DIVISION 23 - MECHANICAL
SECTION 23 00 00 - GENERAL MECHANICAL

PART 1.00 GENERAL CONDITIONS

1.01 WORK INCLUDED

A. The general conditions of the general specifications are made a part of these specifications and apply the same as if attached hereto. The contractor should, before bidding, read and thoroughly understand all general conditions, priority and scheduling.

1.02 SCOPE OF WORK

A. This section calls for the furnishing of labor, materials, equipment, and all the services, and of performing all operations required for the complete mechanical systems as hereinafter specified and/or shown on the accompanying drawings.

1.03 GENERAL REQUIREMENTS

A. Contractor shall install his work to meet the existing conditions as found at buildings and property, and to accommodate work of other trades. This contractor shall be responsible for timely placing of sleeves in forms before concrete is poured. Cooperate with the general contractor and place pipes and ducts in floors, walls, furred spaces, etc., so there will be no delay. Sheet metal or iron pipe sleeves shall be provided for pipes passing through floors, wall or partitions.

B. Contractor shall furnish and properly install materials, devices, equipment, insulation, controls, appurtenances, etc., mentioned in these specifications and/or shown on plans or required to make a complete and satisfactory installation in working order whether fully shown or not.

C. Contractor should visit the site and acquaint himself thoroughly with conditions governing installation of his work.

D. All other plans shall be checked in relation to these plans so that all conditions will be furnished and installed in this contract to provide complete and satisfactory systems.

1.04 LAWS, RULES, REGULATIONS, FEES, ETC.

A. The entire mechanical work shall comply with rules and regulations of the local and state authorities having jurisdiction including the State Fire Marshal and the State Board of Health. All modifications required by the said authorities at any time shall be made by the mechanical contractor without additional charge. In cases where alterations to or deviations from this specification and accompanying plans are required by the authorities, contractor shall report same to the Engineer and obtain his approval before work is started.

1.05 DRAWINGS

A. Plans and detail sketches are submitted to limit, explain, and define structural conditions,

specified requirements, pipe sizes, and manner of erecting work. Structural or other conditions may require certain deviations from manner of installation shown, and such deviations shall be made as required, but specified sizes and requirements necessary for satisfactory operation shall remain unchanged.

B. It may be necessary to shift or to change routing of ducts and or piping and this shall be done, but such changes must be referred to Architect for approval before proceeding. Extra charges will not be allowed for these changes.

C. Typical details are shown on plans, and in any cases where Contractor is not certain about the method of installation of this work, he shall ask for details, lack of details will not be an excuse for improper installation.

D. Contractor bidding on this portion of the work must be fully experienced in installations of equal size, complexity and quality. In bidding, he acknowledges that he fully understands the scope of the work and design and has the ability, for the contract price to assemble and install the equipment, piping, and ductwork shown or specified, so as to mold same into a satisfactory workable system and arrangement, without responsibility for capacities and sizes set by these documents.

E. Contractor shall recognize that the amount of information and detail that could be provided in Contract Documents is limitless and could extend into every minute detail, step, sequence, and operation to a point where only workmen would be required, without drawing on ability experience, and ingenuity of the Contractor.

1.06 MATERIALS

A. Where directed by the Architect, Contractor shall submit sample for approval before proceeding.

1.07 STANDARDS

A. In general, standards for products and workmanship shall be as described in each individual section.

B. The standards referred to, except as modified in these specifications shall have full force and effect as though printed in these specifications. These standards are not furnished to bidders for the reason that the manufacturers and trades involved are assumed to be familiar with their requirements. The Engineer will furnish, upon request, information as to how copies of the standards referred to may be obtained.

C. Notwithstanding any reference in this section of the specifications to any article, device, product, material, fixture, form or type of construction by name, make or catalogue number, such references shall be interpreted as establishing a standard of quality and shall not be construed limiting competition and the Contractor in such cases, may at his option, use any article, device, product, material, fixture, form or type of construction which in the judgment of the Architect, expressed in writing, is equal to that specified.

1.08 MATERIALS SPECIFIED OR SUBSTITUTED (Prior Approvals)

A. Refer to Instructions to Bidders.

1.09 SHOP DRAWINGS

A. Before proceeding with the work, contractor shall make complete shop and working drawings of such apparatus or connections as directed by the Architect and/or hereinafter specified. These drawings shall show construction details and dimensions of each piece of equipment so drawn.

B. Engineer approval of shop drawings shall not relieve the Contractor from responsibility of incorrectly figured dimensions or any other errors in these drawings or specified even though approved by the Architect, shall not relieve this Contractor from furnishing and erecting same.

C. Ten (10) sets of prints of shop drawings shall be submitted to Engineer for approval. These prints shall be supplied as part of this contract. Submit all shop drawings at the same time or as soon as practical after award of the contract. No separate items will be accepted.

D. Where laws or local regulations provide that certain accessories such as gauges, thermometers, relief valves and parts be installed on equipment, it shall be understood that such accessories shall be furnished if no specific reference to them is made in the specifications.

1.10 CUTTING AND PATCHING

A. All cutting necessary for this work will be done by this Contractor at his own expense, but all patching shall be done by the General Contractor. No beams or joists shall be cut without prior approval of the Engineer. After initial resurfacing has been done any further cutting, patching or painting shall be done at the expense of this Contractor.

1.11 INTERFERENCES

A. The drawings are generally diagrammatic and this Contractor shall harmonize his work with that of the different trades so that interferences of the different equipment, piping, etc., shall be installed so as to function properly. In the case where interference develops, the Architect is to state which equipment, piping, etc., is to be relocated regardless of which item was first installed.

1.12 EXCAVATION AND BACKFILL

A. This Contractor shall do all excavating required to lay the specified services and after same have been laid, he shall do all backfilling to the satisfaction of all parties concerned and shall cart away from the premises all unnecessary dirt, rubbish, etc., as directed. Backfill shall be well tamped. All backfill shall be done according to the "Compaction And Backfill" section of these specifications.

1.13 SPACE REQUIREMENTS

A. Contractor shall check all plans pertaining to this job so as to be fully aware of the space limitations for all various items of equipment. Equipment is not to be bid on, submitted for preliminary approval nor placed on the job if it is so bulky and large that adequate access for proper maintenance and servicing cannot be achieved in the space provided.

1.14 FOUNDATIONS AND SUPPORTS

A. This contractor shall furnish and install foundations and supports of concrete or steel shapes for equipment requiring same, unless specifically indicated otherwise or specified.

B. All floor mounted mechanical equipment shall be mounted on 4" high concrete housekeeping pad unless specifically shown otherwise on plans. Refer to plans for special requirements for foundations and supports.

1.15 HANGERS, ESCUTCHEONS, ETC.

A. See Section 23 05 29 – Supports and Anchors.

B. Mechanical Contractor shall furnish and install all thimbles, inserts and other requirements necessary for the support of his equipment and piping. Assist and cooperate with other trades in locating and placing these items.

1.16 CEILING AND WALL ACCESS PANEL

A. Factory made access doors and frames, prime coat finish, screw driver latch(s) of suitable size as required.

B. Access panels in rated ceiling to have same rating as ceiling.

C. Where valves, dampers, controls, fire dampers, smoke dampers, and detectors, reheat coils, etc. are concealed in walls or non-accessible ceilings, install factory made access doors and frames.

1.17 DUCTWORK ACCESS PANELS

A. Access panels in ductwork to be double wall type with insulation sandwiched in between, same insulation value as adjacent ductwork.

1.18 SIPHON PREVENTERS

A. Furnish and install approved type siphon preventors on all equipment and fixtures in such a manner as to prevent water being siphoned back into the water supply in the event the water supply is shut off.

1.19 FLAME SPREAD PROPERTIES OF MATERIALS

A. All materials and adhesives used for acoustical linings, jackets and insulation shall comply

with requirements of NFPA 90A and 90B and UL guide # 40V.8.15. Products exceeding a flame spread rating of 25, or a smoke developed rating of 50, as determined by ASTM Test Method E-84 are prohibited. Adhesives and sealers shall be fire retardant and fire resistant when dry. Flame proofing treatments which are subject to decomposition, deterioration, or the effects of moisture are prohibited.

1.20 DOMESTIC AND FIRE WATER TIE-IN

A. Contractor shall provide any necessary meters and tap fees for domestic or fire water tie-ins to utility companies. All domestic and fire water taps shall have aboveground reduced pressure back flow preventors near the tie-in point. Coordinate with Engineer exact location.

B. All backflow preventors shall be heat traced and insulated with 1-1/2" fiberglass insulation with water tight aluminum jacket.

1.21 PROTECTION OF EQUIPMENT

A. See individual sections for protection of equipment.

B. This Contractor shall at all times take such precautions as may be necessary to properly protect his equipment from damage. Failure on the part of the Contractor to comply with the above to the entire satisfaction of the Architect will be sufficient cause for the rejection of the particular piece of equipment in question.

1.22 TESTING

A. All pressure lines, unless elsewhere specified, shall be tested under 150# hydrostatic pressure unless rated pressure is less for a minimum of 5 hours. Contractor shall provide valve at farthest point in line to bleed off air and for inspection.

B. Notice shall be given the Architect before tests are made, the test is not to be drawn off pipes and pipes are not to be covered or insulated until filled pipes have been examined and testing approved by the Architect.

C. In case of defects, they shall be made good to the satisfaction of the Architect and work retested. All such work shall be done by the Contractor with no additional expense to the Owner.

D. Contractor shall make any other such tests as may be called for by the Architect, and all other tests so called for elsewhere in these specifications.

1.23 CLEANING AND ADJUSTING

A. Before receiving final approval from the Architect, the Contractor shall clean out all lines; adjust all valves, control equipment and other equipment. Clean all pipe and equipment and leave the entire installation in good working order. All heaters, fans, grilles, controls, etc., shall be adjusted to perform in correct and satisfactory manner, with sequences, etc., as called for in the specifications hereinafter specified and on plans.

1.24 PAINTING

A. Refer to Section 09 90 00 – Painting and Coating and 230553 – Mechanical Identification for painting requirements.

1.25 MOTORS, MOTOR STARTERS AND ELECTRICAL WORK

A. Refer to Section 23 05 13 - Motors.

B. Motors shall be suitable for voltage indicated on the plans, plus or minus 10% and be designed for constant operation at 40 degrees C ambient, 65 degrees C rise for class A, 90 degrees C rise for Class B, etc. Electrical equipment furnished under this contract shall meet standards as set forth by NEMA and NEC requirements. All electrical equipment shall be UL labeled.

1.26 PARTS LIST AND INSTRUCTION MANUAL

A. See individual sections for specific instructions.

B. This Contractor shall deliver to the Architect three (3) copies of printed instructions relating to operating, proper maintenance and repair parts list indicating the various parts by name, number and diagram for each piece of equipment installed. Test and balance report shall also be included in parts list and instruction manual.

C. The shop drawings, parts list, and maintenance and repair instructions shall be neatly bound in a canvas-covered notebook and turned over to the Architect before acceptance of the work.

1.27 BOILER TEST CERTIFICATES

A. Each boiler, water heater (with a capacity equal to or greater than 50 gallons), and pressure vessels are to be inspected by a State of Louisiana certified inspector upon installation.

B. Submit a copy of each report to the Architect and include one copy in each of the Close-out Manuals.

1.28 GUARANTEE

A. Contractor shall guarantee materials, equipment and workmanship installed and performed under this contract for a period of one (1) year from date of the final completion and official acceptance of the contract.

B. He shall furnish free of charge to the Owner all materials and labor necessary to comply with the above guarantee, which shall be based on defective materials and/or workmanship, and on such basis shall be responsible if a deficiency is found, for any adjustment, replacement, or correction which may be necessary to replace the project to first class condition. This guarantee shall include refrigerant charges, but shall not include the changing of filters.

1.29 RECORD DRAWINGS

A. The Contractor shall maintain a set of record drawings on-site throughout the construction. The record drawings shall reflect accurate dimensional record of all underground, buried, above ceiling, or otherwise concealed work.

B. The Contractor shall maintain these record documents and keep them up-to-date daily.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 05 00 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1.00 GENERAL

1.01 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Sleeves.
   5. Escutcheons.
   6. Grout.
   7. Mechanical demolition.
   8. Equipment installation requirements common to equipment sections.
   9. Concrete bases.
   10. Supports and anchorages.

1.02 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, crawlspaces, 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.

1.03 SUBMITTALS

A. Welding certificates.

1.04 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Mechanical Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

PART 2.00 PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.02 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series or BAg1, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12.

G. Solvent Cements for Joining Plastic Piping:
   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.

2.03 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

2.04 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

B. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

C. Pressure Plates: Carbon steel. Include two for each sealing element.

D. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PVC: Permanent, with nailing flange for attaching to wooden forms.

F. PVC Pipe: ASTM D 1785, Schedule 40.

G. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.06 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
1. Finish: Polished chrome-plated and rough brass.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
1. Finish: Polished chrome-plated and rough brass.

