a network architecture schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
  - 3. A complete point list of all points connected to the BMS. Including all necessary points, protocol documentation, and factory support information for systems provided and integrated into the BMS.
  - 4. Submittal shall include a copy of each graphics developed by the Graphic User Interface including a flowchart (site map) indicating how the graphics are being linked to one another for system navigation.

1.5 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain carton while shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.
- B. Contractor shall deliver all materials to area of project designated by the Owner's Representative. Vehicles shall not block fire lanes or fire doors during delivery of materials.
- C. Owner shall not accept deliveries for the Contractor.
- D. The general contractor shall designate an area within the facility for storage of all materials. At the end of each working day, all materials shall be returned to the designated area.
- E. No material storage facilities are available on site. The Contractor is to include in his bid the cost of storage trailers or other suitable storage facilities.
- F. The cost of all material handling, delivery and freight is the Contractor's responsibility.
- G. Maintain premises free from accumulation of waste materials or rubbish caused by this work.
- H. The Contractor shall arrange and pay for parking.

1.6 WARRANTY

- A. The Contractor shall provide a one-year written guarantee against defects in material and workmanship furnished under this Contract. The costs of such guarantee shall be part of the purchase price.
- B. The guarantee shall include all necessary material, travel, labor and parts to replace defective components or materials at the job site.
- C. The Contractor shall make allowances in his guarantee to cover diagnosis of system defects which might ultimately be the responsibility of others to correct.
- D. The warranty shall include all necessary factory and field software required to perform the specified tasks.
- E. Warranty document signed by the owner and the consulting engineer must be included with the maintenance manuals supplied to owner. The warranty period will not begin until all systems are installed and operational as well as all commissioning checklists and all other documents pertaining to this job are furnished to the owner. All warranties to start upon final completion.

1.7 EMERGENCY SERVICE

- A. The Contractor shall provide normal and overtime emergency repair service for the system.
- B. The Contractor shall check-in upon arrival and departure with staff to ensure the service required has been conducted and completed.

- C. The system must be operational before the responding service person leaves the property.

#### 1.8 DAMAGE

- A. The Contractor shall be responsible during the installation and testing periods of the fully integrated automation facility controls system for any damage to the building, its contents, etc. caused by the Contractor's work.
- B. The Contractor shall be responsible for repair or replacement of existing facilities including doors and hardware, interior partitions, floors and ceilings, building finishes, mechanical or electrical equipment, or property damaged as a result of the performance of this work.

#### 1.9 SAFETY

- A. All work shall be performed in compliance with the Occupational Safety and Health Act of 1970 and Construction Safety Act Standards.

#### 1.10 INSTALLATION

- A. The BMS supplier shall furnish on-the-job supervision for the proper installation of devices in cooperation with, or as may be required by, other trades. This supervision shall include the following:
  - 1. Provide specific on-site instructions to others on mounting and installation to assure that the installer is properly instructed in the work.
  - 2. Provide supervision as required by others to properly perform installation work.
  - 3. Install, test, trouble-shoot and correct all system software provided under this specification.
- B. The Contractor shall furnish all material and labor to provide a complete and functional system, which operates in accordance with the requirements of this specification.
- C. Pay for and obtain all permits, approvals, fees and charges required for this work.

#### 1.11 INSTALLERS

- A. The TCC supplier shall furnish on-the-job supervision for the proper installation of devices in cooperation with, or as may be required by, other trades.

#### 1.12 PRODUCT SUPPORT AND SERVICE

- A. Manufacturer shall have an in-place support facility within 90 miles of the site with technical staff, spare parts inventory and necessary test and diagnostics equipment. Provide 800 number accesses to 24-hour support center, staffed with factory-trained personnel to assist in trouble shooting and problem resolution.

#### 1.13 COORDINATION

- A. Provide a designated project manager who shall be responsible for the following:
  - 1. Construct and maintain project schedule.
  - 2. On-site coordination with all applicable trades and subcontractors.

3. Authorized to accept and execute order and instructions from Owner/Architect
  4. Single point of contact.
- B. Site and Schedule Coordination:
1. Contractor shall assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
  2. Contractor shall coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
  3. Contractor shall integrate all facets of the integrated systems installation into the project construction schedule.
  4. Contractor shall coordinate schedule updates and changes with the various integration manufacturers.

## PART 2 – BUILDING MANAGEMENT SYSTEM REQUIREMENTS

### 2.0 BMS SYSTEM REQUIREMENTS

- A. The BMS shall perform supervisory monitoring, command, and control functions including, but not limited to:
- B. The system shall include a Graphic User Interface which shall allow for graphic navigation between systems, graphic representations of systems, access to real-time data, ability to override points, and access to all supervisory monitoring and control functions.
- C. All software used by the BMS and all software used to install and configure the BMS shall be licensed to and delivered to Agency Computer Services.
  1. Provide application support necessary for automating intelligent control and providing the following capabilities:
    - a. I/O capability from operator workstation
    - b. System security for each operator via software password and access levels.
    - c. Automatic system diagnostics
    - d. Automatic and manual database save and restore
    - e. Custom graphics options and library of HVAC equipment and symbols
    - f. Alarm and Event processing, messages and reactions
    - g. Trend logs retrievable in spreadsheets
    - h. Object property and status and control
    - i. Automatic restoration of field equipment on power restore
    - j. Custom report development
    - k. Workstation custom application editors for scheduling and control
    - l. Demand limiting, duty cycling, run-time totalization
    - m. Automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing
    - n. Weekly, monthly and annual scheduling features
  2. Support details on building systems, areas or pieces of equipment:
    - a. Schedules

- b. Historical Information
  - c. Schematics
  - d. Reports
- D. TCC shall generate real time trends and historical data collection to automatically sample, store and display system data. Samples for all physical hardware input and output points shall be collected during the warranty period, to allow the user to immediately analyze equipment performance and all problem-related events. Point history files for binary input or out points and analog output points shall be archived on the server workstation hard drive.
- E. The TCC shall generate real time and historical alarms to indicate whenever a safety device has tripped, status does not match the command state or a defined event does not match the normal condition.

## 2.1 SYSTEM ARCHITECTURE

### A. GENERAL BMS:

1. Provides flexible full client-server architecture for building automation applications from a single location or multiple locations; allows configurations for small single-seat to large multi-use installations.
2. Actual consumption figures can be compared to target (budget) figures.
3. Proven concept – Can be employed in buildings of any size.
4. Offers ranges from small systems with just a few data points to solutions for large building complexes with several thousand data points.
5. Connection via BACnet.
6. Graphical User Interface (GUI) which allows for graphical navigation between systems.
  - a. Graphical representations of systems
  - b. Access to real-time data for systems
  - c. Ability to override points in a system
  - d. Access to all supervisory monitoring and control functions.
7. Programmable controllers shall execute DDC PID Control loops, and scan and update process values and outputs as least once per hour.

### B. PERFORMANCE REQUIREMENTS: At minimum, control systems shall meet the following performance requirements:

1. Graphical Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
2. Graphical Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
3. Object Command: reaction time of less than two seconds between operator command of binary object and device reaction.
4. Object Scan: Transmit change of state and change of analog values to control units or workstations within 6 seconds
5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations shall receive alarms within 5 seconds of each other.
6. Program Execution Frequency: Run capability of applications as often as 5 seconds, but selected consistent with mechanical process under control.

## 2.2 GRAPHICS AND TRENDING

- A. Dynamic graphic screen for controls provided as part of this project shall display each piece of mechanical equipment indicated below tied to the DDC system. Each system screen shall display position of mechanical components, setpoints, schedules, overrides and adjustments made. Room numbers and locations shall be displayed.
- B. Each graphic shall represent system as installed. Values displayed shall be marked with descriptors and setpoints in the appropriate engineering units.
- C. Graphical programming software shall allow interactive mouse driven placement of block icons and graphic screen and connection of block I/O's. User must be able to edit all settings and parameters of all I/O blocks.
- D. Graphic software shall allow multitasking and ability to allow users to use 3<sup>rd</sup> party programs while operator workstation software is online. The software shall allow user to geographic maps, building floor plans and mechanical and electrical system schematics.
- E. Graphics package must allow user to perform the following functions:
  - 1. Define Symbols
  - 2. Position items and information blocks on graphic screens
  - 3. Attach physical or virtual points to a graphic
  - 4. Define background screens
  - 5. Edit, display orient text descriptors
  - 6. Control to display and edit colors for different elements
  - 7. Create links to other graphic display pages
- F. The TCC shall include programming for trend points defined and directed by the Engineer. These can be requested at any time during the warranty period. Trend "change of state" for all digital inputs and outputs. Trend analog points in 1 hour increments. Maintain trend history for 30 days. The following points will be associated with trend reports:
  - 1. Outside Air Temperature and Humidity
  - 2. Minimum outside air CFM
  - 3. Air Handling Unit Discharge temperature
  - 4. Totalization of all VAV boxes associated to units
  - 5. VFD Speed Frequency
  - 6. Hot water supply and return temperatures
  - 7. Individual boiler supply and return temperatures
  - 8. Chilled water supply and return temperatures
  - 9. Electrical Metering and Sub-Metering
  - 10. Electrical power kW and kWh

## 2.3 OPEN PROTOCOL COMMUNICATIONS

- A. The sub-systems shall provide communications based upon the following open standards protocol of data exchange:
  - 1. BACnet – typically used for building systems such as HVAC, lighting and fire and life safety.
  - 2. Modbus – Process control and metering systems

## 2.4 OPERATORS WORKSTATION

### A. Agency Operator Workstation:

1. Personal computer operator workstations shall be provided for command entry, information management, system monitor, event management and database management functions. All real-time control functions shall be resident in the Building Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation control.
2. AGENCY MUST APPROVE AND PROVIDE ALL WORKSTATIONS SELECTED.
  - a. Workstation shall consist of a personal computer with the following minimum requirements:
    - 1) 8 GB RAM
    - 2) Hard drive with 320 GB available space
    - 3) Video card with 512 MB RAM capable of supporting a minimum of 1920 x 1080 resolution with a minimum of 32-bit color
    - 4) DVD-RW Drive
    - 5) Mouse and 101-key enhanced keyboard
3. Personal computer shall be a Windows 7 64-bit or Windows 2008 R2 and shall include an Intel I7 or similar processor.
4. The PC monitor shall be of flat panel type and shall support a minimum display resolution of no less than 1920 x 1080 pixels. The display shall have a minimum of 21-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
5. Provide an Epson FX-870 or equivalent printer at each workstation location or on the network (Ethernet) for recording alarms and operator transactions.
  - a. Provide a color printer for printing of dynamic trend graph report, Excel reports, graphics and any other screen displays

## 2.5 COMMISSIONING

- A. Upon completion of the installation, the Contractor shall start up the system and perform all necessary calibration, testing, and debugging operations.
- B. Verify that all hardware components are installed, connected, communicating, and operating properly.
- C. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power. These procedures shall apply to all gateways to other systems, including fire alarm/life safety.
- D. Verify that all system software is installed, configures, and complies with specified functional requirements.
- E. Perform final acceptance testing in the presence of the Owner's Representative, and Engineer executing a point by point inspection against a documented test plan that demonstrates compliance with system requirement as designed and specified.



- F. Submit documented test plan to Owner and Engineer for their review at least ten (10) days prior to the acceptance test, inspection and check-off.
- G. Conduct final acceptance testing in the presence of the Owner's Representative, and Engineer, verifying that each device point, and sequence is operating properly and reporting to the control panel and control center.
- H. Acceptance test is contingent on successful completion of check-off. If check-off is not completed due to additional work required, the test shall be rescheduled and another complete check-off shall be conducted until complete in one pass, unless portions of the system can be verified as not adversely affected by additional work.
- I. System shall not be considered accepted until all acceptable test items have been successfully checked off and accepted in writing. Beneficial use of part or all of the system shall not be considered as acceptance of the system.

