DIVISION 23: HEATING, VENTILATING, AND AIR-CONDITIONING

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SECTION 23 0100 – COMMON HVAC REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Furnish labor, materials, and equipment necessary for completion of work as described in Contract Documents.

B. It is the intent of these specifications that the systems specified herein are to be complete and operational before being turned over to the owner. During the bidding process, the contractor is to ask questions or call to the engineer's attention any items that are not shown or may be required to make the system complete and operational. Once the project is bid and the contractor has accepted the contract, it is his responsibility to furnish and install all equipment and parts necessary to provide a complete and operational system without additional cost to the owner.

C. Furnish and install fire stopping materials to seal penetrations through fire rated structures and draft stops.

D. Includes But Not Limited To:
   1. General procedures and requirements for HVAC.

E. Related Sections:
   1. Section 23 0593: Testing, Adjusting, and Balancing for HVAC.

1.3 SUBMITTALS

A. Substitutions: By specific designation and description, standards are established for specialties and equipment. Other makes of specialties and equipment of equal quality will be considered provided such proposed substitutions are submitted to the Architect for his approval, complete with specification data showing how it meets the specifications, at least 5 working days prior to bid opening. A list of approved substitutions will be published as an addendum.
   1. Submit a single electronic copy of Manufacturer's catalog data including Manufacturer's complete specification for each proposed substitution.
   2. The Architect or Engineer is to be the sole judge as to the quality of any material offered as an equal.

B. Product Data, Shop Drawings: Within 30 days after award of contract, Submit electronic copies of Manufacturer's catalog data for each manufactured item.
   1. Literature shall include enough information to show complete compliance with Contract Document requirements.
   2. Mark literature to indicate specific item with applicable data underlined.
   3. Information shall include but not be limited to capacities, ratings, type of material used, guarantee, and such dimensions as are necessary to check space requirements.
   4. When accepted, submittal shall be an addition to Contract Documents and shall be in equal force. No variation shall be permitted.
   5. Even though the submittals have been accepted by the Engineer, it does not relieve the contractor from meeting all of the requirements of the plans and specifications and providing a complete and operational system.

C. Drawings of Record: One complete sets of mechanical drawings shall be provided for the purpose of showing a complete picture of the work as actually installed.
   1. These drawings shall serve as work progress report sheets. Contractor shall make notations neat and legible therein daily as the work proceeds.
   2. The drawings shall be kept at the job at a location designated by the Mechanical Engineer.

3. At completion of the project these "as-built" drawings shall be signed by the Contractor, dated, and returned to the Architect.

D. Operating Instructions and Service Manual: The Mechanical Contractor shall prepare 2 copies of an Operation and Maintenance Manual for all mechanical systems and equipment used in this project. Manuals shall be bound in hard-backed binders and the front cover and spine of each binder shall indicate the name and location of the project. Use plastic tab indexes for all sections. Provide a section for each different type of equipment item. The following items shall be included in the manual, together with any other pertinent data. This list is not complete and is to be used as a guide.
   1. Provide a master index at the beginning of the manual showing all items included.
   2. The first section of the manual shall contain:
      a. Names, addresses, and telephone numbers of Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Plumbing Contractor, Sheet Metal Contractor, and Temperature Control Contractor.
      b. List of Suppliers which shall include a complete list of each piece of equipment used with the name, address, and telephone number of vendor.
      c. General Description of Systems including –
         1) Location of all major equipment
         2) Description of the various mechanical systems
         3) Description of operation and control of the mechanical systems
         4) Suggested maintenance schedule
      d. Copy of contractor's written warranty
   3. Provide a copy of approved submittal literature for each piece of equipment.
   4. Provide maintenance and operation literature published by the manufacturer for each piece of equipment which includes: oiling, lubrication and greasing data; belt sizes, types and lengths; wiring diagrams; step-by-step procedure to follow in putting each piece of mechanical equipment in operation.
   5. Include parts numbers of all replaceable items.
   6. Provide control diagram and operation sequence, along with labeling of control piping and instruments to match diagram.
   7. Include a valve chart indicating valve locations.

E. Include air balance and/or water balance reports.

1.4 SUBMITTALS FOR COMMON HVAC REQUIREMENTS

A. Samples: Sealer and gauze proposed for sealing ductwork.

B. Quality Assurance / Control:
   1. Manufacturer’s installation manuals providing detailed instructions on assembly, joint sealing, and system pressure testing for leaks.
   2. Specification data on sealer and gauze proposed for sealing ductwork.

C. Quality Assurance
   1. Requirements: Construction details not specifically called out in Contract Documents shall conform to applicable requirements of SMACNA HVAC Duct Construction Standards.
   2. Pre-Installation Conference: Schedule conference immediately before installation of ductwork.

1.5 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies:
   1. Perform work in accordance with applicable provisions of local and state Plumbing Code, Gas Ordinances, and adoptions thereof. Provide materials and labor necessary to comply with rules, regulations, and ordinances.
   2. In case of differences between building codes, state laws, local ordinances, utility company regulations, and Contract Documents, the most stringent shall govern. Promptly notify Architect in writing of such differences.

B. Applicable Specifications: Referenced specifications, standards, and publications shall be of the issues in effect on date of Advertisement for Bid.

1. "Heating, Ventilating and Air Conditioning Guide" published by the American Society of Heating and Air Conditioning Engineers.
2. "Engineering Standards" published by the Heating, Piping, and Air Conditioning Contractors National Association.
3. "2018 International Building Code", "2018 International Mechanical Code", “2018 International Plumbing Code” and "2018 International Fire Code" as published by the International Conference of Building Officials.
4. "National Electrical Code" as published by the National Fire Protection Association.
5. "2018 International Energy Conservation Code ".

C. Identification: Motor and equipment name plates as well as applicable UL and AGA labels shall be in place when Project is turned over to Owner.

1.6 INSPECTIONS AND PERMITS

A. Pay for permits, fees, or charges for inspection or other services. Local and state codes and ordinances must be properly executed without expense to Owner and are considered as minimum requirements. Local and state codes and ordinances do not relieve the Contractor from work shown that exceeds minimum requirements.

1.7 ADDITIONAL WORK:

A. Design is based on equipment as described in the drawing equipment schedule. Any change in foundation bases, electrical wiring, conduit connections, piping, controls and openings required by alternate equipment submitted and approved shall be paid for by this division. All work shall be in accordance with the requirements of the applicable sections.

PART 2 - PRODUCTS FOR COMMON HVAC REQUIREMENTS

A. Finishes, Where Applicable: Colors as selected by Architect.

B. Duct Hangers:
1. One inch 25 mm by 18 ga 1.27 mm galvanized steel straps or steel rods as shown on Drawings, and spaced not more than 96 inches 2 400 mm apart. Do not use wire hangers.
2. Attaching screws at trusses shall be 2 inch 50 mm No. 10 round head wood screws. Nails not allowed.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Site Inspection:
1. Examine premises and understand the conditions which may affect performance of work of this Division before submitting proposals for this work.
2. No subsequent allowance for time or money will be considered for any consequence related to failure to examine site conditions.

B. Drawings:
1. Mechanical drawings show general arrangement of piping, ductwork, equipment, etc, and do not attempt to show complete details of building construction which affect installation. This Contractor shall refer to architectural, structural, and electrical drawings for additional building detail which affect installation of his work.
   a. Follow mechanical drawings as closely as actual building construction and work of other trades will permit.
   b. No extra payments will be allowed where piping and/or ductwork must be offset to avoid other work or where minor changes are necessary to facilitate installation.
   c. Everything shown on the mechanical drawings shall be the responsibility of Mechanical Contractor unless specifically noted otherwise.

2. Consider architectural and structural drawings part of this work insofar as these drawings furnish information relating to design and construction of building. These drawings take precedence over mechanical drawings.
3. Because of small scale of mechanical drawings, it is not possible to indicate all offsets, fittings, and accessories which may be required. Investigate structural and finish conditions affecting this work and arrange work accordingly, providing such fittings, valves, and accessories required to meet conditions. Do not scale drawings for locations of equipment or piping. Refer to large scale dimensioned drawings for exact locations.

C. Insure that items to be furnished fit space available. Make necessary field measurements to ascertain space requirements including those for connections and furnish and install equipment of size and shape so final installation shall suit true intent and meaning of Contract Documents.
1. If approval is received to use other than specified items, responsibility for specified capacities and insuring that items to be furnished will fit space available lies with this Division.
2. If non-specified equipment is used and it will not fit job site conditions, this Contractor assumes responsibility for replacement with items named in Contract Documents.