2.07 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3.00 EXECUTION

3.01 MECHANICAL DEMOLITION

A.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.
1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
5. Equipment to Be Removed: Disconnect and cap services and remove equipment.
6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. 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 in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors.

M. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

N. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

O. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 7 Section "Through-Penetration Firestop Systems" for materials.

Q. Verify final equipment locations for roughing-in.

R. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 15 Sections specifying piping systems.

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

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.

E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.

F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
1. Comply with ASTM F 402, for safe-handling practice of cleaners, primers, and solvent cements.
2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.
3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
4. PVC Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

K. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

L. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

M. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.04 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.05 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. 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.

D. Install equipment to allow right of way for piping installed at required slope.

3.06 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement.

3.07 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 5 Section "Metal Fabrications" for structural steel.

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

C. Field Welding: Comply with AWS D1.1.

3.08 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages 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.

3.09 GROUTING

A. Mix and install grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

DIVISION 23 – MECHANICAL
SECTION 23 05 13 - MOTORS

PART 1.00 GENERAL

1.01 SECTION INCLUDES

A. Single phase electric motors.

B. Three phase electric motors.

1.02 RELATED WORK

A. Section 23 21 23 - Pumps

1.03 REFERENCES

A. AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

B. AFBMA 11 - Load Ratings and Fatigue Life for Roller Bearings.

C. ANSI/IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.

D. ANSI/NEMA MG 1 - Motors and Generators

E. ANSI/NEMA 70 - National Electrical Code

1.04 SUBMITTALS

A. Submit product data under provisions of Sections 01 30 00 - Administrative Requirements & 23 00 00 – General Mechanical.

B. Submit test results verifying nominal efficiency and power factor for three phase motors larger than 5 horsepower.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 70 00 - Execution Requirements.

B. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacture of electric motors for commercial use, and their accessories, with documented product development, testing, and manufacturing experience.

1.07 REGULATORY REQUIREMENTS

A. Conform to ANSI/NFPA 70.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 01 60 00 – Product Requirements.

B. Store and protect products under provisions of Section 01 60 00– Product Requirements.

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

1.09 WARRANTY - See General Section 23 00 00– General Mechanical.

PART 2.00 PRODUCTS

2.01 MOTORS

A. Motors controlled by VFD's shall comply with NEMA MG1, Part 31, Definite Purpose Inverter Fed Motors (withstand repeated voltage peaks of 1600V with rise times of 0.1 microseconds and greater).

B. Starters for single phase motors which are not automatically started shall be manual type with melting alloy thermal overload protection and pilot light. Starters for automatically controlled single phase motors shall be magnetic type with NEMA rated AC magnetic contactor, melting alloy thermal overloads and pilot light.

C. Starters for three phase motors 25 horsepower and below shall be combination type starter/disconnect, full voltage non reversing (FVNR), with magnetic NEMA rated contactors rated for horsepower of motor served, adjustable trip magnetic circuit breaker disconnect (circuit breaker, not a fused switch) capable of being padlocked in the open position, 10K a/c minimum fault rating with higher rating when necessary due to available faut levels. Starters shall have a fused 100VA minimum control transformer (120V unless required otherwise), HOA switch, push to test operating pilot light, solid state overload relays set for actual motor nameplate full load amps, phase failure and phase reversal protection relay, minimum two NO. and two N.C auxiliary contracts and terminal blocks factory prewired for field wiring. Starters shall be housed in a NEMA 1 enclosure for indoor locations and NEMA 3R enclosure for outdoor or wet locations.

D. Starter for motors 30 horsepower and above shall be soft start type or variable frequency drives

E. Coordinate with electrical and specify fault rating on all motor controllers.

2.02 MANUFACTURERS

A. Electrical Service - Refer to Division 26 for required electrical characteristics.

B. Motors: Design for continuous operation in 40 degrees C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, Service Factor, and motor enclosure type.

C. Visible Nameplate: Indicating motor information as required by NEC 430-7(a).

D. Electrical Connection: Conduit connection boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide screwed conduit connection in end frame.

E. Starters: General electric, Cerus Industrial

2.03 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 65 degree C temperature rise insulation, Minimum 1.15 service factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.04 SINGLE PHASE POWER - CAPACITOR START MOTORS

A. Starting Torque: Three times full load torque.

B. Starting Current: Less than five times full load current.

C. Pull-up Torque: Up to 350 percent of full load torque.

D. Breakdown Torque: Approximately 250 percent of full load torque.

E. Motors: Capacitor in series with starting winding; capacitor-start/capacitor-run motors shall have two capacitors in parallel with run capacitor remaining in circuit at operating speeds.

F. Drip-proof Enclosure: Class A 65 degree C temperature rise insulation, NEMA service factor, prelubricated sleeve ball bearings.

G. Enclosed Motors: Class A 65 degree C temperature rise insulation, NEMA service factor, prelubricated sleeve ball bearings.

2.05 THREE PHASE POWER - SQUIRREL CAGE MOTORS

A. Starting Torque: Between one and one-half times full load torque.

B. Starting Current: Six times full load current.

C. Power Output, Locked Rotor Torque, Breakdown or Pullout Torque: NEMA Design B characteristics.

D. Design, Construction, Testing, and Performance: Conform to ANSI/NEMA MG for design B motors.

E. Insulation System: NEMA Class B or better.

F. Testing Procedure: In accordance with ANSI/IEEE 12, Test Method B. Load test motors to determine freedom from electrical or mechanical defects and compliance with performance data.

G. Motor Frames: NEMA standard T-frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.

H. Thermister System (Motor Frame Sizes 254T and larger): Three PTC thermister imbedded in motor windings and epoxy encapsulated solid state control relay for wiring into motor starter.

I. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for re-lubrication, rated for minimum AFBMA 9, L-10 life of 20,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

J. Sound Power Levels: To ANSI/NEMA MG1.

K. Nominal Efficiency: Meet or exceed values in schedules at full load and rated voltage when tested in accordance with ANSI/IEEE 112, and ASHRAE 90.1.

L. Motors, Motor Starters and Electrical Work: Mechanical Contractor shall furnish all motors, motor starters, start-stop push buttons, pilot lights, firestats, interlocking diagrams, etc. for each piece of motor driven equipment under this Contract. Mechanical Contractor shall install all motors. All motor starters, start-stop push buttons, pilot lights, etc. shall be turned over to the Electrical Contractor for installation. Electrical contractor shall be responsible for power wiring. This contractor will be responsible for control wiring.

M. Motor Starters and Push Buttons: All automatic starters shall be nominal 600 volt rating. All starters shall have two (2) auxiliary contacts.
   1. Starters for single speed motors, 3/4 through 25 HP inclusive, shall be magnetically operated, "Across-the-line" 3 phase, with three overload relays, "HAND-OFF-AUTO" selector switch and pilot in cover. Starters shall be combination type with fused or circuit breaker type disconnect mechanism.
   2. Starters for 30 HP and larger are to be reduced voltage, auto-transformer, combination type with fused or circuit breaker type disconnect mechanism. Starters shall be complete with three overload relays, "HAND-OFF-AUTO" selector switch and

pilot lights.

3. Enclosures for starters mounted indoors shall be NEMA 1. Enclosures for starters mounted outdoors or in wet areas shall be NEMA 3 R.
4. Remote push button stations shall be as follows: Start-stop stations shall be recess mounted with neon pilot lamp of proper voltage.
5. Push buttons for controls which are interlocked with automatic controls shall be maintained contact type. All others may be of momentary contact type.
6. Control voltage for all motor starters shall 120 volts provided by integral control voltage transformers.
7. If the Mechanical Contractor purchases equipment of larger horsepower than specified or shown on the plans, he shall pay all costs to increase the wiring and conduit.

PART 3.00 EXECUTION

3.01 APPLICATION

A. Motors drawing less than 250 watts and intended for intermittent service may be germaine to equipment manufacturer and need not conform to these specifications.

B. Motors shall be open drip-proof type, except where specifically noted otherwise.

C. Single phase motors for shaft mounted fans or blowers shall be permanent split capacitor type.

3.02 NEMA OPEN MOTOR SERVICE FACTORS

HORSEPOWER	3600 RPM	1800 RPM	1200 RPM	900 RPM
1/6-1/3	1.35	1.35	1.35	1.35
1/2	1.25	1.25	1.25	1.15
3/4	1.25	1.25	1.15	1.15
1	1.25	1.15	1.15	1.15

3.03 MOTOR EFFICIENCY

A. Each motor furnished on the job must meet ASHRAE 90.1 and shall have a minimum guaranteed efficiency as listed in table below. Minimum guaranteed efficiencies for all motors shall be clearly stamped on motor nameplate. The lack of such stamp shall be cause for rejection of motor.

HORSEPOWER	EFFICIENCY
1, 1-1/2, 2	84.00
3	88.50
5, 7-1/2, 10	90.20
15, 20	91.70
25, 30, 40	93.00

50, 60, 75	94.10
100, 125, 150, 200	95.00

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 05 23 - VALVES

PART 1.00 GENERAL

1.01 SECTION INCLUDES

A. Butterfly Valves

B. Check Valves

C. Plug Valves

D. Drain Valves

E. Gate Valves

F. Pet Cocks

G. Ball Valves

1.02 RELATED WORK

A. Section 23 21 13 - Hydronic Piping

B. Section 23 21 23 - Pumps

C. Section 23 21 16 - Hydronic Specialties

1.03 SUBMITTALS

A. Submit copies of valve ordering schedule for approval prior to ordering valves.

B. Submit detailed shop drawings under provisions of individual sections. Clearly indicate make, model, type, size, and pressure ratings, and materials of construction.

1.04 APPROVAL OF PRODUCT PRIOR TO BIDDING

A. Refer to Instruction to Bidders.

PART 2.00 PRODUCTS

2.01 MANUFACTURERS

A. Certain items in this Specification are listed by manufacturer and/or manufacturer's model number to establish general style, type, character, and quality or product desired. Similar items manufactured by other than those listed will be considered, providing submittals are made according to Pre-Bid approval requirements of Instruction to Bidders.

B. Where no manufacturer or model number are given, any product meeting performance or design criteria, or referenced trade association standard may be used and Pre-Bid Approval is not required.

C. Provide valves of same manufacturer throughout wherever possible.

D. Provide valves with manufacturer's name and pressure rating clearly marked on outside of body.

2.02 VALVE CONNECTIONS

A. Provide valves suitable to connect to adjoining piping as specified for pipe joints. Use pipe size valves.

B. Thread pipe sizes 2 inches and smaller.

C. Flange pipe sizes 2-1/2 inches and larger.

D. Solder or screw to solder adapters for copper tubing.

E. Provide butterfly valve with tapped lug body when used for isolating service.

2.03 BALL VALVES

A. Ball valves 2" and smaller (heating coils) valves to be bronze body with stainless steel cartridge, threaded, combination valve and flow control. Control range 2-32 psid.

B. Manufacturer's: NIBCO T-590-Y-66 or Red & White 5092

C. Ball valves 3" and larger (chilled water) to be cast steel 150 lbs. psig flange type, ASTM A216, GR. WCB carbon steel, 416 stainless steel stem and ball, Teflon gasket, malleable iron handles.

D. Manufacturer's: NIBCO F515 or Red & White 4151

2.04 CHECK VALVES

A. Chilled Water, Hot Water:
Body: Cast iron ASTM A-48 Class 35
Seat: Bronze ASTM 145 Alloy
Disc: Bronze ASTM 145 Alloy
Spring: Stainless Steel Type 302
Bushing: 6" and smaller ASTM B-16 8" and larger ASTM 145
Set screws: Stainless Steel Type 304
Manufacturer's: NIBCO F-918-B or Red & White 435, B&G, Armstrong

2.05 BALANCING VALVES (Eccentric Plug Type)

A. Valves shall be of the non-lubricated eccentric type with resilient faced plugs and shall be furnished with end connections as shown on the plans. Flanged valves shall befaced and drilled to the ANSI 125/150 lb. standard.

B. Port areas for valves through 20" shall be minimum 80% of ull pipe area and port areas of 24" and larger valves shall be minimum 70% of full pipe area.

C. Valve bodies shall be of ASTM A126 Class B cast iron in compliance with AWWA C504 Section 2.2. Bodies in 3" and larger valves shall be furnished with a welded overlay seat of not less than 90% pure nickel in accordance with AWWA C507 Section 7.2. Valves utilizing resilient seat attached to the body shall not be acceptable. As per AWWA C504-80 Section 35.2 and AWWA C507-73 Section 7.2, sprayed or plated seats are not acceptable, nor shall screwed in seats be acceptable.