## 2.6 TRAINING

- A. Provide training of the building's personnel in the proper operation procedures. The O&M manuals shall be used and referenced as part of the training program.
- B. Operator training shall include, but not limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the system's operation.
- C. The training shall be in two sessions as follows:
  - 1. Initial Training: One day session (8 hours) after the system is started up and at least one week before the acceptance test.
  - 2. Follow-up Training: Two days (16 hours) after the system has been accepted. These sessions shall deal with more advanced topics as requested by the Owner, such as how to add additional points, create and gather data for trends.
- D. Training shall cover all operating features of the system, including the following:
  - 1. System set-up and cardholder database configuration.
  - 2. Access control features.
  - 3. Alarm monitoring features.
  - 4. Report generation and searches.
  - 5. Card management.
  - 6. Disk backup procedures.
  - 7. Routine maintenance and adjustment procedures.
- E. The TCC shall provide on digital video disk (DVD) a digital media recording of the complete training session.

## PART 3 - CONTROL WIRING

### 3.0 CONTROL WIRING

- A. A complete cabling system shall be provided and installed, and will adhere to the highest workmanlike standard of appearance and quality. TCC contractor is responsible for any

- power required for control panels. Including circuit breakers, conduit, interlock wiring, etc.
- B. Provide a 110 VAC receptacle for all temperature control and master control panels
  - C. Each controller shall have a “packaged” power supply in a separate enclosure without exposure to 120v hazard. (arc-flash hazard)
  - D. Any power for controls shall be fed from circuits in electrical panels shall not be taken from receptacles, lighting, or equipment circuits. Unitary control power may be taken from the equipment served. TCC contractor responsible for power source to unitary and all application specific controllers and all other control power requirements.
  - E. All control circuits within electrical panels shall be marked to indicate equipment served and located and noted on as built drawings.
  - F. All cable connections shall be continuous runs where possible. Any junctions must be made in a metal enclosure, connections must be soldered or wire nuts, taped and the metal enclosure must be mechanically attached to nearest ground. No crimped connections.
  - G. Lines shall be properly supported at regular intervals. Seal conduit penetrations of air handling units and custom air handling units airtight and at penetrations points
  - H. Bundle and harness multi-conductor cable in place of single cables where a number of cables follow a common path. Install wire and cable with sufficient slack to allow for equipment and piping vibration.
  - I. All sizing and shield terminations must adhere to manufacturer’s recommendations.
  - J. Wireless controllers are not approved unless specifically mentioned in the sequence of operations or noted on plans

#### PART 4 – CONTROL DEVICES

##### 4.0 CONTROL PANELS

- A. TCC to provide all panelboards that will include all instruments, controllers and accessories. Provide complete identification for each group of components. Provide complete wall-mounted enclosed panelboard with engraved nameplate. Enclosure must have hinged doors with keyed lock, with manufacturer’s standard shop painted finish and color.
- B. Bring entire panelboard to main terminal strip with marked wire to component designations.
- C. Provide additional wall-mounted enclosure if necessary for positioning and changeover switches, thermometers and gages.

##### 4.1 “BUILDING LEVEL” NETWORK CONTROLLERS

- A. Networked building level controllers are required to support BACnet IP, BACnet MS/TP, Modbus RTU protocols. Modbus RTU may be used for integration to third party devices if BACnet is not available. Any secondary, non standard variable communication

protocols are now allowed. The building level network controllers shall communicate BACnet IP and shall command all time schedules, summer/winter changeover commands, custom trends, holiday and event scheduling, alarming and all other network controllers associated within the building network.

- B. The network controller shall be integrated and interoperable with the facility infrastructure through VLAN access. The user shall be able to access system data locally through any computer connected to the network with the proper rights.
- C. The building network controller shall be user programmable and have capability to operate in stand-alone mode. The controller will distribute and receive global information from unitary controllers, application specific controllers (ASC) and communicate on a peer-to-peer basis with all other networked controllers. Processor clock speed must be capable of at least 130 MHz supported with at least 70 MB of memory. UL 916 PAZX, ULC-S527-M8 listings required.
- D. The network controller to have battery back-up with minimum seven day operation life. The controller must contain a predetermined failure mode. The building controller shall manage I/O communication signals and allow unitary controllers and ASC to share real and virtual information.
- E. Each DDC controller provided shall leave open points to allow 10% of each control point type. This includes one universal input and output.

#### 4.2 UNITARY / APPLICATION SPECIFIC CONTROLLERS

- A. Unitary / Application Specific Controllers must have full stand alone capability including time of day and holiday scheduling. The unitary controller shall be pre-programmed with the proper application for the desired sequence. The unitary controller database must have ability to be backed up and restored locally or through front end work station.
- B. Unitary controllers shall communicate BACnet MS/TP and are to be fully programmable. Controllers require a 10% spare point capacity to be provided for all applications. All control sequences within the unitary controller shall be stored in non-volatile memory.
- C. After loss of power, the unitary controller must run the programmed application using programmed setpoints and configuration. Factory restores are not acceptable. Unitary controllers must have minimum 72 hour backup life.
- D. Inputs shall be 0-20mA, dry contacts, 0-10 VDC. Digital outputs shall be 24VAC OR VDC minimum. Each output shall be configurable as normally open or closed. RJ-11 connection ports for monitoring or programming access must be provided with all unitary controllers. Digital expanders or other devices that group multiple signals are not allowed. Each point must have its own location on controller.
- E. Unitary controllers for unit ventilators, small air handling units, and VAC boxes shall be mounted on the side of the unit with the zone temp sensor in a sensible location within the zone served in accordance with contract drawings.

#### 4.3 SENSORS

- A. DDC Room Thermostats/Sensors: Provide room / zone thermostats that work in conjunction with the associated unit or unitary controller. Thermostats shall have visible thermometers, setpoint indication and adjustment in offices and conferences rooms. Wall

plate, button style or sensors mounted in the return duct are acceptable where regular space sensors cannot be mounted. Provide protective cages in fitness and common areas. Programmed set point shall be limited to 2 degree +/- increments for specific areas.

- B. TEMPERATURE / HUMIDITY SENSORS: All duct and space temperature sensors shall have minimum +/-1.4 Deg. F 59 Deg F. to 95 Deg. F accuracy. All humidity sensors have a 0-100% RH scaling range with +/-2% accuracy. The response time shall be a minimum of 30 seconds for a 60% change. The outputs for humidity and temperature sensors must utilize a 0-10 VDC or 4-20 mA signal as required and must use a power supply of 24VAC or VDC. ALL duct mounted sensors shall have at least 4" insertion probe. Do not submit products that do not meet this range.
- C. MIXED AIR SENSORS: These sensors must be bendable averaging, type made of copper or aluminum. For AHU's the sensor must be at least 22 ft in length and is used across air coils. Capillary clips for mounting are required for all mixed air sensors.
- D. OUTDOOR AIR SENSORS: The outdoor air sensor will be installed on the north wall in the shade, out of direct sunlight. Provide weather cover. If sensor does not provide accurate temperature it must be relocated until a proper reading is calibrated. Accuracy must be +/- 2 Deg. F.
- E. DISCHARGE AIR AND DUCT SENSORS: Rigid insertion type. All sensors must be properly secured and mounted to not allow any vibration. Install sensor to get most accurate reading.
- F. WATER SENSORS: Temperature sensors for water are to be well type with thermal conductive compound. Wells are to be threaded brass with the sensor coated with heat transfer compound. Strap on sensors will not be acceptable. +/- 1 Deg. F Accuracy.
- G. FREEZE THERMOSTAT: These devices must be the manual reset type. This device must be wired using a normally closed contact in series with the motor starting circuit and a normal open set of contacts as an input to unitary or building network controller. The sensing element must be copper and at least 20 feet in length. Sensor must be installed in serpentine manner across coil so it senses the lowest temperature by any one foot section. Provide capillary clips for all Freeze Thermostats.
- H. CARBON DIOXIDE SENSORS: The range for all CO2 sensors is 0-2000ppm programmable with an accuracy of +/-30 ppm +/-2% of measured value. Response time under 60 seconds for 90% step change. Inputs power must be 24 VDC; 100 mA max, Analog Output 4-20 mA/0-10VDC acceptable. Sensors will not have displays and be located in return ducts where necessary.
- I. CURRENT SENSOR: All current sensors shall be capable of alarming to the BAS for belt losses, pump coupling shear or other mechanical failure of loads. Current sensors must be self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- J. AIR FLOW MEASURING STATION: Provide and install Ebtron GTC model or equivalent. Probe operating temperature range -40-110 Deg F. The device must use 24VAC. Analog 4-20mA output signal. NEMA 4X Water Tight enclosure. Accuracy of 200-1000 fpm +/- 5% reading.
- K. DIFFERENTIAL PRESSURE TRANSMITTERS: Provide Setra 2604 air or 2302 wet model Setras or equivalent for all differential pressure transmitters. Range shall span from 0-100PSIG. With .025% accuracy.

4.4 VALVES, DAMPERS AND ACTUATORS

- A. TCC shall furnish and size all control valves. The valves are to provide the required capacity and the close off rating shall be in excess of the system pressure. Proportional type valves to be rated at 250 psi static pressure. Proportioning type valve bodies shall be packaged type with throttling type inner valves.
- B. TCC will provide and size all dampers for various units. Dampers shall be tight closing “ultra low leakage”, opposed blade with side and edge seals. They must be sized and furnished under this section. Damper blades shall be no less than 16 gauge galvanized steel with maximum blade width of 8 inches. Blade shall be secured to ½ inch zinc plated axles and hardware with nylon bearings.
- C. All damper and valve actuators must be fail safe spring return type with sufficient force to operate the dampers or valves under all normal operating conditions. They must return to the normally open position upon loss of power. Actuators for unitary controllers shall fail in place.
- D. All actuators must be of the same manufacturer and have internal circuitry feedback to provide a positioning of the damper or valve through the entire sequence. All damper actuators to have auxiliary switches for open and close indication. All actuators must utilize a 0-10 VDC signal and remain consistent throughout.

END OF SECTION

**SECTION 15910 INTEGRATED BUILDING MANAGEMENT SYSTEM (IBMS)**

**PART 1 - GENERAL AND GENERAL**

**1.1 SPECIAL CONDITIONS**

- A. The Contractor shall furnish all equipment, materials, tools, labor, engineering, drawings, approvals from governing agencies, etc. necessary for a complete Integrated Building Management System (IBMS), with said systems being made ready for operation in accordance with the requirements of the authorities having jurisdiction. The purpose of the furnished specifications and drawings is to convey to the Contractor the scope of work required, all of which the Contractor is responsible to furnish, install, adjust, and make operable.
- B. The Contractor shall provide all devices and equipment required by these specifications.
- C. The IBMS platform shall integrate all specified building subsystems into one overall system, providing a complete integrated approach to managing and controlling facilities from a flexible, easy-to-use unified interface to system operators.

**1.2 SCOPE OF WORK**

- A. The Contractor shall furnish and commission, unless, otherwise indicated, a fully integrated building management system with the capability to interface with other building systems. IBMS shall allow full integration of building, utility, safety, security, fire alarm and mass notification systems with capability to support multi-vendor environments utilizing standard protocols and be able to integrate third-party systems using standard or existing vendor proprietary protocols.
- B. All subsystem's core software and hardware shall be from the same manufacturer; subsystems may reside on separate or converged servers, but must function as one integrated platform.
- C. IBMS shall provide single and unified graphical user interface (GUI) that provides two way communication and control to the following subsystems:
  - 1. Building Automation
  - 2. Fire Detection and Notification
  - 3. Fire Suppression
  - 4. FM 200 Fire Suppression
  - 5. Utility / Sub metering
  - 6. Physical Access Control
  - 7. Intrusion Detection
  - 8. Video Surveillance
  - 9. Solar Array
- D. IBMS shall provide IFTTT logical sequencing between subsystems and allow an event in one subsystem to trigger action sequence in a secondary subsystem.
- E. General Contractor and the Installing Contractors shall furnish and/or install all equipment and systems specified in these specifications.
- F. Installing Contractors shall include in their bid all the required conduit and wiring for low voltage and 120V power requirements to panels, devices, controllers, etc. for their specific equipment.