D. Be aware there are 2 separate parts of this building. The “Product Process Area”, which requires all food grade stainless steel piping, ductwork, grilles, registers, and other mechanical devices. Ant the Area 1 “Office and Toilet Areas” which require standard commercial piping, ductwork, grilles, registers, and other mechanical devices.

3.2 PREPARATION

A. Cut carefully to minimize necessity for repairs to existing work. Do not cut beams, columns, or trusses.
1. Patch and repair walls, floors, ceilings, and roofs with materials of same quality and appearance as adjacent surfaces unless otherwise shown. Surface finishes shall exactly match existing finishes of same materials.
2. Each Section of this Division shall bear expense of cutting, patching, repairing, and replacing of work of other Sections required because of its fault, error, tardiness, or because of damage done by it.
3. Cutting, patching, repairing, and replacing pavements, sidewalks, roads, and curbs to permit installation of work of this Division is responsibility of Section installing work.

3.3 INSTALLATION

A. Arrange pipes, ducts, and equipment to permit ready access to valves, unions, traps, starters, motors, control components, and to clear openings of doors and access panels.

3.4 STORAGE AND PROTECTION OF MATERIALS:

A. Provide storage space for storage of materials and assume complete responsibility for losses due to any cause whatsoever. Storage shall not interfere with traffic conditions in any public thoroughfare.

B. Protect completed work, work underway, and materials against loss or damage.

C. Close pipe openings with caps or plugs during installation. Cover fixtures and equipment and protect against dirt, or injury caused by water, chemical, or mechanical accident.

3.5 EXCAVATION AND BACKFILL

A. Perform necessary excavation of whatever substance encountered for proper laying of all pipes and underground ducts.
1. Excavated materials not required for fill shall be removed from site as directed by Engineer.
2. Excavation shall be carried low enough to allow a minimum coverage over underground piping of 5'-0" or to be below local frost level.
3. Excess excavation below required level shall be backfilled at Contractor's expense with earth, sand, or gravel as directed by Engineer. Tamp ground thoroughly.
4. Ground adjacent to all excavations shall be graded to prevent water running into excavated areas.

B. Backfill pipe trenches and allow for settlement.
   1. Backfill shall be mechanically compacted to same density as surrounding undisturbed earth.
   2. Cinders shall not be used in backfilling where steel or iron pipe is used.
   3. No backfilling shall be done until installation has been approved by the Engineer.

3.6 COOPERATION

A. Cooperate with other crafts in coordination of work. Promptly respond when notified that construction is ready for installation of work under Division 23000. Contractor will be held responsible for any delays which might be caused by his negligence or failure to cooperate with the other Contractors or crafts.

3.7 SUPERVISION

A. Provide a competent superintendent in charge of the work at all times. Anyone found incompetent shall be removed at once and replaced by someone satisfactory, when requested by the Architect.

3.8 INSTALLATION CHECK:

A. An experienced, competent, and authorized representative of the manufacturer or supplier of each item of equipment indicated in the equipment schedule shall visit the project to inspect, check, adjust if necessary, and approve the equipment installation. In each case, the equipment supplier's representative shall be present when the equipment is placed in operation. The equipment supplier's representative shall revisit the project as often as necessary until all trouble is corrected and the equipment installation and operation is satisfactory to the Engineer.

B. Each equipment supplier's representative shall furnish to the Owner, through the Engineer, a written report certifying the following:
   1. Equipment has been properly installed and lubricated.
   2. Equipment is in accurate alignment.
   3. Equipment is free from any undue stress imposed by connecting piping or anchor bolts.
   4. Equipment has been operated under full load conditions.
   5. Equipment operated satisfactorily.

C. All costs for this installation check shall be included in the prices quoted by equipment suppliers.

3.9 CLEANING EQUIPMENT AND PREMISES

A. Properly lubricate equipment before Owner's acceptance.

B. Clean exposed piping, ductwork, equipment, and fixtures. Repair damaged finishes and leave everything in working order.

C. Remove stickers from fixtures and adjust flush valves.

D. At date of Substantial Completion, air filters shall be new, clean, and approved by Owner's representative.

E. Trap elements shall be removed during cleaning and flushing period. Replace trap elements and adjust after cleaning and flushing period.

3.10 TESTS

A. No piping work, fixtures, or equipment shall be concealed or covered until they have been inspected and approved by the inspector. Notify inspector when the work is ready for inspection.

B. All work shall be completely installed, tested as required by Contract Documents and the city and county ordinances and shall be leak-tight before the inspection is requested.

C. Tests shall be repeated to the satisfaction of those making the inspections.

D. Water piping shall be flushed out, tested at 100 psi and left under pressure of supply main or a minimum

of 40 psi for the balance of the construction period.

3.11 WARRANTEE

A. Contractor shall guarantee work under Division 23 to be free from inherent defects for a period of one year from acceptance.
   1. Contractor shall repair, revise or replace any and all such leaks, failure or inoperativeness due to defective work, materials, or parts free of charge for a period of one year from final acceptance, provided such defect is not due to carelessness in operation or maintenance.
   2. In addition, the Contractor shall furnish all refrigeration emergency repairs, emergency service and all refrigerant required due to defective workmanship, materials, or parts for a period of one year from final acceptance at no cost to the Owner, provided such repairs, service and refrigerant are not caused by lack of proper operation and maintenance.

B. In addition to warrantee specified in General Conditions, heating, cooling, and plumbing systems are to be free from noise in operation that may develop from failure to construct system in accordance with Contract Documents.

3.12 SYSTEM START-UP, OWNER'S INSTRUCTIONS

A. Off-Season Start-up
   1. If Substantial Completion inspection occurs during heating season, schedule spring start-up of cooling systems. If inspection occurs during cooling season, schedule autumn start-up for heating systems.
   2. Notify Owner 7 days minimum before scheduled start-up.
   3. Time will be allowed to completely service, test, check, and off-season start systems. During allowed time, train Owner's representatives in operation and maintenance of system.
   4. At end of off-season start-up, furnish Owner with letter confirming that above work has been satisfactorily completed.

B. Owner's Instructions
   1. Instruct building maintenance personnel and Owner Representative in operation and maintenance of mechanical systems utilizing Operation & Maintenance Manual when so doing.
   2. Minimum instruction periods shall be as follows –
      a. Mechanical - Four hours.
      b. Temperature Control - Four hours.
      c. Refrigeration - Two hours.
   3. Instruction periods shall occur after Substantial Completion inspection when systems are properly working and before final payment is made.
   4. None of these instructional periods shall overlap another.

3.13 PROTECTION

A. Do not run heat pump, air handling units, fan coil units, or other pieces of equipment used for moving supply air without proper air filters installed properly in system.

B. The mechanical systems are not designed to be used for temporary construction heat. If any equipment is to be started prior to testing and substantial completion, such equipment will be returned to new condition with full one year warranties, from date of substantial completion after any construction use. This includes, but is not necessarily limited to: Equipment, filters, ductwork, fixtures, etc.

3.14 COMMON HVAC REQUIREMENTS:

A. INSTALLATION
   1. During installation, protect open ends of ducts by covering with plastic sheet tied in place to prevent entrance of debris and dirt.
   2. Make necessary allowances and provisions in installation of sheet metal ducts for structural conditions of building. Revisions in layout and configuration may be allowed, with prior written approval of Architect. Maintain required airflows in suggesting revisions.
   3. Hangers And Supports:

a. Install pair of hangers close to each transverse joint and elsewhere as required by spacing indicated in table on Drawings.
b. Install upper ends of hanger securely to floor or roof construction above by method shown on Drawings.
c. Attach strap hangers to ducts with cadmium-plated screws. Use of pop rivets or other means will not be accepted.
d. Where hangers are secured to forms before concrete slabs are poured, cut off flush all nails, strap ends, and other projections after forms are removed.
e. Secure vertical ducts passing through floors by extending bracing angles to rest firmly on floors without loose blocking or shimming. Support vertical ducts, which do not pass through floors, by using bands bolted to walls, columns, etc. Size, spacing, and method of attachment to vertical ducts shall be same as specified for hanger bands on horizontal ducts.

B. CLEANING
1. Clean interior of duct systems before final completion.

END OF SECTION 23 0100

SECTION 23 0523 - VALVES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 22 0100 apply to this Section.

1.2 SUMMARY

A. General valve materials and installation procedures for all piping systems.

B. Valve materials and installation procedure for all piping systems from the boiler room to and connections in the process area must be e316 stainless steel with a minimum pressure rating of 400 psi. They will be installed and attached to the stainless steel piping specified for that area.