D. Valve shaft seals shall be of the multiple V-ring type and shall be externally adjustable, re-packable without removing the bonnet or actuator from the valve, and re-packable under pressure. Shaft seals shall conform to AWWA C504-80, Section 3.7 and AWWA C507-73, Section 10.2. Valves utilizing O-ring seals or non-adjustable packing shall not be acceptable. All exposed nuts, bolts, springs, washers zinc plated.

E. Valve pressure ratings shall be 175 psi through 12" and 150 psi for 14" through 48". Each valve shall be given a hydrostatic and seat test.

F. Where required, valves shall be capable of providing drip-tight shutoff up to the full rating with pressure in either direction.

G. Acceptable Manufacturers
   1. Dezurik Series 100
   2. Alloyco 257A
   3. Nexus

2.06 DRAIN VALVES

A. Bronze gate, class 125, ASTM B-62 with bronze wedge, hose cap and safety chain.

B. Acceptable Manufacturer's
   1. NIBCO T-113-HC
   2. Crane 1701

2.07 PRESSURE RATINGS

A. Unless otherwise indicated, use valves suitable for 150 minimum psig WSP and 450 degrees F and maximum 200 psig and 250 degrees F.

2.08 VALVE OPERATORS

A. Provide one plug cock wrench for every ten plug cocks sized 2 inches and smaller, minimum

of one. Provide each plug cock sized 2-1/2 inches and larger with a wrench, with set screw.

B. For butterfly valves (provide gear operators for sizes 8 inches and larger. For smaller sizes, provide lever lock handle with toothed plate for shut-off service and infinitely adjustable handle with lock nut and memory stop for throttling service.

C. Provide valves located more than 8 feet from floor in equipment room areas with chain operated sheaves. Extend chains to 4 feet above floor and hook to clips arranged to clear walking aisles.

D. All valves shall be furnished with valve stem extensions to facilitate insulation installation.

PART 3.00 EXECUTION

3.01 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install butterfly valves for shut-off and isolating service, to isolate equipment, part of systems, or vertical risers.

C. Provide spring-loaded check valves on discharge of condenser water chilled water, and hot water pumps.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 05 29 - SUPPORTS AND ANCHORS

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Pipe and equipment hangers, supports, and associated anchors.

B. Equipment bases and supports.

C. Sleeves and seals.

D. Flashing and sealing equipment and pipe stacks.

1.02 RELATED WORK

A. Section 23 07 00 - Piping and Equipment Insulation.

B. Section 23 21 13 - Hydronic Piping.

1.03 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 30 00 – Administrative Requirements.

B. Indicate hanger and support framing and attachment methods.

PART 2.00 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER'S

A. Fee and Mason

B. Grinnel

2.02 PIPE HANGERS AND SUPPORTS

A. Hangers for pipe sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.

B. Hangers for pipe sizes 2 to 4 inches and cold pipe sizes 6 inches and over: Carbon steel, adjustable, clevis.

C. Multiple or trapeze hangers: Steel channels with welded spacers and hanger rods; cast iron roll and stand for hot pipe sizes 6 inches and over.

D. Vertical Support: Steel riser clamp.

E. Floor support for pipe sizes 4 inches and over: Welded steel bracket and wrought steel clamp; adjustable steel yoke and cast iron roller for hot pipe 6 inches and over.

F. Shields for insulated piping 2 inches and smaller: 18 gauge galvanized steel shield over insulation in 180 degree segments, minimum 12 inches long at pipe support.

G. All hangers to be sized to include insulation.

2.03 HANGER RODS

A. Steel Hanger Rods: Threaded both ends, threaded one end, or continuous threaded.

2.04 INSERTS

A. Inserts: Malleable iron case or galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms, size inserts to suit threaded hanger rods.

2.05 FLASHING

A. Metal Flashing: 26 gauge galvanized steel.

B. Lead Flashing: 5 lb./sq. ft. sheet lead for waterproofing.

C. Caps: Steel, 22 gauge minimum, 16 gauge at fire resistant elements.

2.06 SLEEVES

A. Sleeves for pipes through non-fire rated floors: Form with 18 gauge galvanized steel.

B. Sleeves for pipes through non-fire rated beams, walls, footings, and potentially wet floors: Form with steel pipe or 18 gauge galvanized steel.

2.07 FABRICATION

A. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

B. Design hangers without disengagement of supported pipe.

2.08 FINISH

A. Prime coat exposed steel hangers and supports.

B. Protect against galvanic action with dielectric unions for dissimilar metals.

PART 3.00 EXECUTION

3.01 INSERTS

A. Provide inserts to General Contractor 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.

D. Where concrete slabs form finished ceiling, provide inserts to be flush with slab surface.

E. Where inserts are omitted, drill through concrete slab from below and provide thru-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.

3.02 PIPE HANGERS AND SUPPORTS

A. Support horizontal piping as follows:

PIPE SIZE DIAMETER	MAX HANGER SPACING	MIN. HANGER
1-1/2 TO 2 INCH	10' - 0"	3/8"
2-1/2 TO 3 INCH	10' - 0"	1/2"
4 to 6 inch	10' - 0"	5/8"
8 to 12 inch	10' - 0"	7/8"
14 to 20 inch	15' - 0"	1"

B. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.

C. Place a hanger within 12 inches of each horizontal elbow.

D. Use hangers with 1-1/2 inch minimum vertical adjustment.

E. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

F. Support riser piping independently of connected horizontal piping.

3.03 EQUIPMENT BASES AND SUPPORTS

A. Provide equipment bases of reinforced concrete as detailed on plans.

B. Provide templates, anchor bolts, and accessories for mounting and anchoring equipment.

C. Provide rigid anchors for pipes after vibration isolation components are installed.

3.04 FLASHING

A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 05 48 - VIBRATION ISOLATION

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Inertia Bases

B. Vibration Isolation

1.02 RELATED WORK

A. Fire Protection System

B. Plumbing System

C. HVAC System

1.03 REFERENCES

A. ASHRAE - Guide to Average Noise Criteria Curves.

1.04 QUALITY ASSURANCE

A. Maintain ASHRAE criteria for average noise criteria curves for all equipment at full load condition.

1.05 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 30 00– Administrative Requirements.

B. Indicate vibration isolator locations, with static and dynamic load on each, on shop drawings and described on product data.

C. Submit manufacturer's installation instructions.

1.06 CERTIFICATES

A. Submit manufacturer's certificate that isolators are properly installed and properly adjusted to meet or exceed specified requirements.

PART 2.00 PRODUCTS

2.01 INERTIA BASES

A. Pumps: Reinforced 3,000 psi concrete base with chamfered edges, without channel frame.

2.02 VIBRATION ISOLATORS

A. A.H. Units: Open spring mount with stiff springs. Horizontal stiffness equal to vertical stiffness. Minimum 1" deflection. No. and size of springs as per A.H. unit manufacturer's recommendations.

B. Color code spring mounts.

C. Select springs to operate at 2/3 maximum compression strain, with 1/4 inch (6 mm) ribbed neoprene pads.

PART 3.00 EXECUTION

3.01 INSTALLATION

A. Install vibration isolators for motor driven equipment.

B. Set steel bases for one inch clearance between housekeeping pad and base. Set concrete inertia bases for 2 inch (50 mm) clearance. Adjust equipment level.

C. Provide spring isolators on piping connected to isolated equipment as follows: Up to 4 inch diameter, first three points of support; 5 to 8 inch diameter, first four points of support; 10 inch diameter and over, first six points of support. Static deflection of first point shall be twice deflection of isolated equipment.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 05 53 - MECHANICAL IDENTIFICATION

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Identification of all mechanical products installed under this Division.

1.02 RELATED WORK

A. Section 09 90 00 - Painting: Identification painting.

1.03 REFERENCES

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

1.04 SUBMITTALS

A. Submit product data under provisions of Section 01 30 00– Administrative Requirements.

B. Mechanical and plumbing contractors shall coordinate color codes and marking procedures.

1.05 APPROVAL OF PRODUCT PRIOR TO BIDDING

A. Refer to Instructions to Bidders, Page IB-3, Paragraph 4.3 Substitution.

PART 2.00 PRODUCTS

2.01 MATERIALS

A. Color: Unless specified otherwise, conform with ANSI/ASME A13.1.

B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light contrasting background color.

C. Metal Tags: Brass with stamped letters, tag size minimum 1-1/2 inch (38 mm) diameter with smooth edges.

D. Stencils: With clean cut symbols and letters of following size:

OUTSIDE DIAMETER OF INSULATION OF PIPE	LENGTH OF COLOR FIELD	SIZE OF LETTERS
3/4" - 1-1/4"	8"	1/2"
1-1/2" - 2"	8"	3/4"
2-1/2" - 6"	12"	1-1/4"

8" - 10"	24"	2 - 1/2"
Over 10"	32"	3 - 1/2"
Ductwork & Equipment	-------	2 - 1/2"

E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing printed markings.

F. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape of not less than 6" wide by 4 mil thick manufactured for direct burial service.

PART 3.00 EXECUTION

3.01 PREPARATION AND INSTALLATION:

A. Degrease and clean surfaces to receive adhesive for identification material.

3.02 INSTALLATION

A. Plastic Nameplates: Install with corrosive-resistant mechanical fasteners, or adhesive.

B. Plastic Pipe Markers: Install in accordance with manufacturer's instructions.

C. Plastic type Pipe Markers: Install complete around pipe in accordance with manufacturer's instructions.

D. Underground Plastic Pipe Markers: Install 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.

E. Equipment: Identify air handling units, pumps, heat transfer equipment, tanks and water treatment devices, and motor starters with plastic nameplates. Small devices, such as in-line pumps, may identified with plastic tags.

F. Controls: Identify control panels and major control components outside panels with plastic nameplates.

G. Valves: Identify valves in main and branch piping with tags.

H. Piping: Identify piping, concealed or exposed, with plastic pipe markers. Tags may be used on small diameter piping. Identify service and flow direction. 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 "T", at each side penetration of structure or enclosure, and at each obstruction.

3.03 PAINTING

A. All surfaces requiring painting shall be left clean by the Mechanical Subcontractor. All painting shall be done by the General Contractor's painting Subcontractor. All exposed piping or insulation, convectors, grilles, or fans, in building or on roof will be painted. Paint pipe,

equipment, hangers and accessories in Equipment Rooms including covering and foundations with two (2) coats of approved paint after thoroughly cleaning. Equipment having factory finish shall be touched up and given one (1) additional coat of machinery enamel color as selected. The above shall be done by the General Contractor. See Section 09 90 00.

B. All piping in all equipment rooms shall be identified with pipe markers with directional arrows. The following color code shall be followed.

LEGEND	PIPING	DIRECTIONAL MARKER	BAND COLOR BACKGROUND
Domestic Water	Green	Green	White
Chilled Water	Blue	Green	Blue
Heating Hot Water Supply	Aluminum	Yellow	Purple
Heating Hot Water Return	Aluminum	Yellow	Orange
Steam	Silver	Black	Black

NOTE: On any asphalt finished surfaces, prime with one (1) coat of aluminum paint before final color.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

PART 1.00 GENERAL

1.01 RELATED DOCUMENTS

A. All division 23 specification sections, drawings, and general provisions of the contract apply to work of this section, as do other documents referred to in this section.

1.02 SCOPE OF WORK

A. The Contractor shall obtain the services of an independent Test and Balance (TAB) Company which specializes in the testing and balancing of heating, ventilating and air conditioning (HVAC) systems to test, adjust and balance all HVAC systems in the building(s).

B. The work included in this section consists of furnishing labor, instruments, and tools required in testing, adjusting and balancing the HVAC systems as described in these specifications or shown on accompanying drawings. Services shall include checking equipment performance, taking the specified measurements, and recording and reporting the results. The testing, adjusting and balancing agency shall act as a reporting agency; that is, list and report each piece of equipment as to identification number, manufacturer, model number, serial number, proper location, specified performance, and report actual performance of all equipment as found during testing. The report is intended to be used during the life of the building as a ready reference indicating original conditions, equipment components, etc.

C. Representatives of the Test and Balance Company shall visit the job site during installation of the HVAC equipment, piping and ductwork as required.

D. Upon completion of the HVAC system installation, the Test and Balance Company shall perform all required testing and balancing with the full cooperation of the Contractor and his Sub-contractors. The Contractor shall make changes and/or adjustments to the HVAC system components that are required by the Test and Balance Company to accomplish proper balancing. The TAB agency shall not supply or install any materials or balancing devices such as pulleys, drives, belts, etc. All of this work is by the Contractor and shall be performed at no additional cost to the Owner.

E. The test and balance report complete with a summary page listing all deficiencies shall be submitted to the Mechanical Engineer. If the Mechanical Engineer agrees with the report, he shall sign it and return it to the Architect. The test and balance report must be complete and must be accepted by the Mechanical Engineer prior to acceptance of the project. Any outstanding test and balance items shall be placed on the punch list and a monetary value shall be assigned to them.