1.3 RELATED REQUIREMENTS

- A. Refer to Section 15905 “Instrumentation and Control for HVAC”.
- B. Requirements of Division 16, Fire Alarm System apply to this Section.
- C. Requirements of Division 15 Sections apply to this Section as well as appropriate sub-references:
- D. Requirements of Division 15 Sections apply to this Section as well as appropriate sub-references:
  - 1. 15950 Testing, Adjusting and Balancing.
  - 2. 15992 HVAC Commissioning.
- E. Requirements of Division 16 Sections apply to this Section as well as appropriate sub-references:
  - 1. 16900 Controls
  - 2. 16910 Access Control Systems and Database Management.
  - 3. 16920 Intelligent Addressable Fire Alarm System.
  - 4. 16950 Occupancy Sensors.

1.4 RELATED WORK

- A. The Division 15 contractors shall be responsible for all new controllers, control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.
- B. The Division 15 contractor shall be responsible for the IBMS platform, software and programming of the IBMS, graphical user interface software (GUI), development of all graphical screens, Web browser pages, setup of schedules, logs, alarms, network management and connection of the IBMS to the local or wide area network.
- C. The Division 15 contractor shall integrate the Modbus electrical meters as supplied by the Division 16 contractors.

1.5 SUBMITTALS

The Contractor shall meet the requirements of this subsection as described below. Submittal documents received that are incomplete shall not be reviewed. Incomplete submittals shall be rejected and returned to the Contractor for correction and resubmittal. Submittals rejected by the Owner and/or Engineering shall be corrected and resubmitted within three weeks of the review letter date.

- A. Preconstruction Submittals “Logical Integration”.
  - 1. Contractor shall submit a detailed design of IBMS subsystems integration.
- B. Engineered Shop Drawing / Permit Submittals “IBMS subsystems integration flow charts, Network Architecture”; “Interoperability Sequencing”, “Functional Performance Testing”:
  - 1. Five copies of shop drawings of the entire IBMS shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall contain complete wiring and schematic diagrams, software descriptions, calculations, and

any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings.

2. Submittal shall also include a network architecture schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.
3. A complete point list of all points connected to the IBMS. Including all necessary points, protocol documentation, and factory support information for systems provided and integrated into the IBMS.
4. Submittal shall include a copy of each graphics developed by the Graphic User Interface including a flowchart (site map) indicating how the graphics are being linked to one another for system navigation.

C. Closeout Submittals “Commissioning”:

1. Upon completion, a complete set of “as-built” drawings and application software shall be provided on compact disk. Drawings shall be provided in AutoCAD and PDF compatible files. Five printed copies of the “as-built” drawings shall be provided in addition to the documents on compact disk.

1.6 DELIVERY, STORAGE, AND HANDLING OF MATERIALS

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain carton while shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.
- B. Contractor shall deliver all materials to area of project designated by the Owner’s Representative. Vehicles shall not block fire lanes or fire doors during delivery of materials.
- C. Owner shall not accept deliveries for the Contractor.
- D. The Owner’s Representative shall designate an area within the facility for storage of all materials. At the end of each working day, all materials shall be returned to the designated area.
- E. No material storage facilities are available on site. The Contractor is to include in his bid the cost of storage trailers or other suitable storage facilities.
- F. The cost of all material handling, delivery and freight is the Contractor’s responsibility.
- G. Maintain premises free from accumulation of waste materials or rubbish caused by this work.
- H. The Contractor shall arrange and pay for parking.

1.7 WARRANTY

- A. The Contractor shall provide a two-year written guarantee against defects in material and workmanship furnished under this Contract. The costs of such guarantee shall be part of the purchase price.
- B. The guarantee shall include all necessary material, travel, labor and parts to replace defective components or materials at the job site.



- C. The Contractor shall make allowances in his guarantee to cover diagnosis of system defects which might ultimately be the responsibility of others to correct.
- D. The warranty shall include all necessary factory and field software required to perform the specified tasks.

1.8 EMERGENCY SERVICE

- A. The Contractor shall provide normal and overtime emergency repair service for the system.
- B. The Contractor shall check-in upon arrival and departure with staff to ensure the service required has been conducted and completed.
- C. The system must be operational before the responding service person leaves the property.

1.9 DAMAGE

- A. The Contractor shall be responsible during the installation and testing periods of the fully integrated automation facility controls system for any damage to the building, its contents, etc. caused by the Contractor's work.
- B. The Contractor shall be responsible for repair or replacement of existing facilities including doors and hardware, interior partitions, floors and ceilings, building finishes, mechanical or electrical equipment, or property damaged as a result of the performance of this work.

1.10 SAFETY

- A. All work shall be performed in compliance with the Occupational Safety and Health Act of 1970 and Construction Safety Act Standards.

1.11 QUALITY ASSURANCE

- A. Codes and Standards:
  - 1. UL Compliance: Provide electrical components of Division 15 control systems which have been UL-listed and labeled, and comply with NEMA standards. Provide control devices, which are UL listed as a signal appliance.
  - 2. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for Division 15 control systems.
  - 3. NFPA Compliance: Comply with NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences; NFPA 72 "National Fire Alarm and Signaling Code."
- B. The IBMS system shall be designed, commissioned and serviced by manufacturer employed, factory-trained personnel.
- C. Materials and equipment shall be the catalogued products of the manufacturers regularly engaged in production and installation of specified Division 15 systems and shall be manufacturer's latest standard design that complies with Division 15 requirements. This requirement does not prohibit the use of 3<sup>rd</sup> party components to the hardware for software.

- D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, and Governing Radio Frequency Electromagnetic Interference and be so labeled.
- E. The manufacturer of the building automation system shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing).
- F. General Contractor shall provide proof of experience with integration to fire alarm/life safety systems. Provide individuals experienced with the installation and startup of equipment related to this type of integration.
- G. General Contractor shall ensure project personnel has all necessary certifications for all IBMS and applicable subsystems

#### 1.12 INSTALLER QUALIFICATIONS

- A. Installers: An authorized factory representative or a branch office of an acceptable manufacturer shall install the IBMSS.
  - 1. Experience with the proposed product line for not less than 2 years.
  - 2. Experience on at least five projects of similar size or complexity.
  - 3. Documentation with this experience with references shall be provided upon request.
- B. Qualifications of manufacturer of integrated building management systems
  - 1. Provide references and contact information for # projects similar in scope completed in the past 5 years

### **PART 2 - PRODUCTS**

#### 2.1 MANUFACTURERS

- A. Manufacturers:
  - 1. Basis of Design Manufacturer: Subject to compliance with requirements, provide products of Siemens Building Technologies or comparable products.
  - 2. All subsystem's core software and hardware shall be from the same manufacturer; subsystems may reside on separate or converged servers, but must function as one integrated single-source platform. Refer to specific sections for subsystem basis of design
  - 3. IBMS Basis of Design: Siemens Desigo CC, JCI, and Trane.

#### 2.2 SYSTEM REQUIREMENTS

- A. The IBMS shall perform supervisory monitoring, command, and control functions including, but not limited to:
  - 1. Graphic Editor
  - 2. System Display Editor
  - 3. Scheduling
  - 4. Alarms
    - a. Notification and routing

- b. Display and acknowledgement
    - c. Storage and reports
  - 5. Trending
    - a. Points to trend
    - b. Sampling intervals
    - c. Start and stop time of trend
  - 6. Overrides
  - 7. Report Generation
    - a. Alarm report
    - b. Electrical power usage report
    - c. Electrical peak demand prediction
    - d. Energy usage report
  - 8. Electrical Power Demand Limiting
- B. The IBMS shall provide native system functionality to include the following system integration:
  - 1. Fire Alarm System
  - 2. Fire Suppression
  - 3. Smoke Control
  - 4. Mass Notification
  - 5. BMS/Building Automation (cooling/heating control, ventilation control, pumps, etc.)
  - 6. Air valves, pressurization, exhaust control, compliance reporting
  - 7. Lighting Control
  - 8. Utility and/or Sub Metering
  - 9. IP Cameras
  - 10. Video Management
  - 11. Access Control
  - 12. Intrusion Detection
  - 13. Integration to third party systems – Hardware, software, programming, commissioning to monitor and/or control a complex network of components for a specific function that is delivered and installed by a third party contractor.
  - 14. Integration to third party equipment – Hardware, software, programming and commissioning needed to communicate and/or interoperate a single function piece of equipment with factory controls and documentation.
  - 15. Energy Distribution (consumption metering of water, electricity, cooling/heating energy, and gas)
- C. The system shall include a Graphic User Interface which shall allow for graphic navigation between systems, graphic representations of systems, access to real-time data, ability to override points, and access to all supervisory monitoring and control functions.
- D. All software used by the IBMS and all software used to install and configure the IBMS shall be licensed to and delivered to the Owner.
  - 1. Provide application support necessary for automating intelligent control and providing actionable information.
  - 2. Support details on building systems, areas or pieces of equipment:
    - a. Schedules
    - b. Historical Information

- c. Schematics
- d. Reports

## 2.3 SYSTEM ARCHITECTURE

### A. Desigo CC:

1. Provides flexible full client-server architecture for building automation and fire safety applications from a single location or multiple locations; allows configurations for small single-seat to large multi-use installations.
2. Allows for energy consumption meters installed in the different types of building services plant to have data transmitted by these meters and recorded by the IBMS.
3. Actual consumption figures can be compared to target (budget) figures.
4. Proven concept – Can be employed in buildings of any size.
5. Offers ranges from small systems with just a few data points to solutions for large building complexes with several thousand data points.
6. Connection via BACnet, OPC or the Web, etc. for straightforward integration.
7. Open interfaces to subsystems.
8. Graphical User Interface (GUI) which allows for graphical navigation between systems.
  - a. Graphical representations of systems
  - b. Access to real-time data for systems
  - c. Ability to override points in a system
  - d. Access to all supervisory monitoring and control functions.

### B. Server Hosted Web Based Operator Interface (Desigo CC):

1. The IBMS shall provide a Web-based graphical interface that allows users to access the IBMS data via the Internet, extranet, or Intranet. Functionality of web-based clients shall provide the same functionality and user interface provided by installed client consoles.
2. A Web server computer will be supplied. The Web server shall use Microsoft's IIS server with Windows 2008 R2 Server, or later, and support browser access via Microsoft Internet Explorer.
3. All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).
4. Web interfaces shall require the use of certificates to ensure safe secure connectivity to the server.
5. Access to the Web interface may be password protected. Users' rights and privileges to points and graphics may be the same as those assigned at any other workstation, or may be differentiated from privileges at installed workstations.
6. The Web interface shall not require modification or creation of HTML or ASP pages using an HTML editor. All graphics shall be available with the same look and functionality whether they are displayed at an installed client console or in a browser.
7. The Web based interface shall provide the same functionalities as those available at any other workstation, including operation and configuration capabilities.
8. The Web server client licensing shall be from the same pool of client licenses available or installed client consoles or Windows desktop app clients.
9. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the owner as required to support the Web access feature.