1.3 QUALITY ASSURANCE

A. Manufacture:
1. Use domestic made valves where possible.

B. General: Support components shall conform to Manufacturer's Standardization Society Specification SP-58.

PART 2 - PRODUCTS

2.1 VALVES

A. Ball Valves:
1. 2" and smaller for domestic and heating hot water service:
2. Construction, 2 inches and smaller: MSS SP-110, Class 150, 400 psi CWP, 316 stainless steel, two-piece body, 316 stainless steel ball, regular port, Teflon seats and stuffing box ring, blow-out proof stem, level handle with balancing stops.
3. 2½" and larger - 3-piece full port, 316 S.S., flanged 400# WOG with seats rated for temperature service.
4. Ball valves shall be used wherever possible.

B. Butterfly Valves:
1. Construction 2-1/2 inches and Larger: MSS SP-67, 200 psi CWP, 316 S.S. resilient replaceable EPDM seat, wafer ends, extended neck, 10 position lever handle.
2. Butterfly valves may be used in lieu of ball valves where temperature and pressure allow.

C. Cutoff service valves shall be ball Valves:

D. Valves used in bypasses and for throttling service shall be ball valves:

E. Flow Control Valves
1. Manufacturers
    1. ITT Bell & Gossett: www.bellgosett.com
    2. Griswold Controls: www.giswoldcontrols.com
2. Construction: Class 125, 316 S.S. with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/blackflush drain.
3. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 305 psi.

F. Swing Check Valves
   1. Up to 2 inches:
      a. MSS SP-80, Class 125. Bronze body and cap, bronze swing disc with rubber seat, solder ends.
   2. Over 2 Inches:
      a. MSS SP-71, Class 125, iron body, bronze swing disc, renewable disc seal and seat, flanged or grooved ends.

G. Relief Valves
   1. Pressure Relief
      a. Manufacturers
         1. Tyco Flow Control: www.tycoflowcontrol.com
         2. Cla-Val Co: www.cla-val.com
         3. Henry Technologies: www.henrytech.com
         4. Watts Regulator Company: www.wattsregulator.com
      b. AGA Z21.22 certified, bronze body, Teflon seat, steel stem and springs, automatic, direct pressure actuated.
   2. Temperature and Pressure Relief
      a. Manufacturers:
         1. Cla-Vol Co: www.cla-val.com
         2. Henry Tecnologies: www.henrytech.com
         3. Watts Regulator Company: www.watssregulator.com

H. Strainers
   1. Size 2 inch and under:
      a. Threaded brass body for 175 psi CWP, Y pattern with 1/32-inch stainless steel perforated screen.
      b. Class 150, threaded bronze body 300 psi CWP, Y pattern with 1/32-inch stainless steel perforated screen
   2. Size 1-1/2 inch to 4 inch:
      a. Class 125. Flanged iron body, Y pattern with 1/6- inch stainless steel perforated screen.

I. Use ball valves or butterfly valves everywhere unless noted otherwise.

J. Approved Manufacturers:
   1. Nibco
   2. Hammond
   3. Stockham
   4. Milwaukee
   5. Victaulic

END OF SECTION 23 0523

SECTION 23 0529 – HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. General hangers and support and installed procedures for all stainless steel heating piping systems.

B. General hangers and support and installed procedures for standard commercial building construction may be used for all piping in the non-process areas that do nor require stainless steel piping.

1.3 QUALITY ASSURANCE

A. Manufacture:
   1. Use domestic made valves, pipe and pipe fittings where possible.

B. General: Support components shall conform to Manufacturer's Standardization Society Specification SP-58.

PART 2 - PRODUCTS

2.1 PIPE HANGERS

A. Adjustable 316 S.S. clevis type of a diameter adequate to support pipe size.

B. Approved Manufacturers:
   1. B-Line Systems Fig. B3100
   2. Grinnell No. 260
   3. Kin-Line 455
   4. Superstrut CL-710

2.2 INSULATING COUPLINGS

A. Suitable for at least 175 PSIG WP at 250 deg F.

B. Approved Manufacturers:
   1. Central Plastics Co
   2. Victaulic Co
   3. Watts Regulator Co

2.3 SLEEVES

A. Sleeves shall be 316 S.S. metal two sizes larger than pipe or insulation.

2.4 INTERMEDIATE ATTACHMENTS

A. Continuous stainless steel threaded rod may be used wherever possible.

B. No chain, wire, or perforated strap shall be used.

2.5 FLOOR AND CEILING PLATES

A. 316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Furnish and install complete system of 316 S.S. piping and ductwork with 316 S.S. hangers and supports or as necessary to completely control entire apparatus. Pipe drawings are diagrammatic and indicate general location and connections. Piping may have to be offset, lowered, or raised as required or directed at site. This does not relieve this Contractor from responsibility for proper erection of systems of piping with all needed hangers and supports.

B. Properly support piping and make adequate provisions for expansion, contraction, slope, and anchorage.
   1. Cut piping accurately for fabrication to measurements established at site and work into place without springing or forcing.
   2. Do not use pipe hooks, chains, or perforated metal for pipe support.
   3. Remove burr and cutting slag from pipes.
   4. Make changes in direction with proper fittings.
   5. Support piping at 8 feet on center maximum for pipe 1-1/4 inches or larger and 6 feet on center maximum for pipe one inch or less. Provide support at each elbow. Install additional support as required.
   6. Suspend piping from roof trusses or clamp to vertical walls using 316 S.S. Unistrut and clamps.

C. Arrange piping to not interfere with removal of other equipment, ducts, or devices, or block access to doors, windows, or access openings.

D. Provide sleeves around pipes passing through floors, walls, partitions, or structural members.
   1. Seal sleeves with plastic or other acceptable material.

3.2 HORIZONTAL PIPING INSTALLATION

A. Locate hangers, supports, and anchors near or at changes in piping direction and concentrated loads.

B. Provide for vertical adjustment to maintain pitch required for proper drainage.

C. Allow for expansion and contraction of the piping.

END OF SECTION 22 0529

SECTION 23 0548 – SEISMIC AND VIBRATION CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install engineering, labor, material, and equipment necessary for a complete anchorage and seismic restraint system and vibration isolation system as described in Contract Documents.
   1. The system design and installation shall be based on Seismic Zone D or above of the International Building Code and other standards listed below.
   2. The work shall include all mechanical isolated and non- isolated equipment, ducts and piping systems which shall include:
      a. Air handling units.
      b. Utility and inline exhaust fans.
      c. Ceiling and roof fans.
      d. Pumps.
      e. Rectangular ductwork 4 sq. ft. in cross-sectioned area and larger.
      f. All heating piping 2-1/2" and larger.

B. Any devices or supports located in the process areas of the building shall be 316 S.S.

1.3 REFERENCE STANDARDS

A. Uniform Building Code, Current Edition

B. NFPA Bulletin 90A, Current Edition

C. UL Standard 181

D. Tri-Services Manual, Fagel Et Al

E. MACNA Guidelines for Seismic Restraints of Mechanical Systems

1.4 SEISMIC REQUIREMENTS & QUALIFICATIONS

A. The Mechanical Contractor shall be responsible for supplying and installing equipment, vibration isolators, flexible connections, rigid steel frames, anchors, inserts, hangers and attachments, supports, seismic snubbers and bracing to comply with the current code. All supports, hangers, bases, braces and anchorage for all non-isolated equipment, ductwork and piping shall be installed as detailed and specified in the contract documents. Specific requirements on equipment anchorage and restraints, locations and sizes shall be furnished to the contractor after shop drawings for mechanical equipment have been reviewed and approved. All supports, hangers, bases, anchorage and bracing for all isolated equipment shall be designed by a professional engineer employed by the restraint manufacturer, qualified with seismic experience in bracing for mechanical equipment. Shop drawings submitted for earthquake bracing and anchors shall bear the Engineer's signed professional seal.

B. The Contractor shall require all equipment suppliers to furnish equipment that meets the seismic code, with bases designed to receive seismic bracing and/or anchorage. All isolated mechanical equipment bracing to be used in the project shall be designed from the Equipment Shop Drawings certified correct by the equipment manufacturer for Seismic Zone III with direct anchorage capability.