F. After all deficiencies have been corrected the Mechanical Engineer shall sign the testing and balancing report, and the Test and Balance Company shall supply four (4) copies of the final and complete report to the Architect for inclusion in the Operation and Maintenance Manuals.

G. The items requiring testing, adjusting, and balancing include (but are not restricted to) the following:

HYDRONIC SYSTEMS:	AIR SYSTEMS
Pumps	Supply Fans
System Mains and Branches	Zone, Branch, & Main Ducts
Heat Exchangers	VAV System
Coils	Diffusers, registers, & grilles
Control Valves	Coils

1.03 DEFINITIONS, REFERENCES, STANDARDS

A. All work shall be in accordance with the latest edition of the Associated Air Balance Council (AABC) National Standards or the latest standards of the National Environmental Balancing Bureau (NEBB). If these contract documents set forth more stringent requirements than the AABC National Standards or the NEBB Standards, these contract documents shall prevail.

1.04 QUALIFICATIONS

A. Agency Qualifications: The TAB Agency shall be a current member of the AABC or the NEBB and must be in good standing with FP&C. A list of these firms shall be obtained from FP&C. Falsification of a TAB report shall be grounds for removal from the FP&C list and the firm's actions shall be reported to the appropriate certification agency. The contractor may use any FP&C approved TAB firm on a state project.

1.05 SUBMITTALS

A. Procedures and Agenda: The TAB agency shall submit the TAB procedures and agenda proposed to be used.

B. Sample Forms: The TAB agency shall submit sample forms, which shall include the minimum data required by the AABC National Standards or the NEBB Standards.

1.06 TAB PREPARATION AND COORDINATION

A. Shop drawings, submittal data, up-to-date revisions, change orders, fan curves, pump curves and other data required for planning, preparation, and execution of the TAB work shall be provided when available and no later than 30 days after the Designer has returned the final approved submittal data to the Contractor.

B. System installation and equipment startup shall be complete prior to the TAB agency's being notified to begin.

C. The building control system (BCS) contractor shall provide and install the control system, including all temperature, pressure and humidity sensors. These shall be calibrated for accurate control. If applicable, the BCS contractor shall install all necessary computers and computer programs, and make these operational. Assistance shall be provided as required for reprogramming, coordination, and problem resolution.

D. All test points, balancing devices, identification tags, etc., shall be accessible and clear of insulation and other obstructions that would impede TAB procedures.

E. Qualified installation or startup personnel shall be readily available for the operation and adjustment of the systems. Assistance shall be provided as required for coordination and problem resolution.

1.07 REPORTS

A. Final TAB Report - The TAB agency shall submit the final TAB report for review by the Architect. On plans provided, all outlets, devices, HVAC equipment, etc., shall be identified (including manufacturer, model number, serial number, motor manufacturer, HP, drive type, fan and motor sheaves and belt number), along with a numbering system corresponding to report unit identification. The TAB agency shall submit an AABC "National Project Performance Guaranty" (or similar NEBB Guaranty) assuring that the project systems were tested, adjusted and balanced in accordance with the project specifications and AABC National Standards (or similar NEBB Standards). The Designer shall certify his approval on the Performance Guaranty.

B. Submit 4 copies of the Final TAB Report to the Engineer for inclusion in the Operation and Maintenance Manuals.

PART 2.00 INSTRUMENTATION

A. All instruments used for measurements shall be accurate and calibrated. Calibration and maintenance of all instruments shall be in accordance with the requirements of AABC National Standards (or similar NEBB Standards).

PART 3.00 EXECUTION

3.01 GENERAL

A. The specified systems shall be reviewed and inspected for conformance to design documents. Testing, adjusting and balancing on each identified system shall be performed. The accuracy of measurements shall be in accordance with AABC National Standards (or similar NEBB Standards). Adjustment tolerances shall be + or - 10% unless otherwise stated.

B. Equipment settings, including manual damper quadrant positions, valve indicators, fan speed control levers, and similar controls and devices shall be marked to show final settings.

C. All information necessary to complete a proper TAB project and report shall be per AABC or NEBB standards unless otherwise noted. The descriptions of work required, as listed in this section, are a guide to the minimum information needed.

D. TAB contractor shall cut insulation, ductwork and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. Upon completion, patch insulation, ductwork and housings using materials identical to those removed. Seal

insulation to reestablish integrity of the vapor barrier.

E. TAB work shall include additional inspection and adjustment of components during the season following the initial balance to include re-balance of any items influenced by seasonal changes or as directed by the Owner.

3.02 AIR SYSTEMS

A. The TAB agency shall verify that all ductwork, splitters, extractors, dampers, grilles, registers, and diffusers have been installed per design, are functional and set full open. Any leakage in the ductwork shall be repaired prior to the test. The TAB agency shall perform the following TAB procedures in accordance with the AABC National Standards or NEBB Standards:

For supply fans:

1. Fan speeds - Test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure fan motor is not in or above the service factor.
3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main supply and return ducts, as applicable to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
4. Outside Air - Test and adjust the outside air on applicable equipment using a Pitot-tube traverse. If a traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet. If a traverse is not practical use the mixed-air temperature method if the inside and outside temperature difference is at least 20 degrees Fahrenheit or use the difference between Pitot-tube traverses of the supply and return air ducts.
5. Static Pressure - Test and record system static pressure, including the static pressure profile of each supply fan.

For exhaust fans:

1. Fan speeds - test and adjust fan RPM to achieve design CFM requirements.
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the service factor.
3. Pitot-Tube Traverse - Perform a Pitot-tube traverse of main exhaust ducts to obtain total CFM. If a Pitot-tube traverse is not practical, an explanation of why a traverse was not made must appear on the appropriate data sheet.
4. Static Pressure - Test and record system static pressure, including the static pressure profile of each exhaust fan.

For zone, branch and main ducts:

1. Adjust ducts to within design CFM requirements. As applicable, at least one zone balancing damper shall be completely open. Multi-diffuser branch ducts shall have at least one outlet or inlet volume damper completely open.

For VAV systems:

1. Identify the type, location, and size of each terminal box. This information shall be

recorded on terminal box data sheets.

2. Test, adjust and record the maximum and minimum box air quantities for each VAV box.
3. Set volume regulators on all terminal boxes to meet design maximum and minimum CFM requirements.
4. Test and record entering and leaving air temperature of hot water coils with full heating air flow and water flow.
5. Insure the entering static pressure is sufficient for normal, proper box operation.

For diffusers, registers and grilles:

1. Tolerances - Test, adjust, and balance each diffuser, grille, and register to within 10% of design requirements. Minimize drafts. Include required CFM, initial test CFM and final CFM.
2. Identification - Identify the type, location, and size of each grille, diffuser, and register. This information shall be recorded on air outlet data sheets.

For coils:

1. Air Temperature - Once air flows are set to acceptable limits, take wet bulb and dry bulb air temperatures on the entering and leaving side of each cooling coil. Dry-bulb temperature shall be taken on the entering and leaving side of each heating coil.

3.03 HYDRONIC SYSTEMS

A. The TAB agency shall, as applicable, verify that all hydronic equipment, piping, and coils have been filled and purged; that strainers have been cleaned; and that all balancing valves (except bypass valves) are set full open. Examine water in system and determine if it has been treated and cleaned. As applicable, it shall check air vents and expansion or compression tank for proper operation. The TAB agency shall perform the following testing and balancing functions in accordance with the AABC National Standards (or similar NEBB Standards):

For pumps:

1. Test and adjust, hot water, pump to meet design GPM requirements. Check pump rotation and verify impeller size. Check pumps for proper operation. Pumps shall be free of vibration and cavitation. Record appropriate gauge readings for final TDH and Block-Off/Dead head calculations. List pump N.P.S.H. (as applies).
2. Current and Voltage - Test and record motor voltage and amperage, and compare data with the nameplate limits to ensure pump motor is not in or above the service factor.

For system mains and branches:

1. Adjust water flow in pipes to within design GPM requirements. As applicable, at least one branch balancing valve shall be completely open.

For heat exchangers:

1. Verify that heat exchangers have been filled and started by others, and are in operation.
2. Current and Voltage - As applicable, test and record motor voltage and amperage, and compare data with the nameplate limits to ensure motor is not in or above the

service factor.

3. Test and adjust water flow through heat exchangers.
4. Test and record entering and leaving temperature and pressure profiles of water or steam heat exchangers.

For coils:

1. Tolerances - Test, adjust, and balance all chilled-water and hot-water coils within 10% of design requirements.
2. Verification - Verify the type, location, final pressure drop and GPM of each coil. This information shall be recorded on coil data sheets.

For control valves:

1. Check operation of automatic valves.
2. Test and record pressure drop and flow across control valves at full flow.

3.04 PROCEDURES FOR CHILLERS

A. Balance water flow through each evaporator to within specified tolerances of indicated flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design conditions:

1. Evaporator-water entering and leaving temperatures, pressure drop, and water flow.
2. If water-cooled chillers, condenser-water entering and leaving temperatures, pressure drop, and water flow.
3. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by chiller manufacturer.
4. Power factor if factory-installed instrumentation is furnished for measuring kilowatt.
5. Kilowatt input if factory-installed instrumentation is furnished for measuring kilowatt.
6. Capacity: Calculate in tons of cooling.

3.05 PROCEDURES FOR COOLING TOWERS

A. Shut off makeup water for the duration of the test, and verify that makeup and blow down systems are fully operational after tests and before leaving the equipment. Perform the following tests and record the results:

1. Measure condenser-water flow to each cell of the cooling tower.
2. Measure entering- and leaving-water temperatures.
3. Measure wet- and dry-bulb temperatures of entering air.
4. Measure wet- and dry-bulb temperatures of leaving air.
5. Measure condenser-water flow rate recirculating through the cooling tower.
6. Measure cooling tower pump discharge pressure.
7. Adjust water level and feed rate of makeup-water system.

3.06 ADDITIONAL TAB SERVICES

A. Job Site Inspections: During construction, the TAB agency shall inspect the installation of pipe systems, sheet metal work, temperature controls, and other component parts of the HVAC systems as required.

B. Verification of HVAC Controls: The TAB agency shall be assisted by the building control systems Contractor in verifying the operation and calibration of all HVAC and temperature control systems. The following tests shall be conducted:

1. Verify that all control components are installed in accordance with project requirements and are functional, including all electrical interlocks, damper sequences, air and water resets, fire and freeze stats, and other safety devices.
2. Verify that all controlling instruments are calibrated and set for design operating conditions.

C. Temperature Testing: To verify system control and operation, a series of three temperature tests shall be taken at approximately two hour intervals in each separately controlled zone. The resulting temperatures shall not vary more than two degrees Fahrenheit from the thermostat or control set point during the tests. Outside temperature and humidity shall also be recorded during the testing periods.

D. TAB Report Verification: At the time of final inspection, the TAB agency may be required to recheck, in the presence of the owner's representative, specific and random selections of data, air quantities, and air motion recorded in the certified report. Points and areas for recheck shall be selected by the owner's representative. Measurements and test procedures shall be the same as approved for the initial work for the certified report. Selections for recheck, specific plus random, will not exceed 10% of the total number tabulated in the report.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 07 00 - PIPING AND EQUIPMENT INSULATION

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Piping Insulation

B. Jackets and Accessories

C. Equipment Insulation

D. Duct Insulation

1.02 RELATED WORK

A. Section 23 31 00 - Ductwork

1.03 REFERENCES

A. ANSI/ASTM C547 - Mineral Fiber Preformed Pipe Insulation

B. ANSI/ASTM C552 - Cellular Glass Block and Pipe Thermal Insulation.

C. ASTM B209 - Aluminum and Aluminum Alloy Sheet and Plate

D. ASTM E845 - Surface Burning Characteristics of Building Materials.

E. NFPA 255 - Surface Burning Characteristics of Building Materials.

F. UL 723 - Surface Burning Characteristics of Building Materials.

1.04 QUALITY ASSURANCE

A. Applicator: Company specializing in application of piping insulation.

B. Materials: Flame spread/fuel contributed/smoke developed rating of 25/50/50 in accordance with ASTM E84, NFPA 255.0, UL 723.