- C. Field Panel Hosted Web Based Operator Interface (Field Panel Web Server):
  - 1. Graphics creation – user shall be able to add/delete/modify system graphics from standard user interface without the need of any external or specialized tools.
- D. Subsystem Interfaces
  - 1. Mass Notification System
  - 2. Fire Alarm and Smoke Control Systems:
  - 3. Desigo Fire Safety FS20
  - 4. XNET Fire Finder XLS and MXL
  - 5. Access Control
  - 6. Video through Axis and ONVIF compatible IP Cameras
  - 7. Building Automation:
    - a. Apogee BACnet IP
    - b. Apogee P2/Ethernet
    - c. Apogee P2 RS-485 using AEM
    - d. Third-party Building Automation and Fire Subsystems based on BACnet
    - e. Third-party subsystems through OPC
    - f. Integration through SNMP

#### 2.4 OPEN PROTOCOL COMMUNICATIONS

- A. The sub-systems shall provide communications based upon the following open standards protocol of data exchange:
  - 1. BACnet – typically used for building systems such as HVAC, lighting and fire and life safety.
  - 2. OPC “no need to upgrade if equipment version is changed using Desigo” – Client Only, capability of historical data /OPCDA “Data Acquisition”
  - 3. Modbus – Process control and metering systems
  - 4. SNMP – IT equipment
  - 5. ONVIF – IP camera systems
  - 6. Axis – Axis camera systems
  - 7. HTTP
  - 8. SMTP
  - 9. QOS – Quality of Service
  - 10. SIP – Session Initiation Protocol (MNS, IP voice)
  - 11. CAP – Common Alerting Protocol (MNS-web based alerts)

#### 2.5 NETWORK COMMUNICATION

- A. Client access to client-server workstation configurations over the Intranet or Internet shall be available via three client options:
  - 1. Web Browser. Client runs in a browser as a Full Trust client application.
  - 2. Dedicated Installed Application. Client runs as a fully installed software installation that can lockdown desktop space and prevent the ability for the software to be minimized or covered by other applications.
  - 3. Windows Desktop App. An app that is downloaded to the client from the server PC, that runs like an installed application, and is automatically updated whenever new apps are available at the server.
- B. Remote Notification:

1. Workstations shall be configured to send out messages to numeric pagers, alphanumeric pagers, SMS (Simple Messaging Service, text messaging) Devices, and email accounts based on a point's alarm condition.
2. There shall be no limit to the number of points that can be configured for remote notification of alarm conditions and no limit on the number of remote devices which can receive messages from the system.
3. On a per point basis, system shall be configurable to send messages to an individual or group and shall be configurable to send different messages to different remote devices based on alarm message priority level.
4. System must be configurable to send messages to an escalation list so that if the first device does not respond, the message is sent on to a second device after a configurable time has elapsed.
5. Workstation shall have the ability to send manual messages allowing an operator to type in a message to be sent immediately.

## 2.6 OPERATORS INTERFACE

- A. Day-to-day operation of the IBMS shall be through a standard browser-based interface. Configuration, programming and operation shall be performed on dedicated operator workstations.

## 2.7 OPERATORS WORKSTATION

- A. Designo CC Workstation Hardware:
  1. Personal computer operator workstations shall be provided for command entry, information management, system monitor, event management and database management functions. All real-time control functions shall be resident in the Building Controllers to facilitate greater distribution, fault tolerance and reliability of the building automation control.
  2. Provide workstation(s) of equal capability as located on plans.
    - a. Workstation shall consist of a personal computer with the following minimum requirements:
      - 1) 8 GB RAM
      - 2) Hard drive with 320 GB available space
      - 3) Video card with 512 MB RAM capable of supporting a minimum of 1920 x 1080 resolution with a minimum of 32-bit color
      - 4) DVD-RW Drive
      - 5) Mouse and 101-key enhanced keyboard
  3. Personal computer shall be a Windows 7 64-bit or Windows 2008 R2 and shall include an Intel I7 or similar processor.
  4. The PC monitor shall be of flat panel type and shall support a minimum display resolution of no less than 1920 x 1080 pixels. The display shall have a minimum of 21-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
  5. Provide an Epson FX-870 or equivalent printer at each workstation location or on the network (Ethernet) for recording alarms and operator transactions.
    - a. Provide a color printer for printing of dynamic trend graph report, Excel reports, graphics and any other screen displays.

- B. Desigo CC shall be installed on at least one computer, with full server and client functionality. Additional clients (dedicated, browser, and Windows desktop application) may be added. Client Options for Applications ranging from casual users to dedicated mission critical console installations.
  - 1. Dedicated Client – designed for mission critical applications, such as UL listed fire safety monitoring or critical process control, where users are focused entirely on monitoring and managing building systems.
  - 2. Software components used for Event Management are locked in-place and cannot be moved or covered by other applications; this ensures that critical events are never missed or hidden
  - 3. Browser Client – For users who demand greater flexibility in their system access, Desigo CC software can run in a browser client, like Internet Explorer.
- C. Windows Desktop Application – a light application that can run like any other Windows application on a desktop.
  - 1. Additional system connections may be made through systems installed with a Desigo CC Front End Process (FEP) configuration.
  - 2. Server, FEP and Dedicated Clients shall run on Windows 7 64-bit or Windows Server 2008 R2 operating system.
  - 3. Browser and Windows desktop application clients shall run on Windows XP (with Internet Explorer 8) or Windows 7 operating systems.
- D. The server shall host all data for the system while the clients are only for the visualization and the user interaction. The clients provide a high-resolution interface to all relevant server data needed for monitoring and command the installation.

## 2.8 SERVERS

- A. Provide servers that shall provide archive locations for all historical data as trends, alarms, and event histories, and transaction logs.
- B. Access to all information on the server shall be through the same user interface used to access the individual workstations. When logged onto a server the operator shall be able to also interact with any of the primary workstations in the facility.
- C. Desigo CC Server Hardware:
  - 1. The Server hardware shall be of equal or better capability as that of Workstation and shall be equipped as follows.
    - a. Locate server as located on plans.
    - b. Server shall consist of the following minimum requirements:
      - 1) 32 GB RAM, DDR3-1333
      - 2) Intel Xeon X5000 Series, 3.0 GHz, 6 Cores, 12 threads
      - 3) Ten hard drives of 2 TB available space for each
        - a) Windows Server 2008 R2 Standard and Desigo CC (Disks 1 and 2)
        - b) GMS SQL server traffic (Disks 3 through 6)
        - c) MNS SQL server traffic (Disks 7 and 8)
        - d) Backup (Disks 9 and 10)
      - 4) Video card with 2 GB RAM capable of supporting dual monitor, 2560 x 1600 resolution

- 5) DVD-ROM Drive
  - 6) Mouse and 101-key enhanced keyboard
2. Server shall be a Windows 2008 R2 Server.
  3. Provide a monitor of flat panel type and shall support a minimum display resolution of no less than 2560 x 1600 pixels. The display shall have a minimum of 21-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts and brightness. The screen shall be non-reflective.
  4. Server shall be robust.
- D. Design CC Operator Interface Software:
1. Basic Interface Description:
    - a. All operator interface functions must be available in clients running in a browser, installed client console, or Windows desktop app.
    - b. Operator interface software shall minimize operator training through the use of user-friendly and interactive graphical applications, 256-character English language point identification, on-line help, and industry standard Windows application software. Interface software shall simultaneously communicate with and share data between Ethernet-connected building level networks.
  2. The user interface shall display relevant information for a selection in multiple panes of a single window without the need for opening multiple overlapping windows on the desktop.
  3. Provide a graphical user interface that shall minimize the use of keyboard through the use of a mouse or similar pointing device, with a "point and click" approach to menu selection and a "drag and drop" approach to inter-application navigation.
  4. The navigation shall be user friendly by utilizing "forward & back" capability between screens and embedded links to graphics, documents, drawings, trends, schedules, as well as external documents (.doc, .pdf, .xls, etc.) or web addresses that are related to any selected object.
  5. Primary selection of objects in the operator interface software shall be available from user defined hierarchical Views, from graphics, or from events in an Event List.
  6. Secondary selection of objects in the operator interface software shall be available from links to any objects or external documents related to the primary selection. Links to related items shall be automatically defined based on where an object is used in the system.
  7. The operator workstation shall be capable of displaying web pages and common document formats (.doc, .xls, .pdf) within the operator workstation application.
  8. The Operator Workstation Software shall be capable of BACnet IP communications. The BACnet Advanced Workstation (B-AWS) shall have demonstrated interoperability during at least one BTL Interoperability Workshop, have demonstrated compliance to BTL B-AWS device classification through BTL listing as specified in ANSI/ASHRAE 135.
  9. Control product shall support the following BACnet Interoperability Building Blocks to facilitate an open and interoperable system.
  10. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. BMS software clients shall run on a Windows XP, Windows 7 or comparable 32/64-bit operating system. System



database parameters shall be stored within an object-oriented database. Standard Windows applications shall run simultaneously with the BMS software. The mouse or Alt-Tab keys shall be used to quickly select and switch between multiple applications. The operator shall be able to work in Microsoft Word, Excel, and other Windows based software packages, while concurrently annunciating on-line BMS alarms and monitoring information.

11. The software shall provide, as a minimum, the following functionality:
  - a. Real-time graphical viewing and control of the BMS environment.
  - b. Reporting of both real-time and historical information.
  - c. Scheduling and override of building operations.
  - d. Collection and analysis of historical data.
  - e. Point database editing, storage and downloading of controller databases.
  - f. Configuration of and navigation through default and personalized hierarchical "tree" views that include workstation and control system objects.
  - g. Event reporting, routing, messaging, and acknowledgment.
  - h. Definition and construction of dynamic color graphic displays.
  - i. Online, context-sensitive help, including an index, glossary of terms, and the capability to search help via keyword or phrase.
  - j. On-screen access to User Documentation, via online help or PDF-format electronic file.
  - k. Automatic database backup at the operator interface for database changes initiated at Building Controllers.
  - l. Display dynamic trend data graphical plot:
    - 1) Must be able to run multiple plots simultaneously.
    - 2) Each plot must be capable of supporting 10 pts/plot minimum.
    - 3) Must be able to command points from selection on dynamic trend plots.
    - 4) Must be able to plot real-time data without prior configuration.
    - 5) Must be able to plot both real-time and historical trend data simultaneously.
  - m. Program editing.
  - n. Transfer trend data to third-party spreadsheet software
  - o. Scheduling reports
  - p. Operator Activity Log
12. Security:
  - a. Operator-specific password access protection shall be provided to allow the administrator/manager to limit users' workstation control, display and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password.
  - b. Operator privileges shall "follow" the operator to any workstation logged onto.
  - c. The administrator or manager shall be able to further limit operator privileges based on which console an operator is logged on to.
  - d. The administrator or manager shall be able to grant discrete levels of access and privileges, per user, for each point, graphic, report, schedule, and BMS workstation application.