1.5 SUBMITTALS

A. Submittal data prior to fabrication, shall include but not be limited to the following:
   1. Complete engineering calculations and shop drawings for all vibration and seismic requirements for all equipment to be isolated and restrained.
   2. The professional stamp of the engineer who is responsible for the design of the Vibration and Seismic Restraint System for isolated equipment.
   3. Details for all the isolators and seismic bracing with snubbers proposed for items in this specification and on the drawings.
   4. Details for steel frames, concrete inertia bases, and anchors to be used in conjunction with the isolation of the items in this specification and drawings.
   5. Clearly outlined procedures for installing and adjusting the isolators, seismic bracing anchors and snubbers.
   6. The proposed location of pipe and duct restraints.

PART 2 - PRODUCTS

2.1 RESTRAINT EQUIPMENT

A. Manufacturer of restraint equipment for isolated equipment shall be the manufacturer of the vibration isolators furnished for the equipment. Design of restraints and anchors for isolated equipment shall also be by the manufacturer.

B. Approved Manufacturers and Suppliers:
   1. Manufacturers and suppliers of restraint equipment and systems approved for use by the Contractor, for isolated and non-isolated systems, are Mason Industries. Inc., Korfund, Amber/Booth Company, Vibration Mountings & Control Co. or prior approved equal.

2.2 INERTIA PADS

A. Reinforced concrete inertia bases, the steel members of which are designed and supplied by the isolator manufacturer. The concrete shall be poured into a welded steel frame, incorporating prelocated equipment anchor bolts, 1/2" diameter reinforcing bars on nominal 8" centers each way, and recessed isolator mounting brackets to reduce the mounting height of the equipment, but yet remain within the confines of the base. The thickness of the base shall be 6 inches, or as indicated on the drawings. Where inertia bases are used to mount pumps, the bases shall be wide enough to support piping elbows. Provide with 1 inch minimum deflection springs.

B. Approved Manufacturers:
   1. Mason
   2. Peabody
   3. Vibration Mountings

PART 3 - EXECUTION

3.1 SEISMIC REQUIREMENTS

A. All mechanical equipment, piping and ductwork shall be braced, snubbed or supported to withstand seismic disturbances and remain operational. Furnish all engineering, labor, materials and equipment to provide protection against seismic disturbances as specified herein.

B. Isolated Equipment:
   1. All vibration isolated equipment shall be mounted on rigid steel frames or concrete bases as described in the vibration control specifications unless the equipment manufacturer certified direct attachment capability. Each spring mounted base shall have a minimum of four all-directional seismic snubbers that are double acting and located as close to the vibration isolators as possible to facilitate attachment both to the base and the structure. The snubbers shall consist of interlocking steel members restrained by shock absorbent rubber materials.
   2. Elastomeric material shall be replaceable and a minimum of 3/4" thick. Snubbers shall be manufactured with an air gap between hard and resilient material of not less than 1/8" nor more

than 1/4". Snubbers shall be installed with factory set clearances. Snubbers shall be equal to Mason Z-1011.

3. A one "g" minimum vertical and lateral level shall be used in the design of all snubbers restraining isolated equipment.

C. Piping:

1. All isolated and non-isolated piping 2-1/2" I.D. and larger shall be protected in all planes by restraints to accommodate thermal movement as well as restrain seismic motion. Locations shall be as scheduled and shall include but not be limited to:
   a. At all drops to equipment and at flexible connections.
   b. At all 45° or greater changes in direction of pipe.
   c. At horizontal runs of pipe, not to exceed 30 feet O.C. spacing.
   d. Piping shall be restrained by a cable restraining system using a minimum of two cables at all restraint points.
   e. Shop drawings shall be submitted with the locations of all restraints shown on a floor plan and noting the size and type of restraint to be used.
   f. Gas piping shall have additional restraints as scheduled.

D. Non Isolated Equipment:

1. The restraint systems for all non isolated equipment shall be designed according to Table 23J, sec. 2312 of the Uniform Building Code with an importance factor of 1.5, a site factor Z = 0.75 and a Cp = 0.3. Horizontal force factor for elements of structures. In addition, the vertical forces restraint requirement shall be computed as 1/2 the value of the horizontal forces. All equipment not anchored directly to floors shall be restrained by cables as designed and furnished by the Restraint Manufacturer.

E. Ductwork:

1. All isolated and non isolated rectangular ductwork 4 sq. feet in cross-sectional area and larger and all isolated and not isolated round ductwork 24" round and larger shall be protected in all planes by restraints to accommodate thermal movement as well as restrain seismic motion. Locations shall be as determined by the Seismic Restraint Manufacturer and shall include but not be limited to:
   a. All horizontal runs of ductwork, not to exceed 30 feet O.C. spacing.
   b. At all 45° or greater changes in direction of ductwork.
   c. At each end of duct runs and drops to equipment.
   d. At each flexible connection.
   e. Ducts shall be restrained by a cable restraining system using a minimum of two cables at all restraint points.
   f. Shop drawings shall be submitted with the size and type of all restraints to be used. A floor plan shall be provided to show the locations of all restraints.

3.2 VIBRATION ISOLATION REQUIREMENTS

A. All mechanical equipment 1 horsepower and over, unless otherwise noted, shall be isolated from the structure by means of resilient vibration and noise isolators designed and supplied by the manufacturer supplying seismic design and equipment. All piping and ductwork shall be isolated from the structure. Isolation equipment, hangers, connections, and other isolating devices shall be designed and installed to prevent transmission of vibration to the structure from the mechanical equipment or any associated piping and ductwork. All isolation systems shall be designed and installed to provide isolation efficiency of 98 percent.

B. All spring supports shall be designed to have an additional travel of 50 percent between the design height and the solid height.

C. All heating, hot water piping in the mechanical equipment room and piping three supports away from other mechanical equipment shall be isolated from the structure by means of vibration and noise isolators. Suspended piping shall be isolated with combination spring and fiberglass hangers in the supporting rods. Floor-mounted piping shall be supported directly on spring mounts.

D. Vertical pipe risers shall be isolated from the structure by means of vibration and noise isolating expansion hangers. The hangers shall have a minimum rated deflection of four times the anticipated pipe movement and shall be enclosed in a housing for fail-safe equipment.

E. Flexible members shall be incorporated in the piping adjacent to all reciprocating equipment.

F. Flexible connections shall be incorporated in the ductwork adjacent to all air-moving units.

END OF SECTION 23 0548

SECTION 23 0553 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install identification of equipment and piping as described in Contract Documents.

B. Mechanical Contractor shall touch-up equipment where factory paint has been damaged. Repaint entire item where more than 20 percent of the surface is involved.

C. Primary painting of walls, ceilings, ductwork, piping and plenums is covered in the general painting section of these Contract Documents.

PART 2 - PRODUCTS

2.1 LABELS

A. Black Formica with white reveal on engraving.

2.2 CODED BANDS

A. Using colored bands and arrows to indicate supply and return, with colored reflective tape, color code all piping installed in this contract at not more than 20-foot intervals, at equipment, at walls, etc., in accordance with ANSI Standards.

B. Approved Manufacturers:
   1. Seton
   2. Craftmark

2.3 PIPE IDENTIFICATION

A. Seaton coded and colored pipe markers and arrows to meet ANSI Standards.

2.4 EQUIPMENT IDENTIFICATION

A. Provide an engraved plastic plate for each piece of equipment stating the name of the item, symbol number, area served, and capacity. Label all control components with plastic embossed mechanically attached labels. Sample:
   1. Supply Fan SF-1 - North Classrooms
   2. 10,000 CFM @ 2.5"

2.5 VALVE IDENTIFICATION

A. Make a list of and tag all valves installed in this work.
   1. Valve tags shall be stainless steel, not less than 1"x2" size, hung with brass chains.
   2. Tag shall indicate heating service.

PART 3 - EXECUTION

3.1 APPLICATION

A. Engraved Plates:

1. Identify thermostats and control panels in mechanical rooms, furnaces, boilers and hot water heating specialties, duct furnaces, air handling units, electric duct heaters, and condensing units with following data engraved and fastened to equipment with screws –
   a. Equipment mark noted on Drawings (i.e., SF-1)
   b. Area served (i.e., North Classrooms)
   c. Capacity (10,000 CFM @ 2.5)

B. Pipe Identification:

1. Symbol

Symbol	Name	Color
STM	Steam Lines	Orange
COND	Steam Condensate Return Line	Lt Orange
HWH	Hot Water Heating	Green
NG	Natural Gas	Yellow
FS	Fire Sprinkler	Red
AIR	Air	Blue

2. Identification and flow arrows shall be following colors for proper contrast:

Arrows & ID Stenciling	Color Shade of Pipe
White	Red, Grays, & black
Black	Yellows, Oranges, Greens, & White

C. Colored plastic bands and arrows

1. Colored bands and arrows shall be used. If used on insulated pipe they shall be installed by wrapping the arrows completely around the pipe and sticking back on itself at each end of the identification label to prevent the labels from coming loose.