1.05 SUBMITTALS

A. Submit product data for each application as per Section 01 30 00– Administrative Requirements.

B. Submit manufacturer's installation instructions.

PART 2.00 PRODUCTS

2.01 INSULATION

A. After all work has been tested and found to be leak free and tight, and accepted by the Architect, insulate as follows:

1. All chilled water, supply and return, piping above ground shall be covered with 2" thick molded cellular foam, foamglas or cell-u-glass type sectional pipe covering to be complete with F.R.J. jacket, with the exception of hot water run-outs - see item No. 2. Sections of covering shall be joined together, the mastic to be buttered on only one of the two adjoining surfaces at both the longitudinal and circumferential joints so that a complete seal at the joints is obtained. The piping insulation is to be secured in place with copper wire spaced not more than 12" on center.
2. All heating water, supply and return, piping above ground shall be covered with 1-½" thick molded cellular foam, foamglas or cell-u-glass type sectional pipe covering to be complete with F.R.J. jacket, with the exception of hot water run-outs – see item No. 2. Sections of covering shall be joined together, the mastic to be buttered on only one of the two adjoining surfaces at both the longitudinal and circumferential joints so that a complete seal at the joints is obtained. The piping insulation is to be secured in place with copper wire spaced not more than 12" on center.
3. All domestic hot and cold piping above ground shall be covered with 1" thick fiberglass, molded type sectional pipe covering complete with FRJ jacket. Sections of pipe covering shall be joined together, the mastic to be buttered on only one of the two adjoining surfaces at both the Longitudinal and circumferential joints so that a complete seal at the joints is obtained. The piping insulation will be secured in place with copper wire spaced not more than 12 on center. All domestic water piping insulation shall be continuous. Contractor shall not cut insulation to fit around structural items. No exceptions.
4. Insulate the square to round connections on each air handling unit with 3" thick 3/4 lb. density insulation board using stick pins randomly spaced 18" apart. Insulation board shall have aluminum vapor barrier.
5. Fittings, flanges, valves, etc., shall be covered with molded or fabricate covers of same material as pipe covering and shall be finished with two (2) coats of white vapor barrier mastic reinforced with 20-20 mesh glass fabric.
6. Insulate all VAV boxes, rectangular supply, return, exhaust, and fresh air ducts with 3" thick 3/4 lb. density fiberglass insulation with reinforced aluminum vapor barrier. Seal all joints with duct tape.
7. All round and flat oval supply air ducts shall be wrapped with 3" thick, 3/4 lb. density fiberglass insulation with reinforced aluminum vapor barrier. Seal all joints with 2" duct tape.
8. Insulate cooling coil condensate drain lines from air handling units with 1/2" thick aerotube type insulation tied on and sealed over with tape.
9. Insulate back of all ceiling diffusers with 3" thick fiberglass with reinforced aluminum vapor barrier.
10. All chilled heating and water valves, and hot water pumps shall be insulated with a factory fabricated removable cover. Cover shall be fabricated of 1" close cell elastomeric insulation complete with Velcro closures.
11. Insulate all horizontal roof drains with 2" thick ¾ lb. density fiberglass insulation with reinforced aluminum vapor barrier. Seal all joints with duct tape.

12. All outdoor mechanical piping shall be covered with aluminum jacket, water tight.
13. All older duct work shall be covered with aluminum jacket, water tight.
14. All external duct work must be externally insulated and double wall. Seal water tight.
15. All exterior ductwork and ductwork run in attic spaces shall be wrapped with 3" thick, 3/4 lb. density fiberglass insulation with reinforced aluminum vapor barrier.
16. Insulate all PVC piping located in a return air plenum with 2" thick ¾ lb. density fiberglass insulation with reinforced aluminum vapor barrier. Seal all joints with duct tape.

PART 3.00 EXECUTION

3.01 PREPARATION

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

3.02 INSTALLATION

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

B. Continue insulation with vapor barrier through penetrations.

C. On insulated piping with vapor barrier, insulate fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.

D. Neatly finish insulation at supports, protrusions, and interruptions.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 09 00 - INTEROPERABLE FACILITY MANAGEMENT SYSTEM

PART 1.00 GENERAL

1.01 OVERVIEW

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating temperature control system, utilizing Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Drawings are diagrammatic only. Equipment and labor not specifically referred to herein or on the plans, that is required to meet the functional intent, shall be provided without additional cost to the Owner. Performance and capabilities are based on Native BACNet approved products.

1.02 INSTALLATION

A. All work described in this section shall be installed, wired, circuit tested and calibrated by factory certified technicians qualified for this work and in the regular employment of the temperature control system manufacturer or its exclusive factory authorized installing contracting field office (representative). The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying longevity of the installing company's relationship with the manufacturer. Supervision, calibration and checkout of the system shall be by the employees of the local exclusive factory authorized temperature control contracting field office (branch or representative).

1.03 CONTROL WIRING

A. All electrical control wiring and power wiring to the control panels shall be the responsibility of the FMCS contractor.

B. The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters and motors.

C. All wiring shall be in accordance with the Project Electrical Specifications Division 26.

1.04 UNACCEPTABLE BIDS

A. Bids by wholesalers, dealers or any other firm whose principal business is not that of manufacturing or installing automatic temperature control systems shall not be acceptable. Bid documents that are not complete in their response to these documents or take exception to any of the capabilities defined within these documents will be rejected.

1.05 SHOP DRAWINGS/SUBMITTALS

A. Eight copies of shop drawings of the entire control system 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 also 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. A complete written Sequence of Operation as well as a hard copy graphical depiction of the application control programs shall also be included with the submittal package.

B. Upon completion of the work, provide a complete set of drawings and application software on disk media. Drawings shall be provided as AutoCAD or ViSiO compatible files.

1.06 MATERIALS

A. All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use. Products shall be BACNet Testing Lab (BTL) approved for this application. Products manufactured by other companies shall not be considered. Exceptions to the specification will qualify the bid as unacceptable.

1.07 WARRANTY

A. The temperature contractor shall provide a one-year warranty.

B. The temperature control contractor's office shall be within a 50-mile radius of the job site.

C. The contractor shall respond to the job site emergency calls within a reasonable amount of time during normal working hours.

1.08 SOFTWARE LICENSE AGREEMENT

A. The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software.

1.09 AGENCY AND CODE APPROVALS

A. All products of the BAS shall be provided with the following agency approvals. With the submittal documents, verification that the approvals exist for all submitted products shall be provided. Systems or products not currently offering the following approvals are not acceptable.
UL-916; Energy Management Systems.
ULC; UL - Canadian Standards Association
FCC, Part 15, Subpart J, Class A Computing Devices

B. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

C. The FMCS manufacturer shall provide documentation supporting compliance with ISO-9001 certification mark from applicable registrar.

PART 2.00 FACILITY MANAGEMENT CONTROL SYSTEM

2.01 GENERAL

A. The Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers

2.02 SPECIFICATION NOMENCLATURE

A. FMCS Facility Management Control System

B. IDC Interoperable Digital Controller

C. IBC Interoperable BACNet Approved Controller

D. GDC Gateway Digital Controller

E. GP Graphical Programmer

F. HMI Human Machine Interface

G. GUI Graphical User Interface

PART 3.00 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

3.01 NETWORK

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system under each internet server. The FMCS requires the incorporation of BACNet Technologies.

3.02 NAC

A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It shall be capable of executing application control programs to provide:
   1. Calendar functions
   2. Scheduling
   3. Trending
   4. Alarm monitoring and routing
   5. Time synchronization
   6. Integration of LONWorks controller data and BACNet controller data
   7. Network Management functions for all LONWorks based devices

B. The Network Area Controller must provide the following hardware features as a minimum:
   1. One Ethernet Port - 10Mbps
   2. One RS-232 port
   3. One LONWorks Interface Port - 78KB FTT - 10A or one MSTP Port
   4. Battery Backup
   5. Flash memory for long term data backup (If battery or flash memory is not supplies, the controller must contain a hard disk with at least 1 gigabyte storage capacity)
   6. The NAC must be capable of operation over a temperature range of 0 to 55C
   7. The NAC must be capable of withstanding storage temperatures of between 0 and 70C
   8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing
   9. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data mechanism to read and write data stored within it.
   10. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

C. The NAC shall provide alarm recognition, storage, routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   1. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up telephone connection, or wide-area network.
   2. Provide for the creation of a minimum of eight alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.
   3. Provide timed (schedule) routing of alarms by class, object, group, or node.
   4. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
   5. Control equipment and network failures shall be treated as alarms and annunciated.
   6. Alarms shall be annunciated in any of the following manners as defined by the user:
   7. Screen message text
   8. Pagers via paging services that initiate a page on receipt of email message
   9. Graphic with flashing alarm object(s)
   10. Printed message, routed directly to a dedicated alarm printer
   11. The following shall be recorded by the NAC for each alarm (at a minimum):
   12. Time and date
   13. Location (building, floor, zone, office number, etc.)
   14. Equipment (air handler#, access way, etc.)
   15. Acknowledgment time, date and user who issued acknowledgment.
   16. Number of occurrences since last acknowledgment.
   17. Alarm actions may be initiated by user defined programmable objects created for that purpose.
   18. Defined users shall be given proper access to acknowledgment any alarm, or specific types or classes of alarms defined by the user.
   19. A log of all alarms shall be maintained by the NAC and/or a server (if configured in

the system) and shall be available for review by the user.

20. Provide a "query" feature to allow review of specific alarms by user defined parameters.
21. A separate log for system alerts (controller failures, network failures, etc.) Shall be provided and available for review by the user.
22. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

D. The NAC shall have the ability to collect data for any property of any object and store this data for future use.
   1. The data collection shall be performed by log objects, resident in the NAC that shall have, at a minimum, the following configurable properties:
   2. Designating the log as interval or deviation.
      a. For interval logs, the object is configured for the time of day, day of week and the sample collection interval.
      b. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
   3. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
   4. Each log shall have the ability to have its data cleared on a timed-based event or by a user-defined event or action.
   5. All log data shall be stored in a relational database in the NAC and the data shall be accessed form a server (if the system is so configured) or a standard Web Browser.
   6. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
   7. All log data shall be available to the user in the following data formats:
      a. HTML
      b. XML
      c. Plain Text
      d. Comma or tab separated values
   8. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.
   9. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:

E. The GUI shall run on Microsoft Windows XP Professional or later.
   1. The GUI shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu–pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

2. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:
3. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphical background, the GUI shall support the use of scanned pictures.
4. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL's, and kinks to other graphic screens.
5. Graphics shall support layering and each graphic object is configurable for assignment to one a layer. A minimum of six layers shall be supported.
6. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
7. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
8. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
9. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
10. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.
11. System Configuration. At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:
12. Create, delete or modify control strategies.
13. Add/delete objects to the system.
14. Tune control loops through the adjustment of control loop parameters.
15. Enable or disable control strategies.
16. Generate hard copy records or control strategies on a printer.
17. Select points to be alarmable and define the alarm state.
18. Select points to be trended over a period of time and initiate the recording of values automatically.
19. On-Line Help. Provide a context sensitive, on-line system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.
20. Security. Each operator shall be required to logon to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

21. System Diagnostics. The system shall monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
22. The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledgment the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
23. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

PART 4.00 WEB BROWSER CLIENTS

4.01 WEB BROWSER CLIENTS

A. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine, or manufacture-specific browsers shall not be acceptable.

B. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the FMCS, shall not be acceptable.

C. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology by the Graphical User Interface. Systems that require different views or that require means of interfacing with objects such as schedules, or logs, shall not be permitted.

D. The Web browser client shall support at a minimum, the following functions:
1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
2. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
4. Storage of the graphical screens shall be in the Network Area Controller (NACS), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
5. Real-time values displayed on a Web page shall update automatically without

requiring a manual "refresh" of the Web page.

6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
7. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
8. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
9. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
10. Commands to start and stop binary objects shall be done by right-clicking the selecting the appropriate command from the pop-up menu. No entry of text shall be required.
11. View logs and charts
12. View and acknowledge alarms
13. Setup and execute SQL queries on log and archive information
14. The system shall provide the capability to specify a user's (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
15. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

4.02 SYSTEM PROGRAMMING

A. The Graphical User Interface software (GUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the GUI shall be through access as assigned by the system administrator. The GUI shall include graphics generation of all HVAC equipment with values and status displayed. The graphics shall be a graphical representation of each piece of equipment being controlled and shall be recognizable as the piece of equipment it is representing. The graphics shall be submitted to owner and engineer for approval prior to installation.

B. A library of control, application, and graphic objects shall be provided to enable the creation of all applications and interface screens. Applications are to be created by selecting the desired control objects from the library, dragging or pasting them on the screen, and linking them together using a built in graphical connection tool. Completed applications may be stored in the library for future use. Graphical User Interface screens shall be created in the same fashion. Data for the user displays is obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Systems requiring separate software tools or processes to create applications and user interface displays shall not be acceptable.

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-

defined library to the user's application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

2. Configuration of each object will be done through the object's property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.
3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
4. All programming shall be done in real-time. Systems requiring the uploading, editing and downloading of database objects shall not be allowed.
5. The system shall support object duplication within a customer's database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

4.03 NETWORK MANAGEMENT

A. The Graphical User Interface software (GUI) shall provide a complete set of integrated LONWorks or BACNet network management tools for working with BACNet networks. These tools shall manage a database for all devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between devices, known as "binding". Systems requiring the use of third party network management tools shall not be accepted.

B. Network management shall include the following services: device identification, device installation, device configuration, device diagnostics, device maintenance and network variable binding.

C. The Network configuration tool shall also provide diagnostics to identify devices on the network, to reset devices, and to view health and status counters within devices.