13. The operator interface software shall include reports to track the actions of each individual operator. The application shall allow querying based on object name, operator, action, or time range.
14. Dynamic Color Graphics application shall include the following:
  - a. Must include graphic editing and modifying capabilities.
  - b. All necessary tools and procedures for the user to create their own graphics
  - c. A library of standard control application graphics and symbols must be included.
  - d. Must be able to command points directly off graphics application.
  - e. Graphic display shall include the ability to depict real-time point values dynamically with text or animation.
  - f. Navigation through various graphic screens shall be optionally achieved through a hierarchical “tree” structure.
  - g. Graphics viewing shall include dynamic pan zoom capabilities.
  - h. Graphics viewing shall include the ability to switch between multiple layers with different information on each layer.
  - i. Graphics shall include a decluttering capability that allows layers to be programmatically hidden and displayed based on zoom level.
  - j. Graphics shall be capable of displaying the status of points that have been overridden by a field HAND switch, for points that have been designed to provide a field HAND override capability.
  - k. Ability to create dashboard views that graphically display system and/ or energy performance. Dashboards will consist of gauges and charts.
15. Reports shall be generated on demand or via pre-defined schedule. As a minimum, the system shall allow the user to easily obtain the following types of reports:
  - a. A general listing of all or selected points in the network
  - b. List of all points currently in alarm
  - c. List of all points currently in override status
  - d. List of all disabled points
  - e. System diagnostic reports including, list of Building panels on line and communicating, status of all Building terminal unit device points
  - f. List of alarm strategy definitions
  - g. List of Building Control panels
  - h. Point tantalization report
  - i. Point Trend data listings
  - j. Initial Values report
  - k. User activity report
  - l. Event history reports
16. Scheduling and Override:
  - a. Provide a calendar type format for simplification of time and date scheduling and overrides of building operations. Schedule definitions reside in the PC workstation and in the Building Controller to ensure time equipment scheduling when PC is off-line, PC is not required to execute time scheduling. Provide override access through menu selection, graphical mouse action or function key. Provide the following capabilities as a minimum:

- 1) Fully support all BACnet Schedule, Calendar, and Command objects.
  - 2) Daily and Weekly schedules
  - 3) Ability to combine multiple points into a logical Command Groups for ease of scheduling (e.g., Building 1 lights)
  - 4) Schedule predefined reports.
  - 5) Ability to schedule for a minimum of up to ten (10) years in advance.
- b. Additionally, the scheduling application shall:
- 1) Provide filtering capabilities of schedules, based on name, time, frequency, and schedule.
  - 2) Provide sorting capabilities of schedules, based on name, time and type of schedule.
17. Collection and Analysis of Historical Data
- a. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or change of value, both of which shall be user-definable. Trend data shall be collected and stored on hard disk for future diagnostics and reporting. Automatic Trend collection may be scheduled at regular intervals through the same scheduling interface as used for scheduling of equipment. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
  - b. System shall support trending in the same device as the monitor point or in an external device.
  - c. Panels shall have a trending level above which the data will be automatically uploaded to the BMS server to prevent overwriting the data in the field panel. The trending level will be user defined in % of available space (e.g., automatically upload when the trend buffer is at 75% of allocated space).
  - d. Trend data reports shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or predefined groups of selected points.
  - e. Provide additional functionality that allows the user to view real-time trend data on trend graphical plot displays. A minimum of ten points may be plotted, of either real-time or historical data. The dynamic graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the display and take "snapshots" of plot screens to be stored on the workstation disk for future recall and analysis. Exact point values may be viewed and the graphs may be printed. A minimum of ten (10) dynamic graphs shall run simultaneously. Operator shall be able to command points by selecting them on the trend plot. Operator shall be able to zoom in on a specific time range within a plot.
18. Dynamic Color Graphic Displays:
- a. Capability to create color graphic floor plan displays and system schematics for each piece of mechanical equipment, including, but not

- limited to, air handling units, chilled water systems, hot water boiler systems, and room level terminal units.
- b. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, point alarm association, or graphics software shall permit the importing of AutoCAD or scanned pictures for use in the system.
  - c. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations within the system schematics or graphic floor plan displays, and shall automatically update to represent current conditions without operator intervention and without pre-defined screen refresh rates.
    - 1) Provide the user the ability to display real-time point values by animated motion or custom picture control visual representation. Animation shall depict movement of mechanical equipment, or air or fluid flow. Provide users the ability to depict various positions in relation to assigned point values or ranges. A library (set) of animated symbols shall be included within the operator interface software's graphics application. Animation shall reflect, ON or OFF conditions, and shall also be optionally configurable for animation speed.
    - 2) Ability to add custom gauges and charts to graphic pages.
    - 3) Equipment state or values can be changed by clicking on the associated point block or graphic symbol and selecting the new state (on/off) or set point.
    - 4) State text for digital points can be user-defined.
  - d. Colors or other visual changes shall be available to indicate status and change as the status of the equipment changes. The state colors shall be user definable.
  - e. The Windows environment of the PC operator workstation shall allow the user to simultaneously view several applications at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.
  - f. All required software shall be provided to allow the user to add, modify or delete system graphic background displays.
  - g. A clipart library of HVAC application and automation symbols shall be provided including fans, valves, motors, chillers, AHU systems, standard ductwork diagrams and laboratory symbols. The user shall have the ability to add custom symbols to the clipart library. The clipart library shall include a minimum of 400 application symbols. In addition, a library consisting of a minimum of at least 100 graphic background templates shall be provided.
  - h. The graphics application shall include a set of standard terminal equipment controller application-specific background graphic templates. Templates shall provide the automatic display of a selected terminal equipment controller's control values and parameters, without the need to create separate and individual graphic files for each controller.
  - i. The graphics application shall be capable of automatically assigning the appropriate symbol for an object (point) selected to be displayed on the graphic based on what the object represents (fan, duct sensor, damper, etc.).

19. The Web-server application shall provide mass change functionality to allow the user to issue a single command to be applied to a selected group of points. User selection capability shall be applied to the following types of groups, at a minimum:
- a. Command the current value of a selected group of a point or points of the same type.
  - b. Command the current value of a selected group of scheduling zones.
  - c. Set or release operator override status for a group of points.
  - d. System configuration and definition:
    - 1) The system shall be fully configurable from clients running in a browser, installed client console, or Windows desktop app.
    - 2) Users must be able to build multiple, separate, personalized hierarchical “tree” views that represent the workstation, control systems, geographical facility layouts, and mechanical equipment relationships.
    - 3) Network wide control strategies shall not be restricted to a single Building Controller, but shall be able to include data from any and all other network panels to allow the development of Global control strategies.
    - 4) Provide automatic backup and restore of all Building Controller databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation is on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate Building Controller. Changes made at the user-interface of Building Controllers shall be automatically uploaded to the workstation, ensuring system continuity.
    - 5) System configuration, programming, editing, graphics generation shall be performed on-line from the operator workstation software.
    - 6) User shall be able to edit point configuration online within a dedicated editor application. The editor shall allow the user to create, view existing, modify, copy, and delete points from the database.
    - 7) User shall be able to edit point configuration of any configurable BACnet point that resides in a devices that supports external editing.
    - 8) The software shall also allow the user to configure the alarm management strategy for each point. The editor shall provide the ability for editing the point database directly online with the Building Controllers.
    - 9) The operator interface software shall also provide the capability to perform bulk modification of point definition attributes to a single or multiple user-selected points.
    - 10) Control program configuration shall be available to the user within a dedicated control program editor application. The editor shall allow for creation, modification and deletion of control programs. The editor shall also include the ability to automatically compile the program to ensure its compatibility with the Building Controllers. The editor shall provide the ability

to selectively enable or disable the live program execution within the Building Controllers.

- 11) Users shall have the ability to view the program(s) that is\are currently running in a Building Controller. The display shall mark the program lines with the following: disabled, comment, unresolved, and trace bits.

e. Event Management:

- 1) Event Routing shall allow the user to send event notification to selected printers or workstation location(s) based on event severity, or point type.
- 2) Event Notification shall be presented to each workstation in a tabular format application, and shall include the following information for each event: name, value, event time and date, event status, priority, acknowledgement information, and alarm count. Each event shall have the ability to sound an audible notification based on the category of the event.
- 3) Event List shall have the ability to list and sort the events based on event status, point name, ascending or descending activation time.
- 4) Directly from the Event List, the user shall have the ability to acknowledge, silence the event sound, print, or erase each event. The interface shall also have the option to inhibit the erasing of active acknowledged events, until they have returned to normal status. The user shall also have the ability to navigate to all information related to a selected point in order to command, launch an associated graphic or trended graphical plot, or run a report on a selected point directly from the Event List.
- 5) Each event shall have a direct link from the Event List to further user-defined point informational data. The user shall have the ability to also associate real-time electronic annotations or notes to each event.

## 2.9 BUILDING AUTOMATION

- A. Refer to Division 15 Section 15905 "Instrumentation and Control for HVAC."
- B. All equipment controlled by these HVAC sub-systems shall be able to be controlled from the central workstation(s), through the graphic display panels, subject to the user's security level.
- C. The Building Automation System (BAS) shall be capable of being integrated into the IBMS.
  1. The system shall provide native BACnet IP communications to the BAS Server.
  2. The system shall not be limited to only standard protocols, but shall also be able to integrate to a wide variety of third-party devices and applications via drivers and gateways.
- D. The Building Automation System shall be based upon the Siemens APOGEE System.
- E. All BAS networked control products provided shall be comprised of an industry standard open protocol internetwork.

- F. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution.
- G. The operator interface application software shall be through Graphical User Interface (GUI). The GUI shall provide a completely interactive user interface.
- H. A full capability software user license shall be provided to the owner for the operator to be able to see, modify, create, upload, download, and save control programs to the BAS controllers.
- I. All necessary BAS hardware for a complete operating system shall be required.
  - 1. Provide all relays, switches, sources of emergency and UPS battery back-up electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.
- J. The BAS Contractor shall prepare and submit for approval a complete acceptance test procedure including submittal data relevant to point index, functions, sequence, interlocks, and associated parameters, and other pertinent information for the operating system. Prior to acceptance of the BAS by the Owner and Engineer, the BAS contractor shall completely test the BAS using the approved test procedure.
- K. When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty
- L. Refer to Building Automation System – Section 15905 for complete specifications.

## 2.10 FIRE ALARM SYSTEM

- A. Refer to Division 16 Section 16920 Intelligent and Addressable Fire Alarm System.
- B. The fire alarm system shall be capable of being integrated into the IBMS.
- C. The system shall monitor and control all alarm points from the building fire alarm system, and provide secondary annunciation to the central workstations.
- D. Fire alarms shall take priority over other alarms in the system, and at the central workstation.
- E. The fire alarm control unit shall be intelligent device addressable, analog detecting, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards. The features and capacities described in the complete 15920 specification are required as a minimum and shall be furnished by the successful contractor.
- F. The fire alarm system shall be in full compliance with National and Local Codes.
- G. The system shall include all required hardware, raceways, interconnecting wiring and software to accomplish the requirements of this specification and the contract drawings, whether or not specifically itemized herein.
- H. All equipment furnished shall be new and the latest state-of-the-art products of a single manufacturer, engaged in the manufacturing and sale of analog fire detection devices for over ten years.
- I. The system as specified shall be supplied, installed, tested and approved by the local authority having jurisdiction, and turned over to the owner in an operational condition.

- J. The system specified shall be that Fire Safety which meets the project requirements.
- K. The system shall be listed by UL for configuration as an approved release system for deluge or pre-action sprinkler systems and clean agent fire extinguishing systems.
- L. General Performance: Comply with NFPA 72 and all contract documents and specification requirements.
  - 1. The system shall operate in the alarm mode upon actuation of any alarm initiating device. The system shall remain in the alarm mode until all initiating device(s) are reset and the fire alarm control panel is manually reset and restored to normal.
  - 2. All interconnections between this system and the monitoring system shall be arranged so that the entire system can be UL certificated.
  - 3. The system shall be capable of remote monitoring via Desigo™ View, a proprietary software system that provides a graphical representation of the fire alarm control panel at a remote PC when connected via Ethernet to the system.
  - 4. The system shall be capable of being configured via a PC tool.
  - 5. The system shall provide a field test function where one person can test the complete system or a specific area while maintaining full operational function of other areas not being tested.
  - 6. Activation of any system fire, security, supervisory, trouble, or status initiating device shall cause the following actions and indications at all network person machine interfaces using an LCD display with multiple detail screens.
- M. Supplier Qualifications:
  - 1. The manufacturer of the supplied products must utilize multi-channel product distribution on a national basis to be considered for this bid. The manufacturer must have factory branches as well as independent distributors to allow the end user with the ability to utilize factory trained and authorized competitive service providers after system installation and commissioning.
  - 2. Provide the services of a factory trained and certified representative or technician, experienced in the installation and operation of the type of system provided. The representative shall be licensed in the State if required by law.
  - 3. The technician shall supervise installation, software documentation, adjustment, preliminary testing, final testing and certification of the system. The technician shall provide the required instruction to the owner's personnel in the system operation and maintenance.
  - 4. The suppliers shall furnish evidence they have an experienced service organization, which carries a stock of spare and repair parts for the system being furnished.
  - 5. The equipment supplier shall be authorized and trained by the manufacturer to calculate, design, install, test, and maintain the air sampling system and shall be able to produce a certificate stating such upon request.
- N. Installer Qualifications:
  - 1. Before commencing work, submit data showing that the manufacturer has successfully installed fire alarm systems of the same scope, type and design as specified.
  - 2. The contractor shall employ on staff a minimum of one NICET Level II technician or a professional engineer, registered in the State of the installation.