END OF SECTION 23 0553

SECTION 23 0593 - TESTING, ADJUSTING, AND BALANCING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Division 23 0100 - Common HVAC Requirements and Basic Mechanical Materials and Methods Sections apply to work of this section.

1.2 SUMMARY SCOPE

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems.
      a. Exhaust Fans.
      b. Central fan systems
      c. Rooftop systems
   2. Hydronic Piping Systems.
      a. Primary - Secondary Systems
      b. Pumps

1.3 SUBMITTALS

A. Agency Data:
   1. Submit proof that the proposed testing, adjusting, and balancing agency meets the qualifications specified below. The firm or individuals performing the work herein specified may not be the installing firm.

B. Engineer and Technicians Data:
   1. Submit proof that the Test and Balance Engineer assigned to supervise the procedures, and the technicians proposed to perform the procedures meet the qualifications specified below.

C. Procedures and Agenda: Submit a synopsis of the testing, adjusting, and balancing procedures and agenda proposed to be used for this project.

D. Sample Forms: Submit sample forms, if other than those standard forms prepared by the AABC or NEBB are proposed.

E. Certified Reports: Submit testing, adjusting, and balancing reports bearing the seal and signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below.
   1. Draft Reports: Upon completion of testing, adjusting, and balancing procedures, prepare draft reports on the approved forms. Draft reports may be hand written, but must be complete, factual, accurate, and legible. Organize and format draft reports in the same manner specified for the final reports. Submit 2 complete sets of draft reports. Only 1 complete set of draft reports will be returned.
   2. Final Report: Upon verification and approval of draft reports, prepare final reports, type written, and organized and formatted as specified below. Submit 4 complete sets of final reports.
   3. Report Format: Report forms shall be those standard forms prepared by the referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data. Divide the contents of the binder into the below listed divisions, separated by divider tabs:
      a. General Information and Summary
      b. Air Systems
      c. Temperature Control System Verification.

F. Report Contents: Provide the following minimum information, forms, and data:
   1. General information and Summary: Inside cover sheet to identify testing, adjusting, balancing agency, Contractor, Owner, Engineer, and Project. Include addresses and contact names and telephone numbers. Also include a certification sheet containing the seal and name, address, telephone number, and signature of the Certified Test and Balance Engineer. Include in this division a listing of the instrumentation used for the procedures along with the instrument calibration sheet.
   2. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form. The report shall contain the following information, and all other data resulting from the testing, adjusting, and balancing work:
      a. All nameplate and specification data for all air handling equipment and motors.
      b. Actual metered running amperage for each phase of each motor on all pumps and air handling equipment.
      c. Actual metered voltage at air handling equipment (phase-to-phase for all phases).
      d. Fan RPM for each piece of air handling equipment.
      e. Total actual CFM being handled by each piece of air handling equipment.
      f. Actual CFM of systems by rooms.
   3. Certify that all smoke and fire dampers operate properly and can be reset under actual system operating conditions.

G. Calibration Reports:
   1. Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of six months prior to starting the project.

1.4 CERTIFICATION

A. Agency Qualifications:
   1. Employ the services of a certified testing, adjusting, and balancing agency meeting the qualifications specified below, to be the single source of responsibility to test, adjust, and balance the building mechanical systems identified above, to produce the design objectives. Services shall include checking installations for conformity to design, measurement, and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, recording and reporting the results, and operation of all systems to demonstrate satisfactory performance to the owner.
   2. The testing, adjusting, and balancing agency certified by National Environmental Balancing Bureau (NEBB) or Associated Air Balance Council (AABC) in those testing and balancing disciplines required for this project, and having at least one person certified by NEBB or AABC as a Test and Balance supervisor, and a registered professional mechanical engineer, licensed in the state where the work will be performed.

B. Codes and Standard:
   1. NEBB: “Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.”
   2. AABC: “National Standards for Total System Balance.”
   3. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

1.5 PROJECT CONDITIONS

A. Systems Operation: Systems shall be fully operation and clean prior to beginning procedures.

1.6 SEQUENCING AND SCHEDULING

A. Test, adjust, and balance the air systems before hydronic, steam, and refrigerant systems within +10% to -5% of contract requirements.

B. The report shall be approved by the Engineer. Test and balance shall be performed prior to substantial completion.

PART 2 - NOT USED

PART 3 - EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system, perform these steps.
   1. Obtain design drawings and specifications and become thoroughly acquainted with the design intent.
   2. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
   3. Compare design to installed equipment and field installations.
   4. Walk the system from the system air handling equipment to terminal units to determine variations of installation from design.
   5. Check filters for cleanliness and to determine if they are the type specified.
   6. Check dampers (both volume and fire) for correct and locked position. Check automatic operating and safety controls and devices to determine that they are properly connected, functioning, and at proper operating setpoint.
   7. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a cross-check with required fan volumes.
   8. Determine best locations in main and branch ductwork for most accurate duct traverses.
   9. Place outlet dampers in the full open position.
   10. Prepare schematic diagrams of system "As-Built" ductwork and piping layouts to facilitate reporting.
   11. Lubricate all motors and bearings.
   12. Check fan belt tension.
   13. Check fan rotation.

3.2 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

3.3 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

B. Provide instruments meeting the specifications of the referenced standards.

C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5%. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

G. Take all readings with the eye at the level of the indicated value to prevent parallax.

H. Use pulsation dampeners where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

I. Take measurements in the system where best suited to the task.

3.4 PERFORMING TESTING, ADJUSTING, AND BALANCING

A. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards. Balancing of the air systems and hydronic systems shall be achieved by adjusting the automatic controls, balancing valves, dampers, air terminal devices, and the fan/motor drives within each system.

B. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

C. Patch insulation, ductwork, and housings, using materials identical to those removed.

D. Seal ducts and piping, and test for and repair leaks.

E. Seal insulation to re-establish integrity of the vapor barrier.

F. Adjust timing relays of environmental equipment motor reduced voltage starters to the optimum time period for the motor to come up to the maximum reduced voltage speed and then transition to the full voltage speed to prevent damage to motor, and to limit starting current spike to the lowest possible and practical.

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

H. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

3.5 RECORD AND REPORT DATA

A. Record all data obtained during testing, adjusting, and balancing in accordance with, and on the forms recommended by the referenced standards, and as approved on the sample report forms.

B. Prepare report of recommendations for correcting unsatisfactory mechanical performances when system cannot be successfully balanced.

C. Report shall be certified and stamped by a registered professional mechanical engineer employed by the agency and licensed in the state where the work will be performed.

D. Engineer is to provide a floor plan and test and balance contractor to include the plan in test and balance report and identify actual cfm on drawing or number the diffusers to match report.

3.6 DEMONSTRATION

A. If requested, testing, adjusting, and balancing agency shall conduct any or all of the field tests in the presence of the engineer.

B. Agency shall include a maximum of one (1) call back to the project within the one year warranty period to make additional adjustments if requested by the engineer.

END OF SECTION 23 0593

SECTION 23 0630- SCHEDULES FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

1. Refer to mechanical equipment schedules on the drawings.
2. All piping work and equipment located in the process areas must be made of 316 stainless steel.
3. All equipment in or serving the process area must be made of 316 stainless steel.

END OF SECTION 23 0630

SECTION 23 0713 - DUCTWORK INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install insulation on stainless steel and galvanized steel air ducts inside building insulation envelope as described in Contract Documents.

B. Furnish and install insulation on fresh air ducts and combustion air ducts within building insulation envelope as described in Contract Documents.

C. Furnish and install insulation on other air ducts where indicated on Drawings.

PART 2 - PRODUCTS

2.1 INSULATION

A. 1-inch-thick fiberglass with aluminum foil scrim kraft facing and have a density of one lb./cu ft.

B. Approved Manufacturers:
   1. Manville Microlite FSK
   2. CSG Type IV standard duct insulation
   3. Owens-Corning FRK
   4. Knauf (Duct Wrap FSK)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct wrap in accordance with Manufacturer's recommendations.

B. Do not compress insulation except in areas of structural interference.

C. Completely seal joints.

D. Cover all inside stainless steel duct wrap with 26 gage embossed aluminum cover with cinch bands. Overlap each joint with a minimum of 2” and caulk all seams.