D. These tools shall provide the ability to "learn" an existing BACNet network, regardless of what network management tool(s) were used to install the existing BACNet devices and newly added devices are part of a single network management database.

E. The network management database shall be resident in the Network Area Controller (NACS), ensuring that anyone with proper authorization has access to the network management database at all times. Systems employing network management databases that are not resident, at all times, within the control system, shall not be accepted.

4.04 OBJECT LIBRARIES

A. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.

B. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.

C. In addition to the standard libraries specified here, the supplier of the system shall maintain an on-line accessible (over the Internet) library, available to all registered users to provide new or updated objects and applications as they are developed.

D. All control objects shall conform to the control objects specified in the BACNET specification.

E. The library shall include applications or objects for the following functions, at a minimum:
   1. Scheduling Object. The schedule must conform to the schedule object as defined in the BACNET specification, providing 7-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphical sliders to speed creation and selection of on/off events.
   2. Calendar Object. The calendar must conform to the calendar object as defined in the BACNET specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphical "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
   3. Duty Cycling Object. Provide a universal duty cycle object to allow repetitive on/off time control of equipment as an energy conserving measure. Any number of these objects may be created to control equipment at varying intervals.
   4. Temperature Override Object. Provide a temperature override that is capable of overriding equipment turned off by other energy saving programs (scheduling, duty cycling etc.) To maintain occupant comfort or for equipment freeze protection.
   5. Start-Stop Optimization Object. Provide a start-stop time optimization object to provide the capability of starting equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled un-occupancy time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on the previous day's performance.
   6. Demand Limiting Object. Provide a comprehensive demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, and gas). The object shall provide the capability of monitoring a demand value and predicting (by use of a sliding window prediction algorithm) the demand at the end of the user defined interval period (1-60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify equipment set points to effect the desired energy reduction. If the list of

sheddable equipment is not enough to reduce the demand to below the set point, a message shall be displayed on the users screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to effect both equipment protection and occupant comfort.

F. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NACS). At a minimum, provide the following as part of the standard library included with the programming software:
   1. BACNet devices. These devices shall include, but not be limited to, devices for control of the AHU system

PART 5.00 INTEROPERABLE CONTROLLERS

5.01 GENERAL

A. BACNet (IBC) Interoperable Controllers
   1. Controls shall be microprocessor based Interoperable BACNet Controllers, bearing the applicable BTL logo on each product delivered. IBC shall be provided for AHU's, Fan Coils, VAV Terminal Boxes and other applications as shown on the drawings. IBC's shall be based on ASHRAE – 135 interoperability.
   2. To simplify controls and mechanical service troubleshooting, the IBC shall be mounted directly in the control compartment of the unitary system. The IBC shall be provided with a sheet metal or polymeric enclosure that is constructed of material allowing for the direct mounting within the primary air stream, as defined by UL-465. The direct mounting shall allow all controls maintenance and troubleshooting to be made while at the unitary equipment.
   3. The IBC'S shall communicate with the SDC at a baud rate of not less than 78.8K baud. The IBC shall provide LED indication of communication and controller performance to the technician without cover removal.
   4. The IBC shall be fully supported and communicate with any and all GUI(s) on the bus.

B. IC Sensor
   1. The IC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IC Sensor shall provide a communications jack for connection to the communication trunk to which the controller is connected. The IC Sensor, the connected controller, and all other devices on the bus shall be accessible by the Graphical Programming tool.
   2. The IC Sensor shall be supplied in the following variations;
      a. Tamper-resistant (no display)
      b. Tamper-resistant with tenant override
      c. Basic user functions (LCD display and setpoint adjustment and tenant override)

d. Full user functions (LCD display and network-variable access and tenant override)

e. ASHRAE 95 compliance (LCD display and sub-base functionality)

3. The IC Sensor shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of the electronics or esthetic covering. The IC Sensor shall allow for the customization of the color on the esthetic covering as a standard offering. User interface with the IC Sensor shall be provided as a configurable function by the FMCS, and shall offer password protection for access to network variable editing. Multiple network variables shall be accessible and editable by the IC Sensor. Icons shall be utilized to represent sensor and controller function status, affording independence from a single language for use interface. All IC sensors shall monitor and display space temperature and humidity.

5.02 IBC FUNCTIONALITY

A. IBC Functionality

1. The IBC shall provide a -40 to 140 degree F ambient operating temperature range. The IBC shall be provided in a modular configuration that allows for the rough in of all wiring without the presence of any of the IBC electronics. IBC devices that require the electronics to be present at the time of wiring, will require an additional controller to be provided for every 10 devices on the drawings, to allow for the preconfiguration and storing for service purposes.

2. All input/output signals shall be directly hardwired to the controller. For all-non-VAV terminal applications, a minimum of two input points of the IBC shall employ a universal configuration that allows for flexibility in application ranging from dry contact, resistive, to voltage/current sourced inputs. If universal points are not available, a minimum of two input points (each) of the dry contact, resistive and analog voltage/current types must be provided on every controller. The outputs of the IBC shall be of the relay and type. IBC devices utilizing non-relay outputs shall provide an interface relay for all points. All analog outputs shall be programmable for their start points and span to accommodate the control devices. Configuration of all I/O points shall be accomplished without physical hardware jumpers, switches or settings. Troubleshooting of input/output signals shall be easily executed with the Graphical Programming tool (GP) or a volt-ohm meter (VOM). All I/O points shall be utilized by the local IBC or shall be available as I/O points for other controllers throughout the network.

3. All IBC's shall be fully application programmable and shall at all times maintain their BTL certification. Controllers offering application selection only (non-programmable), require a 10% spare point capacity to be provided for all applications. All control sequences within or programmed into the IBC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

4. The IBC shall be provided with the ability to interface with the Graphical Programming tool. The interface port shall be provided at the wall sensor or within the unitary equipment, as specified on the plans. The interface port shall allow the GP to have full functionality as described in GP section of this specification. Through the connected controller all IBC devices shall be accessible by the Graphical Programming tool.

PART 6.00 OTHER SYSTEM HARDWARE

6.01 OTHER SYSTEM HARDWARE

A. Control Valves: Control system contractor shall be responsible for selection of the proper control valves including line size, pressure rating, flow-coefficient, shut-off rating and allowable leakage factor. Modulating water valves shall be sized for nominal 4 psi maximum pressure drop. All chilled water valves shall be two-way is a 3-way valve and all hot water valves shall be 3-way modulating with linear throttling plug. Valve stems shall be silicone brass or stainless steel.

B. Wall Mount Room Thermostats/Humidistats: Each room thermostat/humidistat shall provide temperature and humidity indication to the digital controller; provide the capability for a software-limited set point adjustment and operation override capability. The integral LCD shall annunciate current room temperature, humidity and set point as well as override status indication. In addition, the thermostat/humidity shall include a port for connection of the portable operator's terminal described elsewhere in this specification.

C. Duct Mount and Outside Air Temperature Sensors: 1000ohm RTD temperature sensors with an accuracy of 0.2 degrees C. Outside air sensors shall include an integral sun shield.

D. Current Sensitive Switches: Solid state, split core current switch that operates when the current level (Sensed by the internal current transformer) exceeds the adjustable trip point. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

E. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors fro mounting all devices as shown. All electrical devices within a control panel shall be factory wired. All external wiring shall be connected to terminal strips mounted within the panel. Provide engraved phenolic nameplates identifying all devices mounted on the face of control panels. A complete set of "as-built" control drawings (relating to the controls within that panel) shall be furnished within each control panel.

F. Humidity Sensors: Accuracy shall have an accuracy of 3% minimum.

G. Air Flow Measuring Station: Furnish air flow measuring station which utilizes thermal dispersion technology with a minimum of 2 sensing points. Station shall be Ebtron Model ST series or prior approved equal.

H. Differential pressure transmitter: Shall be equipped with a local display. The range shall be selected so that the anticipated setpoint shall be midrange. Transmitters for chilled water and hot water applications shall have a bypass manifold for serving.

I. CO2 transmitter: CO2 transmitters shall have a range from 0 to 2000ppm and shall be accurate to $\pm$ 5% of reading.

J. Flow transmitter: Shall be a dual turbine flow meter as manufactured by Onicon.

PART 7.00 SEQUENCE OF OPERATION

7.01 AIR HANDLING UNIT:

A. System shall be started and stopped from the FMCS when the starter H-O-A switch is in the auto position. All safety controls shall stop the unit regardless of which position the H-O-A switch is in.

B. Discharge air temperature sensor shall transmit temperature to the local panel of FMCS. FMCS shall modulate the cooling coil 3-way valve to maintain setpoint (adjustable at GUI).

C. Return air humidity shall be transmitted to the local panel of the FMCS. The FMCS shall open the chilled water valve 100% when the return air humidity rises above setpoint (Adjustable at GUI).

D. A high limit thermostat located in the unit return air will stop the fan on a rise in temperature above its setpoint. Thermostat shall be set at 125 degrees F and require a manual reset. Smoke detector shall stop the fan through the fire alarm system.

E. In addition to maintaining the temperatures in all three ducted zones, The chilled water coil shall be utilized to maintain humidity setpoint in each ducted zone.

7.02 DUCT MOUNTED HEATING,REHEATING HOT WATER COILS

A. The heating coils shall only operate when its associated air unit is operating. As temperature drops, the three-way valve shall modulate open to maintain setpoint. As temperature rises above setpoint the coil shall by-pass the heating/reheating hot water.

B. During unoccupied periods the heating and cooling setpoints shall be reset to the unoccupied heating and cooling setpoints which are individually adjustable at the GUI. Each thermostat/humidistat will include an override button. The duration of override shall be individually adjustable at the GUI. Each heating hot water coil shall have an individual schedule and this schedule shall be adjustable at the GUI.

7.03
7.07 I/O SUMMARY CHART

	DO	DI	AI	AO
AHU				
Fan start/stop	X			
Fan status		X		
Supply temperature			X	
Cooling valve				X
Chilled water supply temperature			X	
Chilled water return temperature			X	

Chilled water 3-way bypass valve					X
VFD drive				X	
Return air temperature			X		
Return air Humidity			X		
Outside air CFM			X		
Outside air Damper				X	
Duct Static Pressure			X		
Duct Hot Water Coils					
Space Temperature			X		
Space Temperature Setpoint			X		
Discharge Temperature			X		
CFM			X		
Heating valve	X				
Override Button		X			
Heating water supply temperature				X	
Heating water return temperature				X	
Heating water 3-way bypass valve					X

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 21 13 - HYDRONIC PIPING

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Pipe and Pipe Fittings

B. Heating Water Piping System

C. Chilled Water Piping System

1.02 RELATED WORK

A. Section 23 00 00 - General Provisions

B. Section 23 05 29 - Anchors and Supports

C. Section 23 05 53 - Mechanical Identification

D. Section 23 07 00 - Piping and Equipment Insulation

1.03 REFERENCES

A. ASTM A53 - Pipe, Steel, Black and Hot-Dipped Zinc Coated, Welded and Seamless.

B. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME B31.9.

1.05 QUALITY ASSURANCE

A. Valves: Manufacturer's name and pressure rating marked on valve body.

B. Welding Materials and Procedures: Conform to ANSI/ASME Sec. and applicable State Labor Regulations.

1.06 SUBMITTALS

A. Submit shop drawing and product data under provisions of Section 01 30 00– Administrative Requirements.

B. Include data on pipe materials, pipe fittings, valves, and accessories.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 01 60 00 – Product Requirement.

B. Store and protect products under provisions of Section 01 60 00 – Product Requirement.

PART 2.00 PRODUCTS

2.01 HEATING WATER PIPING

A. Steel Pipe: ASTM A53, Schedule 40 ERW.

B. Piping terminal heating coils (3' max.) Type M hard drawn copper, ASTM 88, wrought copper fittings.

2.02 CHILLED WATER PIPING - (ABOVE GROUND)

A. Steel pipe: ASTM A53, Schedule 40, ERW.

2.03 EQUIPMENT DRAINS AND OVERFLOWS

A. For piping materials see piping section.

B. All A.H. unit drains shall have cleanouts.

C. All A.H. unit auxiliary drains shall be piped separately from primary drains to floor drains.

D. Drain piping (A.H. units) copper tubing type M, hard drawn, ASTM 88 wrought copper fittings.

2.04 FLANGES, UNIONS, AND COUPLINGS

A. Pipe Size 2 inches and under: 150 psig malleable iron unions for threaded ferrous piping; bronze unions for copper pipe, soldered joints.

B. Pipe size over 2 inches: 150 psig forged steel slip-on flanges for ferrous piping; bronze flanges for copper piping; 1/16 inch thick preformed neoprene.

2.05 VALVES

A. For valves in hydronic systems, see Valve Section 23 05 23.

2.06 RELIEF VALVES

A. Bronzed body, teflon seat, stainless steel stem and springs, automatic.

PART 3.00 EXECUTION

3.01 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.