3. Contractors unable to comply with the provisions of Qualification of Installers shall present proof of engaging the services of a subcontractor qualified to furnish the required services.
- O. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- P. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- Q. Preliminary Testing: Preliminary tests shall be conducted to ensure that all devices and circuits are functioning properly. After preliminary testing is complete, a letter shall be provided certifying that the installation is complete and fully operable. The letter shall state that each initiating and indicating device was tested in place and functioned properly. The letter shall also state that all panel functions were tested and operated properly. The Contractor and an authorized representative from each supplier of equipment shall be in attendance at the preliminary testing to make necessary adjustments.
- R. Final Acceptance Test: The owner shall be notified in writing when the system is ready for final acceptance testing. Test the system in accordance with the procedures outlined in NFPA 72.
- S. Refer to Fire Alarm System – Section 16910 for complete specifications.

## 2.11 SECURITY

- A. Refer to Division 16 Section 16910, Access Control and Database Management Systems.
- B. All access control alarms shall be reported to the central workstation(s), through the graphic display panels, subject to the user's security level.
- C. Coupled with closed circuit TV, any access alarms shall automatically display the appropriate camera view of the alarm at the central workstation.
- D. The integrated Access Control System's (ACS) primary function shall be to regulate access through specific doors, gates or barriers to secured areas of the facility. It shall also have the provision of capturing cardholder images and producing access cards used to provide this access.
- E. The ACS shall be designed, installed, commissioned and serviced by manufacturer employed, factory trained personnel.
- F. All materials supplied by the Security Contractor shall be new and shall comply with the latest published specifications and recommendations of the manufacturer in all respects unless otherwise indicated. The Security Contractor shall supply the latest model available for all equipment items. Unless otherwise indicated in the specification, all electronic equipment shall be a standard, unmodified production model.
- G. The system will only permit authorized operators, who have been given permissions to log on to the ACS at a workstation, to administer aspects of the system.
- H. The system shall support a graphics module that allows the design, import and construction of site plans, drawings, dynamic symbols, alarm instructions and card templates. This graphics module shall support the standard ACS partitioning, to prevent

those System Operators without the appropriately assigned privileges from accessing graphical objects.

- I. The PACS shall allow intrusion system functionality:
  - Automatic system arming and disarming
  - Independent securing/disarming discrete areas within a site
  - Graphical depictions of areas and their status on site plans
  - Configurable entry and exit timers to allow passage before alarm activation
  - Cardholder-specific privileges on alarm points that cannot be secured
  - Perimeter arming of an area
  - Support for the intrusion arming terminal
- J. The system shall be fully upgradeable, with the possibility of upgrading software and hardware components at minimum cost.
- K. Each ACS shall be designed so that they can be easily added to an expanding facility and communicate with the ACS using the same communications channels as any existing ACS.
- L. Refer to Access Control, Security and CCTV – Section 16910 for complete specifications.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. The IBMS supplier shall furnish on-the-job supervision for the proper installation of devices in cooperation with, or as may be required by, other trades. This supervision shall include the following:
  - 1. Provide specific on-site instructions to others on mounting and installation to assure that the installer is properly instructed in the work.
  - 2. Provide supervision as required by others to properly perform installation work.
  - 3. Install, test, trouble-shoot and correct all system software provided under this specification.
- B. The Contractor shall furnish all material and labor to provide a complete and functional system, which operates in accordance with the requirements of this specification.
- C. Pay for and obtain all permits, approvals, fees and charges required for this work.

#### **3.2 INSTALLERS**

- A. The IBMS supplier shall furnish on-the-job supervision for the proper installation of devices in cooperation with, or as may be required by, other trades.

#### **3.3 PRODUCT SUPPORT AND SERVICE**

- A. Manufacturer shall have an in-place support facility within 70 miles of the site with technical staff, spare parts inventory and necessary test and diagnostics equipment. Provide 800 number accesses to 24-hour support center, staffed with factory-trained personnel to assist in trouble shooting and problem resolution.

3.4 COORDINATION

- A. Provide a designated project manager who shall be responsible for the following:
  - 1. Construct and maintain project schedule.
  - 2. On-site coordination with all applicable trades and subcontractors.
  - 3. Authorized to accept and execute order and instructions from Owner/Architect
  - 4. Single point of contact.
- B. Site and Schedule Coordination:
  - 1. Contractor shall assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
  - 2. Contractor shall coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
  - 3. Contractor shall integrate all facets of the integrated systems installation into the project construction schedule.
  - 4. Contractor shall coordinate schedule updates and changes with the various integration manufacturers.

3.5 COMMISSIONING

- A. Upon completion of the installation, the Contractor shall start up the system and perform all necessary calibration, testing, and debugging operations.
- B. Verify that all hardware components are installed, connected, communicating, and operating properly.
- C. Verify that all systems are operable from local controls in the specified failure mode upon panel failure or loss of power. These procedures shall apply to all gateways to other systems, including fire alarm/life safety.
- D. Verify that all system software is installed, configures, and complies with specified functional requirements.
- E. Perform final acceptance testing in the presence of the Owner's Representative, and Engineer executing a point by point inspection against a documented test plan that demonstrates compliance with system requirement as designed and specified.
- F. Submit documented test plan to Owner and Engineer for their review at least ten (10) days prior to the acceptance test, inspection and check-off.
- G. Conduct final acceptance testing in the presence of the Owner's Representative, and Engineer, verifying that each device point, and sequence is operating properly and reporting to the control panel and control center.
- H. Acceptance test is contingent on successful completion of check-off. If check-off is not completed due to additional work required, the test shall be rescheduled and another complete check-off shall be conducted until complete in one pass, unless portions of the system can be verified as not adversely affected by additional work.
- I. System shall not be considered accepted until all acceptable test items have been successfully checked off and accepted in writing. Beneficial use of part or all of the system shall not be considered as acceptance of the system.

3.6 TRAINING

- A. Provide training of the building's personnel in the proper operation procedures. The O&M manuals shall be used and referenced as part of the training program.
- B. The Division 25 Contractor shall provide 24 hours of instruction to the Owner's designated personnel on the operation of the IBMS. Operator training shall include, but not limited to; the overall operation program, equipment functions (both individually and as part of the total integrated system), commands, systems generation, advisories, and appropriate operator intervention required in responding to the system's operation.
- C. The training shall be in two sessions as follows:
  - 1. Initial Training: One day session (8 hours) after the system is started up and at least one week before the acceptance test.
  - 2. Follow-up Training: Two days (16 hours) after the system has been accepted. These sessions shall deal with more advanced topics as requested by the Owner, such as how to add additional points, create and gather data for trends.
- D. Training shall cover all operating features of the system, including the following:
  - 1. System set-up and cardholder database configuration.
  - 2. Access control features.
  - 3. Alarm monitoring features.
  - 4. Report generation and searches.
  - 5. Card management.
  - 6. Disk backup procedures.
  - 7. Routine maintenance and adjustment procedures.
- E. The Contractor shall provide on digital video disk (DVD) a digital media recording of the complete training session.

END OF SECTION

## SECTION 15911 - VARIABLE SPEED MOTOR DRIVES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES:

- A. Variable Speed Motor Drives
  - 1. Adjustable Frequency Drive
  - 2. Adjustable Frequency Drive Bypass
  - 3. Hydronic Pumps.

#### 1.2 REFERENCES

- A. ANSI - American National Standards Institute
- B. NEMA - National Electrical Manufacturers Association
- C. UL - Underwriters Laboratories. Inc.
- D. ETL - Electrical Testing Laboratories
- E. NEC - National Electrical Code
- F. ISO - International Standards Organization
- G. IEC - International Electrotechnical Commission

#### 1.3 SUBMITTALS

- A. Submittals shall include the following:
  - 1. System summary sheet
  - 2. Sequence of operation
  - 3. Shop drawing indicating dimensions, required clearances and location and size of each field connection
  - 4. Power and control wiring diagrams
  - 5. System profile analysis including variable speed pump curves and system curve. The analysis shall also include pump, motor and AFD efficiencies, job specific load profile, staging points, horsepower and kilowatt/hour consumption.
- B. Submittals must be specific to this project. Generic submittals will not be accepted.

#### 1.4 QUALITY ASSURANCE

- A. Existing Belt Driven Supply Air and Return air motors for the two air handlers will now be driven with variable speed drives specified in this section.
- B. The manufacturer shall be fully certified by the International Standards Organization per ISO 9001. Proof of this certification shall be furnished at time of submittal.
- C. The manufacturer shall carry a minimum product liability insurance of \$5,000,000.00 per occurrence.

- D. Manufacturer shall be listed by Underwriter's Laboratories as a manufacturer of packaged pumping systems.
- E. Bidders shall comply with all sections of this specification relating to packaged pumping systems. Any deviations from this specification shall be bid as a voluntary alternate clearly defined in writing. If no exceptions are noted, the supplier or contractor shall be bound by these specifications.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Subject to compliance with these specifications, the following manufacturers shall be acceptable:
  - 1. ABB
  - 2. Hitachi
  - 3. Vector
  - 4. Graham
  - 5. Allen Bradley
  - 6. Hyundai
  - 7. Approved Equal

### 2.2 MANUFACTURED UNITS

- A. The control system shall include as, a minimum, the programmable logic controller, adjustable frequency drive(s) and remote sensor/transmitters as indicated on the plans. Provide additional items as specified or as required to properly execute the sequence of operation.
- B. The variable speed pump adjustable frequency drive(s) and AFD bypass circuitry shall be mounted in a unit mounted, NEMA3R enclosure. Unit shall be pre-wired at the factory to permit a single point incoming power connection. Contractor shall make internal wiring changes to the units to supply power to motors from VFD Drives.
- C. The control cabinet shall be designed and fabricated in compliance with construction code 508 of Underwriters Laboratories, Inc. The entire cabinet shall be listed by and bear the ETL label.
- D. A door interlocked disconnect switch shall be provided for each adjustable frequency drive.

### 2.3 COMPONENTS

- A. Adjustable Frequency Drive
  - 1. The adjustable frequency drive(s) shall be pulse width modulation (PWM) type, microprocessor controlled design. Unit shall be the VLT 6000 Series manufactured by Graham Company.
  - 2. The AFD, including all factory installed options, be tested to UL Standard 508. The AFD shall also meet C-UL and be CE marked and built to ISO 9001 standards.
  - 3. The VFD shall be housed in a NEMA 1 enclosure. AFDs with plastic enclosures shall not be acceptable.

4. The VFD shall employ an advanced sine wave approximation and voltage vector control to allow operation at rated motor shaft output speed with no de-rating. This voltage vector control shall minimize harmonics to the motor to increase motor efficiency and life. Power factor shall be near unity regardless of speed or load.
5. The VFD shall have balanced DC link reactors to minimize power line harmonics. VFDs without a DC link reactor shall provide a 3% impedance line reactor.
6. Automatic motor adaptation (AMA) algorithm shall be utilized. This feature shall allow for automatically optimized drive performance and efficiency leading to additional energy savings .
7. Input and output power circuit switching can be done without interlocks or damage to the VFD.
8. The following customer modifiable adjustments shall be provided:
  - a. Accel time
  - b. Decel time
  - c. Minimum frequency
  - d. Maximum frequency
9. The AFD shall be capable of displaying the following information in plain English via a 40 character alphanumeric display:
  - a. Frequency
  - b. Voltage
  - c. Current
  - d. Kilowatts per hour
  - e. Fault identification
  - f. Percent torque
  - g. Percent power
  - h. RPM
10. All AFDs shall be warranted for a period of 18 months after shipment. This warranty shall cover parts and labor.