END OF SECTION 23 0713

SECTION 23 0714 – ROUND SUPPLY DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install round supply duct insulation as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Insulation shall be UL rated with FSK (foil-skrim-kraft) facing.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Fiberglass blanket insulation

B. Approved Manufacturers:
   1. Johns-Manville R-4 Microlite (R-4 does not include the vapor barrier material).
   2. Owens-Corning faced duct wrap insulation FRK-25 ED-150
   3. Certainteed Standard Duct Wrap.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Insulate round air supply ducts. No insulation on round stainless steel exhaust ducts.

B. Facing shall overlap 2" at joints and shall be secured with outward clinch staples on 4" centers.

C. Ducts over 30" in width shall have spot application of adhesive, weld pins or metal screws and caps on not more than 18" centers applied to underside.

D. 3" wide vapor barrier paper shall be applied over seams and sealed with vapor barrier adhesive.

E. Insulate attenuators.

F. Insulate high and low pressure flex ducts.

G. Cover all inside stainless steel duct wraps with 26 gage embossed aluminum cover with cinch bands. Overlap each joint with a minimum of 2” and caulk all seams.

END OF SECTION 23 0714

SECTION 23 0715 - DUCT LINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install acoustic lining in following above ground metal ductwork as described in Contract Documents unless detailed otherwise:
   1. Supply air
   2. Return air
   3. Mixed air
   4. Transfer air
   5. Relief air
   6. Elbows, fittings, and diffuser drops greater than 12 inches in length.

B. Duct lining is limited to area 1 and is not allowed in any stainless steel ductwork.

1.3 SYSTEM DESCRIPTION

A. Duct dimensions shown on Drawings are for free area inside insulation. Allowance must be made for insulation, where applicable.

1.4 RATINGS:

A. Material shall have maximum air friction correction factor of 1.10 at 1000 FPM velocity and have a minimum sound absorption coefficient NRC of .60.

PART 2 - PRODUCTS

2.1 DUCT LINER

A. One inch thick, 1-1/2 lb density fiberglass, factory edge coated.

B. Duct lining materials are to meet the requirements of UL 181 for mold, humidity, and erosion resistance.

C. Approved Manufacturers:
   1. Certainteed Ultralite 150 Certa Edge Coat
   2. Knauf - Type M
   3. Manville - Lina-Coustic
   4. Owen Corning Fiberglas - Aeroflex

2.2 ADHESIVE

A. Water Base Type:
   1. Cain - Hydrotak
   2. Duro Dyne - WSA
   3. Kingco - 10-568
   4. Miracle - PF-101
   5. Mon-Eco - 22-67
   6. Techno Adhesive - 133

B. Solvent Base (non-flammable) Type:
   1. Cain - Safetak

2. Duro Dyne - FPG
3. Kingco - 15-137
4. Miracle - PF-91
5. Mon-Eco - 22-24
6. Techno Adhesive - 'Non-Flam' 106

C. Solvent Base (flammable) Type:
1. Cain - HV200
2. Duro Dyne - MPG
3. Kingco - 15-146
4. Miracle - PF-96
5. Mon-Eco - 22-22
6. Techno Adhesive - 'Flammable' 106

2.3 FASTENERS

A. Adhesively secured fasteners not allowed.

B. Approved Manufacturers:
1. AGM Industries Inc - "DynaPoint" Series DD-9 pin
2. Cain
3. Duro Dyne
4. Omark dished head "Insul-Pins"
5. Grip nails may be used if each nail is installed by "Grip Nail Air Hammer" or by "Automatic Fastener Equipment" in accordance with Manufacturer's recommendations.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install mat finish surface on air stream side. Secure insulation to cleaned sheet metal duct with continuous 100% coat of adhesive and with 3/4-inch-long mechanical fasteners 12 inches on center maximum unless detailed otherwise on Drawings. Pin all duct liner.

B. Accurately cut liner and thoroughly coat ends with adhesive. Butt joints tightly. Top and bottom sections of insulation shall overlap sides. If liner is all one-piece, folded corners shall be tight against metal. Ends shall butt tightly together.

C. In casings and plenums further contain insulation with wire mesh.

3.2 FIELD QUALITY CONTROL

A. If insulation is installed without longitudinal and end joints butted together, installation will be rejected, and work removed and replaced with work that conforms to this Specification.

B. Insulation shall be installed in accordance with Duct Liner Application Standard SMACNA Manual 15.

3.3 ADJUSTING, CLEANING

A. Keep duct liner clean and free from dust. At completion of project, vacuum duct liner if it is dirty or dusty.

END OF SECTION 23 0715

SECTION 23 0719 – HOT WATER HEATING & RETURN PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install insulation on piping mains, branches, risers, fittings, and valves, pump bodies and flanges as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIAL

A. 3 lb./cu.ft. heavy density fiberglass with fire retardant vapor barrier jacket with self-sealing laps. Thickness shall be 1-1/2 inches on heating supply and return lines.

B. Approved Manufacturers:
1. Owens-Corning Fiberglass heavy density with ASJ-SSL jacket
2. Equals by Johns-Manville or CTM.
3. Zeston covers for valves and fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipes:
1. Install in accordance with manufacturer's directions on clean dry pipes.
2. Butt joints firmly together.
3. Seal vapor barrier longitudinal seam overlap with vapor barrier adhesive.
4. Wrap butt joints with four-inch strip of vapor barrier jacket material cemented with vapor barrier adhesive.
5. Finish with bands applied at mid-section and at each end of insulation.

B. Valves & Fittings:
1. Insulate and finish by one of following methods:
   a. With hydraulic setting insulating cement, or equal, to thickness equal to adjoining pipe insulation.
   b. With segments of molded insulation securely wired in place.
   c. With prefabricated covers made from molded pipe insulation finished with vapor barrier adhesive.
   d. Zeston covers and factory applied insulation diapers.
2. Finish fittings and valves with Zeston covers.

C. Piping that is stainless steel in product process areas shall be insulated as indicated. The insulation shall then be protected with the following weatherproof finishes as indicated on contract drawings:
1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.

D. Where factory premolded one piece PVC insulating fitting covers are to be used, proper factory precut Hi-Lo Temp insulation shall be applied to the fitting. Ends of Hi-Lo Temp insulation shall be tucked snugly into throat of fitting and edges adjacent to pipe covering tufted and tucked in. Fully insulate pipe fittings. One piece PVC fitting cover is then secured by stapling, tack fastening, banding or taping ends to adjacent pipe covering and covered with metal jacket.

END OF SECTION 23 0719

SECTION 23 0721 – FIRE STOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install fire stopping as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Fire stopping material shall meet ASTM E814, E84 and be UL listed.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Material shall be flexible, long lasting, intumescent acrylic seal to accommodate vibration and building movement.

B. Caulk simple penetrations with gaps of 1/4" or less with:
   1. Dow Corning Fire Stop Sealant
   2. Pensil 300

C. Caulk multiple penetrations and/or penetrations with gaps in excess of 1/4" with:
   1. Dow Corning Fire Stop Foam
   2. Pensil 200
   3. IPC flame safe FS-1900
   4. Tremco “Tremstop 1A”

PART 3 - EXECUTION

3.1 INSTALLATION

A. Follow manufacturer's installation instructions explicitly.

B. Seal penetrations of ductwork, piping, and other mechanical equipment through one-hour and two-hour rated partitions as shown on Architectural and Mechanical Drawings.

C. Install fire stopping material on clean surfaces to assure adherence.

END OF SECTION 23 0721

SECTION 23 0722 - REFRIGERANT PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install insulation on above ground refrigerant suction piping and fittings, including thermal bulb, from thermal expansion valve as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Insulation shall have flame-spread rating of 25 or less and a smoke density rating of 50 or less as tested by ASTM E-84 method.

B. Ratings:
   1. Upper rating of =210 deg. F.
   2. Lower rating of -110 deg. F.
   3. UV stabilized for ten year life.
   4. Thermal conductivity of 0.24.
   5. Water vapor transmission of .03 perms per inch.
   6. Material to be polyolefin food grade.

PART 2 - PRODUCTS

2.1 FLEXIBLE FOAMED PIPE INSULATION

A. Thickness:
   1. 1/2 inch for one inch outside diameter and smaller pipe.
   2. 3/4 inch for 1-1/8 through 2 inch outside diameter pipe.
   3. One inch for 2-1/8 inches outside diameter and larger pipe (two layers of 1/2 inch).
   4. One inch sheet for fittings as recommended by Manufacturer.