D. After completion, fill, clean, and treat systems.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.

B. Install piping to conserve building space, and not interfere with use of space and other work.

C. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Provide clearance for installation of insulation, and access to valves and fittings.

E. Provide access where valves and fittings are not exposed.

F. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.

G. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.

H. Prepare pipe and fittings, supports, and accessories for finish painting. Refer to Section 099000 – Painting and Coating.

3.03 APPLICATION

A. Install brass male adapters each side of valves in copper piped system. Sweat solder adapters to pipe.

B. Install ball or butterfly valves for throttling, bypass, or manual flow control services.

C. Provide spring loaded check valves on discharge of condenser water pumps.

D. Use plug cocks for throttling service. Use non-lubricated plug cocks only when shut-off or isolating valves are also provided.

E. Use lug end butterfly valves to isolate equipment.

F. Provide 3/4 inch gate or ball drain valves at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. Pipe to drain if specified on drawings.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 21 16 - HYDRONIC SPECIALITIES

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Air vents.

B. Flow indicators, controls, meters.

C. Thermostats and Pressure Gages

1.02 RELATED WORK

A. Section 23 21 13 - Hydronic Piping

1.03 REFERENCES

A. ANSI/ASME - Boilers and Pressure Vessels Code.

1.04 REGULATORY REQUIREMENTS

A. Conform to ANSI/ASME Boilers and Pressure Vessels code Section 8D for manufacturer of tanks.

1.05 QUALITY ASSURANCE

A. Manufacturer: For each product specified, provide components by same manufacturer throughout.

1.06 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01 30 00 – Administrative Requirements.

B. Submit shop drawings and product data for manufactured products and assemblies required for this project.

C. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.

1.07 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01 70 00 – Execution Requirements.

B. Include installation instruction, assembly views, lubrication instructions, and replacement parts

lists.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 01 60 00.

PART 2.00 PRODUCTS

2.01 MANUFACTURERS

A. Certain items in this Specification are listed by manufacturer and/or manufacturer's model number to establish general style, type, character, and quality of product desired. Similar items manufactured by other than those listed will be considered, providing submittals are made according to Pre-Bid Approval requirements of Instructions to Bidders, page IB-3, Paragraph 4.3.

B. Where no manufacturer or model number are given, any product meeting performance or design criteria, or referenced trade association standard may be used but Pre -Bid Approval is required.

2.02 AIR VENTS

A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8" brass needle valve at top of chamber.

B. Float Type: Brass or semi-steel body, copper float, stainless steel valve and valve seat; suitable for system operating temperature and pressure, with isolating valve.

C. Washer Type: Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring-loaded ball check valve.

2.03 STRAINERS

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

B. Size 2-1/2" to 4" flanged iron body for 175 psig working pressure, Y pattern with 1/8" stainless steel perforated screen.

C. Size 5 inch and larger: Flanged iron body for 175 psig working pressure, Y pattern with 1/8" stainless steel perforated screen.

2.04 FLOW METERS

A. Heavy duty, 316 stainless steel pitot tube type flow measuring sensor with instrument connections with valves 1/4" SAE flare by 1/8" female NPT brass valves on 1/8" male NPT fittings.

B. Portable meter consisting of case containing one, 3 percent accuracy pressure gauge with 0-60 feet pressure range; two, 3 percent accuracy pressure gauges with 0-135 inches and 0-60 feet pressure ranges for 500 psig maximum working pressure, color coded hoses for low and high pressure connections, and connectors suitable for connection to read-out valves.

2.05 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Case: Die-cast aluminum or brass, 9 inches long.

B. Tube: Red or blue reading, [mercury] [mercury or organic-liquid] [organic-liquid] filled, with magnifying lens.

C. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

D. Window: Glass.

E. Connector: [Adjustable type, 180 degrees in vertical plane.

F. Stem: Aluminum, or brass for thermowell installation and of length to suit installation.

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

2.9 PRESSURE GAGES

A. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.

B. Case: Liquid-filled type, cast aluminum] 4-1/2-inch diameter.

C. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.

D. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.

E. Movement: Mechanical, with link to pressure element and connection to pointer.

F. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

G. Pointer: Red[or other dark-color] metal.

H. Window: Glass.

I. Ring: Stainless steel.

J. Accuracy: Grade B, plus or minus 2 percent of middle half

K. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.

L. Range for Fluids under Pressure: Two times operating pressure.

2.05 ACCEPTABLE MANUFACTURERS

A. Annubar with Eagle Eye flow meter.

B. PRESCO Annular with model GM meter.

C. Palmer - Wahl Instruments Inc.

D. Trerice, H. O. Co.

E. Weiss Instruments, Inc.

F. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

PART 3.00 EXECUTION

3.01 INSTALLATION AND APPLICATION

A. Install specialties in accordance with manufacturer's instructions to permit intended performance.

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 valved drain and hose connection on strainer blow down connection.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 31 00 - DUCTWORK

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Low pressure duct.

B. Medium and high pressure duct.

C. Fire and Smoke Dampers

1.02 RELATED WORK

A. Section 23 05 23 - Supports and Anchors

B. Section 23 07 00 - Piping and Equipment Insulation

C. Section 23 36 00 - Air Terminal Units

D. Section 23 37 00 - Air Inlets and Outlets

E. Section 23 05 93 - Testing and Balance

1.03 REFERENCES

A. ASHRAE, 2021 Fundamentals

B. ASHRAE, 2024 HVAC Systems & Equipment

C. NFPA 90A, 90B.

D. H.V.A.C. Duct Construction Standards - SMACNA 2020.

1.04 DEFINITIONS

A. Duct sizes: Inside clear dimensions for wrapped ducts, maintain sizes inside lining. Metal to metal sizes for internally lined ductwork.

B. Low Pressure: Three pressure classifications: 1/2" WG positive or negative static pressure and velocities less than 2,000 fpm, 1" WG positive or negative static pressure and velocities less than 2,500 fpm and 2" WG positive or

C. Medium Pressure: Three pressure classifications: 3 inch WG positive or negative static pressure and velocities less than 4,000 fpm, 4" WG positive static pressure and velocities greater than 2,000 fpm. 6" WG positive static pressure and velocities greater than 2,000 fpm.

1.05 REGULATORY REQUIREMENTS

A. Construct ductwork to NFPA 90A and NFPA 90B Standards.

B. Store and protect products under provisions of Section 01 60 00.

C. Construct ductwork to International Mechanical Code Standards

PART 2.00 PRODUCTS

2.01 LOW PRESSURE DUCTWORK

A. Furnish and install all ducts for the air conditioning, heating and ventilating systems. Ductwork shall be complete with grilles, vanes splitters, flashings, hangers, flexible connections, manual dampers, fresh air inlet louvers, reinforcing angles, transitions to equipment, etc.

B. All low pressure ductwork (mean velocity less than 2,000 FPM and static pressure in duct 2" of water or less) shall be constructed as per SMACNA Standards, 1995 Edition, Chapter 1, and shall be of the gauge metal and reinforced as per SMACNA Standards, 1995 Edition.

C. Flashing shall be of the same material as specified under the roofing and flashing section of these specifications, or of 16-ounce sheet copper and shall be furnished and installed around all outside openings used for ducts or fans where required. Roof flashing shall extend at least 8" above roof. Cooperate with roofing contractor when installing flashing.

D. All duct connections to equipment shall be made with fire and mildew resistant flexible connections of canvas or other acceptable materials. Connections shall have suitable metal collar frames at each end and shall not be less than 4" long with at least 1" of slack in the connection. Flexible connections shall be heat resistant to 500 degrees F continuously.

E. Duct dimensions shown are metal sizes. All edges shall be straight and true.

F. All flexible connections, duct liner and adhesives shall be U.L. listed as having a maximum flame spread of 50, fuel contribution of 25 and smoke contribution of 25.

G. This Contractor shall furnish and install in ductwork all dampers, vanes splitters, etc.. as shown on the drawings or necessary to make the system complete. Where dampers or splitters can not be accessed through lay in ceiling, Contractor shall provide lockable 24" x 24" access door. Contractor shall coordinate location with Architect.

H. Shafts shall be marked to show position of dampers, vanes, splitters, etc.

I. Ductwork shall be supported in accordance with SMACNA Plate No. 17 and No. 18, up to and including band iron hangers attached to duct by means of screws or rivets per hanger.

J. Access doors shall be provided in ductwork for all automatic dampers and each manual damper 3 square feet in area or larger, and shall be so located that damper can be completely

serviced through the access door. Access door shall be provided with felt gaskets and suitable hinges and locks. Where access doors occur in insulated duct, double skin insulated doors shall be used.

K. Where square ducts are shown, provide single vane elbows as per Plate 22, Figure A, SMACNA Standards, 2020 Edition. For all ductwork over 18" provide double vane square elbow as shown in Figure C of the Plate.

L. All low pressure ductwork joints shall be sealed with hard cast "iron grip".

M. Flexible air duct for connections between low pressure rectangular duct and ceiling diffusers shall be pre- insulated and listed by Underwriters Laboratories under U.L Standard 181 as a Class 1 flexible air duct and complying with NFPA Standards 90A and 90B.

N. All flex duct 45 degree and 90 degree turns shall be metal hard duct.

2.02 LOW LOSS TAP

A. All round low pressure connections to rectangular ducts shall be made with a factory fabricated 45 degree low loss entry "shoe" tap with damper constructed of minimum 26 gage galvanized steel. The damper shall have a 2" raised handle with a high quality locking quadrant. A 3/8" continuous rod with "U" bolts connects the damper to the rod. Nylon end bearings are required where the rod penetrates the spin collar barrel.

B. Provide Flexmaster #STOD-BO3, Dace # 26 ga STOD-C03, or prior approved equal.

C. For medium pressure systems where used upstream of VAV terminals, the damper can be eliminated (use Flexmaster #STO or Dace 24 ga STO). Gauge shall be 24 gauge on medium pressure systems.

PART 3.00 EXECUTION

3.01 INSTALLATION

A. See details of ductwork symbols and connections on drawing.

B. Provide neoprene flexible connections between all ductwork and HVAC equipment.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 70 00 - CENTRAL STATION AIR HANDLER

PART 1.00 GENERAL

1.01 WORK INCLUDED

A. Applied Air Handling Units.

1.02 RELATED SECTIONS

A. Section 23 05 16 - Expansion Compensation.

1.03 REFERENCES

A. AMCA 300 - Reverberant Method for Sound Testing of Fans.

B. AMCA 301 - Method for Publishing Sound Ratings for Air Moving Devices.

C. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

D. ANSI/UL 900 - Test Performance of Air Filter Units.

E. ARI 260 - Standard for Sound Rating of Ducted Air Moving and Conditioning Equipment

F. ARI 410 - Standard for Forced Circulation Air-Cooling and Air-Heating Coils.

G. ARI 430 - Standard for Central Station Air Handling Units.

H. ARI 1060 Air-To-Air Energy Recovery Ventilation Equipment

I. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.

J. ASTMB 117 - Standard Practice for Operation Salt Spray Apparatus

K. NEMA MG1 - Motors and Generators

L. NFPA 90 A & B - Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems.

M. SMACNA - HVAC Duct Construction Standards.

N. UL 1995 - Heating and Cooling Equipment

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum of five years documented experience.

B. The management system governing the manufacture of this product is ISO (International Organization for Standardization) 9001:2015 certified.

C. Air-handling unit assembly shall have UL (Underwriters Laboratories) 1995 certification for safety, including use with electric heat.

D. Products requiring electric connection shall be listed and classified by ETL and CSA (Canadian Standards Association) as suitable for the purpose specified and indicated.

E. All coils shall be rated in accordance with AHRI Standard 410, latest edition. Chilled water, hot water, and steam coils shall be certified, in accordance with AHRI Standard 410.

F. Direct expansion coils shall be designed and tested in accordance with ANSI/ASHRAE (American National Standard Institute/American Society of Heating, Refrigerating and Air-Conditioning Engineers) 15 Safety Code for Mechanical Refrigeration.

G. Unit performance shall be rated in accordance with AHRI Standard 430 for Central Station Air Handling Unit Supply Fans and subject to verification of rating accuracy by AHRI-sponsored, third party testing.

H. Units shall meet NFPA (National Fire Protection Association) 90A requirements.

1.05 SUBMITTALS

A. Submit unit performance including: capacity, nominal and operating performance.

B. Submit Mechanical Specifications for unit and accessories describing construction, components, and options.

C. Submit shop drawings indicating overall dimensions as well as installation, operation and service clearances. Indicate lift points and recommendations. Indicate unit shipping split locations, and split dimensions, installation and operating weights including dimensions.