B. Automatic AFD Bypass

1. Variable speed pumping system shall be equipped with an automatic bypass.
2. Bypass shall consist of a main power disconnect with ground fault protection, a pair of interlocked contactors and a motor overload relay. All are to be mounted in a NEMA 1 enclosure.
3. Automatic bypass shall operate as described in the sequence of operation.

C. Sensor / Transmitters

1. Provide field mounted differential pressure sensor transmitter(s) as indicated on the plans. Unit shall transmit an isolated 4-20mA dc signal indicative of process variable to the

pump logic controller via standard two wire 24 DC system. It shall be protected against radio frequency interference.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Drives are to coupled with hydronic pumps for the geothermal HVAC System.
- B. Install equipment in accordance with manufacturer's instructions.
- C. Power wiring, as required, shall be the responsibility of the electrical contractor or contractor selected by the Control Contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.
- D. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the controls contractor. All wiring shall be performed per manufacturer's instructions and applicable state, federal and local codes.

#### 3.2 DEMONSTRATION

- A. The system manufacturer or factory trained representative shall provide start-up of the pumping system. This start-up shall include verification of proper installation, system initiation, adjustment and fine tuning. Start-up shall not be considered complete until the sequence of operation, including all alarms, has been sufficiently demonstrated to the owner or owner's designated representative. This jobsite visit shall occur only after all hook-ups, tie-ins, and terminations have been completed and signed-off on the manufacturer's start-up request form.
- B. The system manufacturer or factory trained representative shall provide on-site training for owner's personnel. This training shall fully cover maintenance and operation of all system components.
- C. The system manufacturer must have a complete HVAC training program available for owner's personnel. The training sessions shall take place at the manufacturer's facility and cover all aspects of HVAC system design, service and operation.

END OF SECTION 15911



## **SECTION 15940 – SEQUENCE OF OPERATION**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

**A. Section includes sequence of operation for:**

1. Occupied/unoccupied cycles.
2. Electric Unit Heaters.
3. Geothermal Units, Single Stage.
4. Geothermal Units, Two Stage.
5. Computer Room Heat Pumps.
6. Packaged terminal air conditioners.
7. Energy Recovery Units.
8. Furnace/Heat Pumps.
9. Variable Flow geothermal pumping system.
10. Natural Gas Unit Heaters.
11. Electric domestic water heaters and recirculating pumps.
12. Parking Garage Ventilation System.
13. Monitor Emergency Generator.
14. Monitor Solar Array.

**B. Related Sections:**

1. Division 15 – Direct Digital Controls
2. Division 15 – HVAC Instrumentation: For equipment, devices, and system components to implement sequences of operation

#### **1.2 SUBMITTALS**

**A. Shop Drawings: Indicate the following:**

1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
2. Submit flow diagrams for each control system, graphically depicting control logic.
3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
4. Coordinate submittals with information requested in Section 15-Direct Digital Controls and Instrumentation sections

#### **1.3 CLOSEOUT SUBMITTALS**

- A. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.**

1.4 DEFINITIONS:

- A. IBMS: Integrated Building Management System

**PART 2 SEQUENCE OF OPERATION**

2.1 OCCUPIED AND UNOCCUPIED CYCLES

- A. Units designated to operate at one level while building is occupied and at another level when building is unoccupied shall be noted in the individual Sequence of Operation.

2.2 NATURAL GAS UNIT HEATERS

- A. Single temperature electric room thermostat set at 68 degrees F maintains constant space temperature by cycling unit fan motor.
- B. Units are not to be connected to energy management system.

2.3 ELECTRIC UNIT HEATERS

- A. Integral or remote electric thermostat to control heater.
- B. Units EWH-1 & 2 are not to be connected to the energy management system.
- C. EWH-3 & 4: Provide a relay so that the unit can be shut down by the IBMS.

2.4 GEOTHERMAL UNITS, SINGLE STAGE

- A. Unit shall be controlled by a wall mounted thermostat/sensor which shall automatically select heating or cooling after passing through a 2 F “dead zone.”
- B. Sensor shall be set so that temperature in room shall always be between 70 F and 74 F while unit room is occupied.
- C. Room shall be 8 F cooler in the heating mode and 4 F warmer in the cooling while unoccupied.

2.5 GEOTHERMAL UNITS, TWO STAGE

- A. Unit shall be controlled by a wall mounted thermostat/sensor which shall automatically select heating or cooling after passing through a 2 F “dead zone.”
- B. Sensor shall be set so that temperature in room shall always be between 70 F and 74 F while unit room is occupied.
- C. Room shall be 8 F cooler in the heating mode and 4 F warmer in the cooling while unoccupied.
- D. Sensor, on a rise in temperature more than 2 F above set point shall turn on/off the second cooling stage, and, more than 2 F below heating set point shall turn on/off the 2<sup>nd</sup> stage of heating.

2.6 COMPUTER ROOM HEAT PUMPS

- A. Units shall be controlled by unit mounted thermostat/sensors.

- B. Sensor shall be set so that temperature in room shall always be between 70 F and 72 F.
- C. Room will not change temperatures on an occupied/unoccupied schedule.
- D. Two identical units in the room are redundant so that only one is necessary for room cooling. Sensors shall be set so that the second unit will operate should the primary unit not maintain cooling (If Room reaches 73F.)
- E. A humidifier in the units shall keep humidity at the 40% level.
- F. Units shall be set to alternate each week.

## 2.7 ENERGY RECOVERY UNITS

- A. Supply Fan Control: The supply fan will be started based on occupancy schedule. When the supply fan status indicates the fan started, the control sequence will be enabled. Upon a loss of airflow, the supply fan will automatically restart.
- B. Return/Exhaust Fan Control: After the supply fan has been started, return fan will be started.
- C. Occupied Mode: The occupancy mode will be controlled via a network input.
- D. Unoccupied Mode: The Unit will remain off during unoccupied periods.
- E. Additional Points Monitored By the IBMS:
  - Supply fan status (sf-s)
  - Return fan status (rf-s)

## 2.8 VARIABLE FLOW GEOTHERMAL PUMPING SYSTEM

- A. Secondary Loop Pumping: the lead secondary pump will be started when the system is enabled. Each variable frequency drive will be modulated in unison to maintain loop pressure. Additional pumps will be started as required to maintain the differential pressure in the secondary loop. When an additional pump is required, the pump with the lowest runtime total shall be enabled to run. If the pump status does not match the command, an alarm will be generated and the pump will be stopped. Upon loss of status, the pump will restart after the system reset is activated.

## 2.9 NATURAL GAS FURNACE/HEAT PUMP SPLIT SYSTEMS

- A. The split system shall be controlled by a programmable thermostat furnished with each unit.
- B. The Energy Management System (IBMS) shall monitor operation of each unit.
- C. Outdoor heat pump (Condensing) units shall be capable of load shedding operation.

## 2.10 PARKING GARAGE VENTILATION SYSTEM

- A. Existing rooftop exhaust fans REF-1 through REF-11 shall be controlled by combustible gas detectors within the space.
- B. The Energy Management System (IBMS) shall monitor operation of the fans.

## 2.11 DOMESTIC HOT WATER

- A. Domestic Hot Water Heaters: IBMS shall enable the DHW heaters and monitor supply temperatures.
  - B. The Domestic Hot Water Heaters will maintain supply temperature via their own integral controls.
  - C. Domestic Hot Water Recirculating Pumps: In the occupied mode of operation the IBMS shall activate and monitor operation of the DHW pumps. In the unoccupied the IBMS shall command the pumps to be shut down. .
- 2.12 PACKAGED TERMINAL AIR CONDITIONING UNITS
- A. Integrate to unit manufacturer supplied controls.
- 2.13 TOILET EXHAUST FANS
- A. The IBMS shall control fans to operate during the occupied cycle and shut down in the unoccupied cycle.
- 2.14 EMERGENCY GENERATOR
- A. The Energy Management System shall monitor operation of the generator.
  - B. Capacity of the emergency generator is 350 KW. When the generator is operating the Building Management System (IBMS) shall shed loads if necessary to limit the building load to less than 350 KW.
- 2.15 SOLAR ARRAY
- A. The Energy Management System (IBMS) shall monitor energy collected by the solar array.

END OF SECTION

## **SECTION 15950 - TESTING, ADJUSTING, AND BALANCING**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. Testing adjusting, and balancing of air systems.
  - 2. Testing adjusting, and balancing of hydronic systems.
  - 3. Measurement of final operating condition of HVAC systems.
  
- B. Related Sections:
  - 1. Division 15 - Direct Digital Controls: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
  - 2. Division 15 - Sequence of Operation: Sequences of operation for HVAC equipment.
  - 3. Division 15 – HVAC Commissioning.

#### **1.2 REFERENCES**

- A. Associated Air Balance Council:
  - 1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.
  
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.
  
- C. Natural Environmental Balancing Bureau:
  - 1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

#### **1.3 SUBMITTALS**

- A. Prior to commencing Work, submit proof of latest calibration date of each instrument.
  
- B. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms, forms prepared following ASHRAE 111 and NEBB Report forms.
  
- C. Field Reports: Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
  
- D. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty or and Copy of NEBB Certificate of Conformance Certification.

- E. Submit draft copies of report for review prior to final acceptance of Project.
- F. Furnish reports in soft cover, letter size, 3-ring binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record actual locations of flow measuring stations balancing valves and rough setting.
- B. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance, ASHRAE 111 or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
- B. Prior to commencing Work, calibrate each instrument to be used.

1.6 QUALIFICATIONS

- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years experience [certified by AABC or Certified by NEBB].
- B. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor.

1.7 SEQUENCING

- A. Sequence balancing between completion of systems tested and Date of Substantial Completion.

**PART 2 PRODUCTS**

Not Used.

**PART 3 EXECUTION**

3.1 EXAMINATION

- A. Verify systems are complete and operable before commencing work. Verify the following:

1. Systems are started and operating in safe and normal condition.
2. Temperature control systems are installed complete and operable.
3. Proper thermal overload protection is in place for electrical equipment.
4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
5. Duct systems are clean of debris.
6. Fans are rotating correctly.
7. Air coil fins are cleaned and combed.
8. Access doors are closed and duct end caps are in place.
9. Air outlets are installed and connected.
10. Duct system leakage is minimized.
11. Hydronic systems are flushed, filled, and vented.
12. Pumps are rotating correctly.
13. Proper strainer baskets are clean and in place or in normal position.
14. Service and balancing valves are open.

### 3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

### 3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

### 3.4 ADJUSTING

- A. Verify recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- D. Report defects and deficiencies noted during performance of services, preventing system balance.
- E. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

- F. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- G. Check and adjust systems approximately six months after final acceptance and submit report.

### 3.5 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.

### 3.6 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to obtain design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.