B. Approved Manufacturers:
   1. Armaflex
   2. Halstead "Insul-tube"
   3. Rubatex
   4. Therma-Cel

2.2 JOINT SEALER

A. Approved Manufacturers:
   1. Armaflex 520
   2. BFG Construction Adhesive #105
   3. Therma-Cel 950.

2.3 MANUFACTURED UNITS

A. Nominal 3/4" wall thickness

B. Approved Manufacturers:
   1. ImcoLock Pipe Insulation
   2. or approved equal

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install insulation in snug contact with pipe and in accordance with Manufacturer's recommendations.

B. Insulation shall be slipped onto pipe prior to connection or applied after pipe is installed, at contractor's option.

C. Close butt joints and miter joints.
   1. Approved Manufacturers:
      a. IMCOA's Fuse-Seal joining system
      b. or factory approved contact adhesive

D. Insulation shall be installed according to manufacturer's recommended procedures.

E. Exterior exposed Insulation shall be finished with two coats of factory approved finish. Color shall be selected by the Owner's representative.

F. Stagger joints on layered insulation.

G. Slip insulation on tubing before tubing sections and fittings are assembled keeping slitting of insulation to a minimum.

H. Seal joints in insulation.

I. Insulate flexible pipe connectors.

J. Insulate thermal expansion valves with insulating tape.

K. Insulation exposed outside building shall have "slit" joint seams placed on bottom of pipe.

L. Insulate fittings with sheet insulation and as recommended by Manufacturer.

END OF SECTION 23 0722

SECTION 23 0768 - STEAM SUPPLY AND CONDENSATE RETURN PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install insulation on piping mains, branches, risers, fittings, and valves, pump bodies and flanges as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MATERIAL

A. 6 lb./cu.ft. heavy density fiberglass with fire retardant vapor barrier jacket with self-sealing laps. Thickness shall be 1-1/2 inches on heating supply and return lines.

B. Approved Manufacturers:
   1. Owens-Corning Fiberglass heavy density with ASJ-SSL jacket
   2. Equals by Johns-Manville or CTM.
   3. Zeston covers for valves and fittings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Pipes:
   1. Install in accordance with manufacturer's directions on clean dry pipes.
   2. Butt joints firmly together.
   3. Seal vapor barrier longitudinal seam overlap with vapor barrier adhesive.
   4. Wrap butt joints with four-inch strip of vapor barrier jacket material cemented with vapor barrier adhesive.
   5. Finish with bands applied at mid-section and at each end of insulation.

B. Valves & Fittings:
   1. Insulate and finish by one of following methods -
   2. With hydraulic setting insulating cement, or equal, to thickness equal to adjoining pipe insulation.
   3. With segments of molded insulation securely wired in place.
   4. With prefabricated covers made from molded pipe insulation finished with vapor barrier adhesive.
   5. With Zeston covers and factory supplied insulation diapers.
   6. Finish fittings and valves with Zeston covers.

C. Piping located outdoors and exposed to the weather shall be insulated as indicated above except the thickness shall be determined according to the worst weather extremes expected. The insulation shall then be protected with one of the following weatherproof finishes as indicated on contract drawings:
   1. Metal jacketing shall be 0.016" (0.4 mm) minimum aluminum or stainless steel with moisture barrier, secured in accordance with the jacket manufacturer's recommendations. Joints shall be applied so they will shed water and shall be sealed completely.

END OF SECTION 23 0768

SECTION 23 0933 – AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 GENERAL CONDITIONS:

A. The General Conditions, Supplementary General Conditions, alternates and addenda, applicable drawings, and the technical specifications, shall all apply to all work under this section.

B. Common HVAC requirements 23 0100.

1.2 SECTION INCLUDES

A. Furnish all labor, materials, equipment, tools and services required to fully complete the Building Energy Management & Temperature Control Systems (BMS) work as is indicated on the drawings and/or specified herein including, but not limited to, the following describeditems.

B. (BMS) utilizing Direct Digital Controls (DDC) as shown on the drawings and as described herein. Drawings are diagrammatic only.

C. All labor, material, equipment and software not specifically referred to herein or on the plans, that is required to meet the functional intent of this specification, shall be provided without additional cost to the Owner.

D. The Owner shall be the named license holder of all software associated, with administration access to functions and folders, usernames, passwords and password phrases, incremental work on the project(s) and will be provided with Superuser Passwords and copies of Stations.

E. System Provider:

1. Control's system provider for this project, shall be Niagara 4 certified and responsible for the control work described herein. Including material, labor, hardware, software, warranty, etc. including cost of system, design, programming, software setup and installation including wire and conduit (See Part 3 Execution of the Specification), checkout, test and demonstration.

F. All equipment and work performed with the BMS shall comply to and seamlessly integrate with the graphical interface as installed by the primary control contractor.

1.3 SYSTEM DESCRIPTION

A. The Building Management System shall be comprised of a network of interoperable, stand-alone digital controllers communicating via BACnet, or FOXS communication protocols to a Niagara 4 Jace. Temperature Control System products shall be manufactured by Honeywell.

B. The BMS shall be comprised of JACE or Controllers within the facility. The BMS shall connect to the owner's local or wide area network, and supervisor installed on temple server depending on configuration. Access to the system, either locally in each building, or remotely from a central site or sites, shall be accomplished through standard Web browsers, via the Internet and/or local area network and a Communication Software (Windows Remote Desktop) if applicable. Each BMS shall communicate to BACnet field controllers and other open protocol systems/devices provided under Division 25 or Division 26. The BMS as provided in this Division shall be based on the Niagara 4 Framework.

C. BACnet controllers shall be BTL listed.

1.4 SUBMITTAL

A. Digital copies in pdf format, of shop drawings of the components and devices for 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 for all controllers, valves, actuators, sensors, switches, routers, etc. 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 shall also be included with the submittal package. The Contractor may use CAD copies of the CAD contract drawings as a place to begin, but the final submittals are to become the product of the Contractor's effort leading to a final system configuration.

B. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol. The Systems Integrator shall be responsible for integrating those diagrams into the overall trunk cable schematic diagrams for the entire Wide Area Network (WAN).

C. Submittal shall also include a complete point list of all physical points to be connected to the BMS. Contractor shall provide necessary point lists, protocol documentation, and factory support information for systems provided in their respective divisions but integrated into the BMS.

D. Submittal shall also include a copy of each of the graphics developed for the Graphic User Interface including a flowchart (site map) indicating how the graphics are to be linked to one another for system navigation. The graphics are intended to be 80% - 90% complete at this stage with the only remaining changes to be based on review comments from the A/E design team and Owner/SPD. The Graphical User Interface shall comply with the SPD Graphics Guidelines.

E. Submittal shall include

1. Updated and adapted sequences of controls provided by this contractor. The sequence of controls contained herein are summary sequences which shall be adapted by this contractor to achieve project set-point temperatures, pressures, humidity levels and air quality. This contractor shall be responsible to adapt the controls programming as required to achieve the project specific needs.
2. Software design data including -
   a. List of software, copies of installation and user manuals
   b. Sequences of operation
   c. Flow charts of implementation of operating sequences
   d. Data files of point function programming, entered set points and parameters, etc. This is to be a permanent file, available for update throughout the life of the control system.

F. Upon completion of the work, provide a complete set of 'as-built' drawings and application/backups software on compact disk and a digital delivered package to SPD engineers. Drawings shall be provided as AutoCAD™ or Visio™ compatible files and include a complete PDF bookmarked set. Contractors shall provide as-builts for their portions of work. The Division 23 contractor shall be responsible for as-builts pertaining to overall BMS architecture and network diagrams. All as-built drawings shall also be installed into the BMS server in a dedicated directory and accessible through a menu option in the Graphical User Interface (GUI). Include IP address and software addresses for equipment connected to the BMS.

1.5 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:
1. BMS - Building Management System
2. JACE – Java Application Control Engine
3. GUI - Graphical User Interface
4. DDC - Direct Digital Controls
5. LAN - Local Area Network
6. WAN - Wide Area Network
7. PICS - Product Interoperability Compliance Statement
8. HTML - Hypertext Markup Language
9. XML - Extensible Markup Language
10. NCP - NetWare Core Protocol
11. ATMD - Active Tuned Mass Damper
12. SSL – Secure Socket Layer
13. TSL – Transport Layer Security
14. BTL - BACnet Testing Laboratory

1.6 DIVISION OF WORK

A. This Division 23 contractor shall be responsible for all controllers (Field Controllers), control devices, control panels, controller programming, controller programming software, controller input/output and power wiring and controller network wiring.

B. This Division 23 contractor shall be responsible for the JACE(s) BMS, software and programming of the BMS, GUI software, development of all graphical screens, Web browser pages, setup of schedules, logs and alarms, and connection of the BMS to the local or wide area network.