D. Provide fan curves with specified operating point clearly plotted.

E. Submit data on electrical requirements. Include safety and start-up instructions.

F. Submit sound data certified to ARI 260.

1.06 REGULATORY REQUIREMENTS

A. Unit shall be manufactured to conform to UL 1995 Standard and shall be listed by either UL/CUL or ETL. Units shall be provided with listing agency label affixed to unit. In the event the unit is not UL/CUL or ETL approved, the contractor shall, at his/her expense provide for a field inspection by a UL/CUL or ETL representative to verify conformance. If necessary, contractor shall perform modifications to the unit to comply with UL/CUL or ETL as directed by the representative, at no additional expense to the owner.

B. Certify air-handling units in accordance with ARI 430. If air-handling units are not certified in accordance with ARI 430, contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

C. Certify air-handling coils in accordance with ARI 410. If air-handling coils are not certified in accordance with ARI 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

1.07 DELIVERY, STORAGE AND PROTECTION

A. All indoor units, painted or unpainted, shall be completely shrink-wrapped from the factory for protection during shipment. Tarping of bare units is unacceptable.

B. Inspect for transportation damage and store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.08 START-UP AND OPERATING REQUIREMENTS

A. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak tested, belts aligned and tensioned, all shipping braces have been removed, and fan has been test run under observation.

1.09 WARRANTY

A. The equipment manufacturer shall provide, at no additional cost, a standard parts warranty that covers a period of one year from unit start-up or 18 months from shipment, whichever occurs first. This warrants that all products are free from defects in material and workmanship and shall meet the capacities and ratings set forth in the equipment manufacturer's catalog and bulletins.

PART 2.00 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Alternate manufacturers must submit a formal prior approval request including dimensional drawings. Prior approval requests that do not include dimensional drawings will not be considered.

B. Units shall ship in the number of sections necessary to meet project requirements.

C. Unit shall be factory-supplied, central station air handler. The air-handling unit may consist of several sections. Refer to mechanical plans a fan with the following factory-installed components as indicated on the equipment schedule.

D. Custom units must meet the scheduled dimensions.

2.02 GENERAL

A. Unit layout and configuration shall be as defined in project plans and schedule.

B. Provide factory-installed external support kit (minimum height of 6") on the base of the unit. External support kit shall be used for ceiling suspension, external isolation, or with housekeeping pad. Contractor will be responsible for providing a housekeeping pad when unit mounting device is not of sufficient height to properly trap unit. Unit mounting devices not constructed of galvanized steel shall be chemically cleaned and coated with both a rust-inhibiting primer and finished coat of rust-inhibiting enamel.

2.03 UNIT CASING

A. Unit shall be constructed of a complete frame with easily removable panels. Removal of any panel shall not affect the structural integrity of the unit.

B. All units shall be supplied with 14-gauge or heavier, G-90 galvanized steel base rails. Bolt-on legs are NOT acceptable. Perimeter lifting lugs for overhead lifting shall be provided on each shipping section. Slinging units in place of lifting lugs shall not be acceptable.

C. Unit shall be thermally broken to minimize the conduction path from the inside of the casing to the outside.

D. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel and shall have one of the following exterior finis:

E. Unpainted G-90 galvanized steel.

F. Casing panels (top, sides, and bottom) shall be constructed of galvanized steel and shall have the following interior finish: Unpainted G-90 galvanized steel.

G. Casing panels (top, sides, and bottom) shall be one piece, double-wall construction with foam insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R value of less than 13.

H. Casing deflection shall not exceed a L/240 ratio when subject to an internal pressure of ± 8-in. wg and shall exhibit no permanent deformation at ± 9-in. wg. L is defined as the longest linear panel or cabinet length (measured to AHRI 1350 Cd level 2).

I. Casing leakage rate shall be less than 1% at 8 in. wg of nominal unit airflow or 50 cfm, whichever is greater. Leakage rate shall be tested and documented on a routine basis on random production units. Optionally, factory witness leak testing and/or test reports shall be available.

J. Side panels shall be easily removable for access to unit and shall seal against a full perimeter

automotive style gasket to ensure a tight seal.

K. The panel retention system shall comply with UL 1995 which states all moving parts (for example, fan blades, blower wheels, pulleys, and belts) that, if accidentally contacted, could cause bodily injury, shall be guarded against accidental contact by an enclosure requiring tools for removal.

L. Accessibility options shall be as follows:

M. Hinged, lockable double-wall access door on either side with removable access panel(s) on the other side.

N. Fan supports, structural members, panels, or flooring shall not be welded, unless aluminum, stainless steel, or other corrosion-resistant material is used. Painted welds on unit exterior steel or galvanized steel are not acceptable.

O. All coil sections shall be doublewall construction with foam insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13. Single height coil sections shall have removable frame sections to facilitate vertical coil extraction.

P. Access doors shall be one piece, hinged, lockable double-wall construction with foam insulation sealed between the inner and outer panels. Panel assemblies shall not carry an R-value of less than 13.

2.04 FANS

A. Plenum Fan: Shall be a SWSI backward curved fans. Fan wheel shall be constructed of aluminum. Blades shall be welded to both front and back plates of the wheel. Fan assembly shall be dynamically balanced per ISO standard 1940 quality grade 6.3.

B. Isolated fan assembly vibration shall not exceed 0.248 in. per second when mounted on active isolators. Vibration shall be measured in both vertical and horizontal directions at the specified fan operating speed using specified motor. For testing purposes, accelerometers shall be mounted on the motor near the bearing locations an removed before shipment.

C. Direct motor shall exceed the minimum efficiency requirements of the ErP Directive for Fans, efficiency class IE4, and specify motor protection according to EN 60529. Motors shall also provide the following: locked rotor protection, phase failure detection, soft start, mains under-voltage detection, over-temperature protection of electronics/motor, and short circuit protection.

D. Performance Ratings: Supply fan performance shall be rated and certified in accordance with AHRI Standard 430, latest edition.

E. Sound Ratings: Manufacturer shall submit first through eighth octave sound power for fan discharge and casing radiated sound. Sound ratings shall be tested in accordance with AHRI 260.

F. Mounting: Direct drive plenum fan: Fan wheel, inlet plate, inlet ring, and motor and motor supports shall be a common assembly. The assembly is mounted directly to panels on an internal bulkhead wall.

G. Fan Accessories: Direct Drive Plenum Fans with EC Motors and BACnet Interface.

2.05 COILS

A. All water coils shall be provided to meet the scheduled performance. All coil performance shall be certified in accordance with AHRI Standard 410. All water shall be tested at 450 psig air pressure.

B. General Fabrication:

1. All water and coils shall have minimum 1/2-in. or 5/8" OD copper tubes mechanically expanded into fins to ensure high thermal performance with lower total flow and pumping requirements. Minimum tube wall thickness shall be 0.016 inches.
2. Aluminum plate fin type with belled collars available from 8 to 12 fins per inch in one fin per inch increments. Fin type shall be sine wave construction.
3. Aluminum-finned coils shall be supplied with die-formed casing and tube sheets of stainless steel as specified.

C. Cooling Coils:

1. Headers shall be constructed of steel with steel MPT connections. Headers shall have drain and vent connections accessible from the exterior of the unit.
2. Configuration: Coils shall be drainable, with non-trapping circuits. Coils will be suitable for a design working pressure of 300 psig at 200°F.

2.06 BASE-LEVEL DRAIN PANS

A. Drain pans shall be foam insulated double-wall stainless steel construction. The pan shall be sloped toward the drain connection. Drain pan shall have 1-1/2-in. MPT connection exiting through the hand side or opposite side of the casing as specified. One drain outlet shall be supplied for each cooling coil section. Drain pan shall allow no standing water and comply with ASHRAE (American Society of Heating, Refrigeration and Air-Conditioning Engineers). Standard 62.1-2010. Where 2 or more coils are stacked in a coil bank, intermediate drain pans shall be provided and the condensate shall be piped to the bottom drain pan. The bottom coil shall not serve as a drain path for the upper coil.

B. Units with heating coils shall have a drain pan under complete heating coil section sloped in 2 planes and pitched toward drain connections to ensure proper drainage during cleaning and to capture water in the event of a coil failure.

C. All drain pan connections supplied by unit manufacturer including, piping, and piping connections extending from stainless steel drain pans shall be constructed of stainless steel. The contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of

condensate.

2.07 FILTERS

A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Construct doors in accordance with Section 2.03, paragraphs D, E, and F. Provide filter block offs as required to prevent air bypass around filters.

B. Flat filter sections shall accept 2-in. Merv 8 filters.

C. Manufacturer shall provide one set of startup filters.

2.08 DAMPERS

A. All dampers, with the exception of external bypass and multi-zones (if scheduled), shall be internally mounted. Dampers shall be premium ultra low leak and located as scheduled. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 5 CFM/square foot at one inch water gauge and 9 CFM/square foot at 4 inches water gauge. All leakage testing and pressure ratings shall be based on AMCA Publication 500. Manufacturer shall submit brand and model of damper(s) being furnished.

2.09 ELECTRICAL ACCESSORIES

A. ECM Power Distribution Panel

1. Power distribution panel shall be enclosed in a NEMA 4 electrical box and shall be included with every fan section which has an ECM fan array.
2. A single line of sight disconnect for the entire fan array shall be located on the outside of the electrical box.
3. Individual circuit breakers for each fan shall be mounted on the power distribution panel to isolate each fan for ser-vice. Fans shall be factory wired back to the power distribution panel.
4. Control wiring from all fans in the array shall terminate at one point inside the power distribution panel to control the entire array. Control signal shall be wired as 0-10 volt and shall include a field installed resistor if 4-20 mA con-trol is required.
5. BACnet communications shall be factory installed in ECM control panel. All motors shall be factory addressed.

END OF SECTION

DIVISION 23 - MECHANICAL
SECTION 23 82 16 – AIR COILS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Contractor shall furnish and install, where indicated on the plans, water coils as described in the following specifications.

1.2 RELATED SECTIONS

A. Section 220700 - Piping Insulation.

B. Section 232116 - Hydronic Specialties.

C. Section 233410 - Ductwork: Installation of duct coils.

D. Section 230900 - Controls Systems

1.3 REFERENCES

A. ANSI/ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.

B. SMACNA - HVAC Duct Construction Standards, Metal and Flexible.

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 013300.

B. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

C. Submit manufacturer's installation instructions.

D. Submit manufacturer's certificate showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements. Coils are tested and rated in accordance with ANSI/ARI 410.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 016000.

B. Store and protect products under provisions of Section 016000.

C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.

D. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Carrier or approved equal

2.2 GENERAL

A. CERTIFICATION - Water coil capacities and pressure drops shall be certified in accordance with ARI Standard 410.

B. TUBES - Primary surface shall be 5/8" O.D. copper tube, staggered in direction of air flow. Tubes shall be mandrel expanded to form fin bond and provide burnished, work-hardened interior surface. Return bends shall be die-formed and silver brazed to tubes

C. HEADERS - Headers shall be of heavy seamless copper tubing, silver-brazed to tubes. Connections shall be of red brass, with male pipe threads, silver-brazed to headers. Provide a 1/4 inch FPT, plugged, vent or drain tap on each connection.

D. FINS - Extended surface shall consist of die-formed, continuous, aluminum fins with formed channels and surface treatment to minimize moisture carryover. Fins shall have fully drawn collars to accurately space fins, and to form a protective sheath for the primary surface. Face velocity for coils condensing moisture is not to exceed 600 fpm.

E. CASING - A structural galvanized steel casing shall protect coil during shipment and provide for stacking of coils. Tube sheets on each end shall have drawn collars to support tubes. An intermediate coil support shall be provided on coils with a finned length more than 60 inches; two intermediate supports above 90 inches long. Casing channels shall be free draining, without depressions to collect moisture and contaminants or block fin area.

F. CIRCUITING - All water coils shall be circuited to provide free draining and venting, thru one vent and drain on each coil, when installed with casing level. Coils shall be circuited, and have connections arranged, for counter flow of air and water with supply on bottom and return on top of coil headers. Coil circuiting shall provide for design water velocity in tubes without exceeding total water pressure drops in schedule. Water pressure drop shall not exceed 30 feet head loss except as specified hereinafter.

G. TEST AND WORKING PRESSURES - Completed coil, including headers, connections and return bends shall be tested with 325 pounds compressed air under water. Coils shall be designed for operation at 250 psig design working pressure and up to 300 degrees

Fahrenheit.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible.

C. Support coil sections independent of piping on steel channel or double angle frames and secure to casings. Provide frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Provide airtight seal between coil and duct or casing.

D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

E. Install coils level.

F. Make connections to coils with unions and flanges.

G. On water coils, provide shut-off valve on supply line and lock shield balancing valve on return line. Locate water supply at bottom of supply header and return water connection at top. Provide manual air vents at high points complete with stop valve.

H. On water heating coils, connect water supply to leaving air side of coil (counter flow arrangement).

3.2 SCHEDULE: See Plans.

END OF SECTION 238216