- C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

### 3.7 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
  - 1. Plumbing Pumps (Recirculating).
  - 2. HVAC Pumps, Two.
  - 3. Packaged Terminal Air Conditioning Units.
  - 4. Fans.
  - 5. Air Inlets and Outlets.
  - 6. Vertical and Horizontal Water Source Heat Pumps.
  - 7. Gas Furnace/Heat Pump Hybrid.
  - 8. Heat Pump Outdoor Units.
  - 9. Energy Recovery Units.
  - 10. Gas Unit Heaters.
  - 11. Existing Rooftop Exhaust Fans (REF-1 through 11).
  - 12. Use Ultrasonic Flow Measuring Device to Measure Loops in the Geothermal Heat Exchanger System.
- B. Report Forms
  - 1. Title Page:
    - a. Name of Testing, Adjusting, and Balancing Agency
    - b. Address of Testing, Adjusting, and Balancing Agency
    - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
    - d. Project name
    - e. Project location
    - f. Project Architect
    - g. Project Engineer
    - h. Project Contractor
    - i. Project altitude
    - j. Report date
  - 2. Summary Comments:
    - a. Design versus final performance
    - b. Notable characteristics of system
    - c. Description of systems operation sequence

- d. Summary of outdoor and exhaust flows to indicate building pressurization
- e. Nomenclature used throughout report
- f. Test conditions
- 3. Instrument List:
  - a. Instrument
  - b. Manufacturer
  - c. Model number
  - d. Serial number
  - e. Range
  - f. Calibration date
- 4. Electric Motors:
  - a. Manufacturer
  - b. Model/Frame
  - c. HP/BHP and kW
  - d. Phase, voltage, amperage; nameplate, actual, no load
  - e. RPM
  - f. Service factor
  - g. Starter size, rating, heater elements
  - h. Sheave Make/Size/Bore
- 5. V-Belt Drive:
  - a. Identification/location
  - b. Required driven RPM
  - c. Driven sheave, diameter and RPM
  - d. Belt, size and quantity
  - e. Motor sheave diameter and RPM
  - f. Center to center distance, maximum, minimum, and actual
- 6. Pump Data:
  - a. Identification/number
  - b. Manufacturer
  - c. Size/model
  - d. Impeller
  - e. Service
  - f. Design flow rate, pressure drop, BHP and kW
  - g. Actual flow rate, pressure drop, BHP and kW
  - h. Discharge pressure
  - i. Suction pressure
  - j. Total operating head pressure
  - k. Shut off, discharge and suction pressures
  - l. Shut off, total head pressure
- 7. Water Source Heat Pumps
  - a. Manufacturer
  - b. Identification/number
  - c. Location
  - d. Model number
  - e. Size
  - f. Air flow, design and actual

- g. Water flow, design and actual
  - h. Water pressure drop, design and actual
  - i. Entering water temperature, design and actual
  - j. Leaving water temperature, design and actual
  - k. Entering air temperature, design and actual
  - l. Leaving air temperature, design and actual
8. Energy Recovery Units:
- a. Location
  - b. Manufacturer
  - c. Model number
  - d. Serial number
  - e. Arrangement/Class/Discharge
  - f. Air flow, specified and actual
  - g. Return air flow, specified and actual
  - h. Outside air flow, specified and actual
  - i. Total static pressure (total external), specified and actual
  - j. Inlet pressure
  - k. Discharge pressure
  - l. Sheave Make/Size/Bore
  - m. Number of Belts/Make/Size
  - n. Fan RPM
9. Return Air/Outside Air Data:
- a. Identification/location
  - b. Design air flow
  - c. Actual air flow
  - d. Design return air flow
  - e. Actual return air flow
  - f. Design outside air flow
  - g. Actual outside air flow
  - h. Return air temperature
  - i. Outside air temperature
  - j. Required mixed air temperature
  - k. Actual mixed air temperature
  - l. Design outside/return air ratio
  - m. Actual outside/return air ratio
10. Exhaust Fan Data:
- a. Location
  - b. Manufacturer
  - c. Model number
  - d. Serial number
  - e. Air flow, specified and actual
  - f. Total static pressure (total external), specified and actual
  - g. Inlet pressure
  - h. Discharge pressure
  - i. Sheave Make/Size/Bore
  - j. Number of Belts/Make/Size
  - k. Fan RPM
11. Duct Traverse:

- a. System zone/branch
- b. Duct size
- c. Area
- d. Design velocity
- e. Design air flow
- f. Test velocity
- g. Test air flow
- h. Duct static pressure
- i. Air temperature
- j. Air correction factor

END OF SECTION

## **SECTION 15992 - HVAC COMMISSIONING**

### **PART 1 GENERAL**

#### **1.1 SUMMARY**

- A. Section Includes:
  - 1. HVAC commissioning description.
  - 2. HVAC commissioning responsibilities.

#### **1.2 COMMISSIONING DESCRIPTION**

- A. HVAC commissioning process includes the following tasks:
  - 1. Coordination of testing and startup of HVAC equipment and systems.
  - 2. Equipment and system verification checks.
  - 3. Assistance in functional performance testing to verify testing and balancing, and equipment and system performance.
  - 4. Provide qualified personnel to assist in commissioning tests, including seasonal testing.
  - 5. Complete and endorse functional performance test checklists provided by Commissioning Authority to assure equipment and systems are fully operational and ready for functional performance testing.
  - 6. Provide equipment, materials, and labor necessary to correct deficiencies found during commissioning process to fulfill contract and warranty requirements.
  - 7. Provide operation and maintenance information and record drawings to Commissioning Authority for review verification and organization, prior to distribution.
  - 8. Provide assistance to Commissioning Authority to develop, edit, and document system operation descriptions.
  - 9. Provide training for systems specified in this Section with coordination by Commissioning Authority.
- B. Equipment and Systems to Be Commissioned:
  - 1. Pumps (New).
  - 2. Piping systems (New Construction).
  - 3. Ductwork (New Construction).
  - 4. Variable frequency pump drives.
  - 5. Split system air conditioning units.
  - 6. Packaged terminal air conditioning units.
  - 7. Water source heat pumps.
  - 8. Gas and electric unit heaters.
  - 9. Exhaust Fans.
  - 10. Energy recovery units.
  - 11. Automatic temperature control system.
  - 12. Combustible gas ventilation systems.
  - 13. Testing, Adjusting and Balancing work.
  - 14. Emergency Generator.

1.3 COMMISSIONING SUBMITTALS

- A. Draft Forms: Submit draft of system verification form and functional performance test checklist].
- B. Test Reports: Indicate data on system verification form for each piece of equipment and system as specified. Use AABC forms as guidelines.
- C. Field Reports: Indicate deficiencies preventing completion of equipment or system verification checks equipment or system to achieve specified performance.

1.4 CLOSEOUT SUBMITTALS

- A. Project Record Documents: Record revisions to equipment and system documentation necessitated by commissioning.
- B. Operation and Maintenance Data: Submit revisions to operation and maintenance manuals when necessary revisions are discovered during commissioning.

1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with AABC or NEBB.

1.6 COMMISSIONING RESPONSIBILITIES

- A. Equipment or System Installer Commissioning Responsibilities:
  - 1. Schedule and attend commissioning meetings.
  - 2. Ensure temperature controls installer performs assigned commissioning responsibilities as specified below.
  - 3. Ensure testing, adjusting, and balancing agency performs assigned commissioning responsibilities as specified.
  - 4. Provide instructions and demonstrations for Owner's personnel.
  - 5. Ensure subcontractors perform assigned commissioning responsibilities.
  - 6. Ensure participation of equipment manufacturers in appropriate startup, testing, and training activities when required by individual equipment specifications.
  - 7. Develop startup and initial checkout plan using manufacturer's startup procedures and functional performance checklists for equipment and systems to be commissioned.
  - 8. During verification check and startup process, execute HVAC related portions of checklists for equipment and systems to be commissioned.
  - 9. Perform and document completed startup and system operational checkout procedures, providing copy to Commissioning Authority.
  - 10. Provide manufacturer's representatives to execute starting of equipment. Ensure representatives are available and present during agreed upon schedules and are in attendance for duration to complete tests, adjustments and problem-solving.
  - 11. Coordinate with equipment manufacturers to determine specific requirements to maintain validity of warranties.
  - 12. Provide personnel to assist Commissioning Authority during equipment or system verification checks and functional performance tests.

13. Prior to functional performance tests, review test procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during tests.
  14. Prior to startup, inspect, check, and verify correct and complete installation of equipment and system components for verification checks included in commissioning plan. When deficient or incomplete work is discovered, ensure corrective action is taken and re-check until equipment or system is ready for startup.
  15. Provide factory supervised startup services for HVAC equipment and systems specified in Division 15. Coordinate work with manufacturer and Commissioning Authority.
  16. Perform verification checks and startup on equipment and systems as specified.
  17. Assist Commissioning Authority in performing functional performance tests on equipment and systems as specified.
  18. Perform operation and maintenance training sessions scheduled by Commissioning Authority.
  19. Conduct HVAC system orientation and inspection.
- B. Temperature Controls Installer Commissioning Responsibilities:
1. Attend commissioning meetings.
  2. Review design for ability of systems to be controlled including the following:
    - a. Confirm proper hardware requirements exists to perform functional performance testing.
    - b. Confirm proper safeties and interlocks are included in design.
    - c. Confirm proper sizing of system control valves and actuators and control valve operation will result capacity control identified in Contract Documents.
    - d. Confirm proper sizing of system control dampers and actuators and damper operation will result in proper damper positioning.
    - e. Confirm sensors selected are within device ranges.
    - f. Review sequences of operation and obtain clarification from Architect/Engineer.
    - g. Indicate delineation of control between packaged controls and building automation system, listing BAS monitor points and BAS adjustable control points.
    - h. Provide written sequences of operation for packaged controlled equipment. Equipment manufacturers' stock sequences may be included, when accompanied by additional narrative to reflect Project conditions.
  3. Inspect, check, and confirm proper operation and performance of control hardware and software provided in other HVAC sections.
  4. Submit proposed procedures for performing automatic temperature control system point-to-point checks to Commissioning Authority and Architect/Engineer.
  5. Inspect check and confirm correct installation and operation of automatic temperature control system input and output device operation through point-to-point checks.

6. Perform training sessions to instruct Owner's personnel in hardware operation, software operation, programming, and application in accordance with commissioning plan and requirements of Division 15.
7. Demonstrate system performance and operation to Commissioning Authority during functional performance tests including each mode of operation.
8. Provide control system technician to assist during Commissioning Authority verification check and functional performance testing.
9. Provide control system technician to assist testing, adjusting, and balancing agency during performance of testing, adjusting, and balancing work.
10. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

C. Testing, Adjusting, and Balancing Agency Commissioning Responsibilities:

1. Attend commissioning meetings.
2. Participate in verification of testing, adjusting, and balancing report for verification or diagnostic purposes. Repeat sample of 10 percent of measurements contained in testing, adjusting, and balancing report as indicated in commissioning plan or as selected by Commissioning Authority.
3. Assist in performing operation and maintenance training sessions scheduled by Commissioning Authority.

1.7 COMMISSIONING MEETINGS

- A. Attend initial commissioning meeting and progress commissioning meetings as required by Commissioning Authority.

1.8 SCHEDULING

- A. Prepare schedule indicating anticipated start dates for the following:
1. Piping system pressure testing.
  2. Piping system flushing and cleaning.
  3. Equipment and system startups.
  4. Automatic temperature control system checkout.
  5. Testing, adjusting, and balancing.
  6. HVAC system orientation and inspections.
  7. Operation and maintenance manual submittals.
  8. Training sessions.
- B. Schedule occupancy sensitive tests of equipment and systems during conditions of both minimum and maximum occupancy or use.

1.9 COORDINATION

- A. Notify Commissioning Authority minimum of four weeks in advance of the following:
1. Scheduled equipment and system startups.
  2. Scheduled automatic temperature control system checkout.
  3. Scheduled start of testing, adjusting, and balancing work.



- B. Coordinate programming of automatic temperature control system with construction and commissioning schedules.

## **PART 2 PRODUCTS**

Not Used.

## **PART 3 EXECUTION**

### **3.1 INSTALLATION**

- A. Install additional balancing dampers, balancing valves, access doors, test ports, and pressure and temperature taps required by Commissioning Authority.
- B. Place HVAC systems and equipment into full operation and continue operation during each working day of commissioning.
- C. Install replacement sheaves and belts to obtain system performance, as requested by Commissioning Authority.
- D. Install test holes in ductwork and plenums as requested by Commissioning Authority for taking air measurements.
- E. Prior to start of functional performance test, install replacement filters in equipment.

### **3.2 COMMISSIONING**

- A. Seasonal Sensitive Functional Performance Tests:
  - 1. Test heating equipment at winter design temperatures.
  - 2. Test cooling equipment at summer design temperatures with fully occupied building.
  - 3. Participate in testing delayed beyond Final Completion to test performance at peak seasonal conditions.
- B. Be responsible to participate in initial and alternate peak season test of systems required to demonstrate performance.

END OF SECTION