1.7 RELATED REQUIREMENTS

A. Division 26, Electrical:
   1. Providing motor starters and disconnect switches.
   2. Power wiring and conduit.

B. Provision, installation and wiring of duct smoke detectors.

   1. Other equipment and wiring as specified in Division 26.

C. Division 23 - See mechanical work and equipment required for installation of BMS including but not limited to -
   1. Piping of control valves
   2. Water flow switches
   3. Water pressure and differential pressure taps.
   4. Thermal wells in piping.
   5. Dampers in ducts and at air handling units.
   6. Openings and holes in duct, plenum, and air handling units for pressure sensors and temperature sensors.
   7. This Division 23 contractor furnishes control valves as scheduled.

1.8 AGENCY AND CODE APPROVALS

A. Products of the BMS shall be provided with the following agency approvals. Verification that the approvals exist for all submitted products shall be provided with the submittal package. Systems or products not currently offering the following approvals are not acceptable.
   1. UL-916; Energy Management Systems
   2. FCC, Part 15, Subpart J, Class A Computing Devices

1.9 SOFTWARE LICENSE AGREEMENT

A. The Owner shall agree to 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.

B. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the BMS, BMS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs passwords, passphrases for access to any component or software program shall be provided to the owner.

C. The installer shall provide NiCS statement to the owner before equipment is approved. The Niagara Software shall allow open access and be set as follows: accept.station.in=”*” accept.station.out=”*” accept.wb.in”*”. The contractor shall not install any software, applications or utilities that are limited in functionality based on the brand of Niagara Framework based device.

D. Licensing, maintenance and programming tool shall be included as part of the one-time controller cost. Provide a written agreement that no periodic or recurring software costs will be applied as they are not accepted by the owner when establishing the contract.

E. Software tools necessary to program, configure, download and service the entire BMS system shall be provided and meet all terms of section 1.01.E.3

1.10 DELIVERY, STORAGE AND HANDLING

A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.

1.11 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It shall be this Contractor's responsibility to check the Contract Documents for possible conflicts between his Work and that of other crafts in equipment location, pipe, duct and conduit runs, electrical outlets and fixtures, air diffusers, and structural and architectural features.

1.12 SCHEDULING

A. Coordination
   1. Coordinate planning and installation of equipment with parties specified to be involved in BMS including but not limited to -
      a. Representative from Control Subcontractor.
      b. Mechanical Subcontractor
      c. Owner Engineers

B. CLOSEOUT

   1. Submit the following manuals for use in operator training and ongoing reference for facility operators – Provide one digital copy in pdf format for each. Bookmark each topic in the pdf.
      a. Operator's Manual
      b. Third Party Software Manuals
      c. O & M manuals including revised As Built documents of materials listed under Shop Drawings and copies of warranties. Include complete wiring and piping interconnection diagrams showing panel and device power and sources.

PART 2 MATERIALS

2.1 GENERAL

A. The BMS shall be comprised of a network of interoperable, stand-alone digital controllers, graphical user interface software, network devices, valves, dampers, sensors, and other devices as specified herein.

B. The installed system shall provide secure password access to all features, functions and data contained in the BMS.

2.2 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, technology, MODBUS, OPC, and other open communication protocols in one open, interoperable system.

B. The supplied system must incorporate the ability to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs.

2.3 NETWORKS

A. The Local Area Network (LAN) is Ethernet based. Most industry protocols like BACnet, Java, XML, HTTPS, and HTMLxx are supported. Owner provides and configures the network equipment for the building network switches and routers. The contractor may temporally install and use other network switches for testing purpose until the owner install the building network equipment. Installation and testing schedule are coordinated by the owner Project Manager.

B. Transmission Control Protocol (TCP) is configured by the owner for full-duplex, bidirectional traffic. TCP ports open by default are ports 80, 443, 1911, 3011, 4911, and 5011. Installation schedule or exceptions request are coordinated by the owner Project Manager.

24 NETWORK ACCESS

A. On site access to the JACEs and the supervisor computer can be achieved by connecting to any network ports configured on a building network switch using TCP IP protocol. The computer used when connecting to the LAN must have a proper OS license and an up-to-date properly licensed anti-virus.

B. Remote access to the JACEs and the supervisor computer is done via the Internet using TCP IP protocol. It requires a secure and unique credential (username and password) and owner approved remote access software.

Computer installed browser: it gives remote access the web interface of either the JACEs or the supervisor computer.

A. The contractor shall supply one or more JACEs Niagara 4 as part of this contract. Number of area controllers required is dependent on the type and quantity of devices provided. Provide Niagara controllers with add on I/O modules to provide auxiliary monitoring and control functions. Provide open Niagara 4 controllers.

B. The JACE shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 32 simultaneous users.

C. Event Alarm Notification and actions
   1. The JACE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   2. The JACE shall be able to route any alarm condition to any defined user location whether connected to a local network or wide-area network.
   3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
      a. To alarm
      b. Return to normal
      c. To fault
   4. Provide timed (schedule) routing of alarms by class, object, group, or node.
   5. 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.

D. Control equipment and network failures shall be treated as alarms and annunciated.

E. The following shall be recorded by the JACE for each alarm (at a minimum):
   1. Time and date
   2. Location (building, floor, zone, office number, etc.)
   3. Equipment (air handler #, access way, etc.)
   4. Acknowledge time, date, and user who issued acknowledgement.
   5. Number of occurrences since last acknowledgement.

F. The Niagara supervisor shall provide the interface between the LAN or WAN and the Jaces and provide global supervisory control functions over the control devices. 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

G. Event Alarm Notification and actions
   1. The Niagara Supervisor shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
   2. The Niagara Supervisor shall be able to route any alarm condition to any defined user location

whether connected to a local network, or wide-area network.

3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but limited to:
   a. To alarm
   b. Return to normal
   c. To fault

H. Alarm actions may be initiated by user defined programmable objects created for that purpose.

I. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.

J. A log of all alarms shall be maintained by the Niagara Supervisor and shall be available for review by the user.

K. Provide a "query" feature to allow review of specific alarms by user defined parameters.

L. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

M. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.

25 DATA COLLECTION AND STORAGE

A. The Niagara Supervisor shall have the ability to collect data for any property of any object and store this data for future use.

B. The data collection shall be performed by log objects, resident in the Niagara Supervisor that shall have, at a minimum, the following configurable properties: Designating the log as interval, change of value (COV) absolute or COV above a tolerance.

1. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
2. For COV logs, the object shall be configured for any change of value or a deviation above a certain 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 Niagara Supervisor log shall maintain 15 months history. Each JACE shall maintain 3-5 days history. All systems shall have the ability to have its data cleared on a time-based event or by a user- defined event or action.

C. All log data shall be stored in the Niagara Supervisor and the data shall be accessed through a standard Web browser.

D. All log data shall be available to the user in the following data formats:

1. HTML
2. XML
3. Plain Text
4. Comma or tab separated values

E. The Niagara Supervisor shall have the ability to archive its log data.

1. Archive on time of day
2. Archive on user-defined number of data stores in the log (buffer size)
3. Archive when log has reached its user-defined capacity of data stores
4. Provide ability to clear logs once archived

26 AUDIT LOG

A. Provide and maintain an Audit Log that tracks all activities performed on the BMS. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the BMS), to another BMS on the network, or to a server. For each log entry, provide the following data:

1. Time and date

2. User ID
3. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

27 DATABASE BACKUP AND STORAGE

A. The BMS shall have the ability to automatically backup its database. The database shall be backed up based on a user-defined time interval.

B. Copies of the current database and, at the most recently saved database shall be stored in the Niagara Supervisor. The age of the most recently saved database is dependent on the user-defined database save interval.

28 Field Controller

A. HVAC control shall be accomplished using BACnet based devices that are either fully programmable or application specific to satisfy the defined sequence of operations.

B. The Division 25 contractor shall provide all programming and documentation.

C. The Division 25 contractor shall run the BACnet network trunk to the nearest JACE. Coordinate locations of the JACE to ensure that maximum network wiring distances, as specified by the BACnet wiring guidelines, are not exceeded. A maximum of 64 devices may occupy any one BACnet trunk and must be installed using the appropriate trunk termination device.

D. The JACE will provide all scheduling, alarming, trending, and network management for the BACnet based devices.

E. The Field Controllers shall communicate with the JACE at a baud rate of 78.8 and not less than 38.4K baud. The BACnet shall provide LED indication of communication and controller performance to the technician, without cover removal.

F. Control sequences within or programmed into the Field Controller shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

G. The Division 23 contractor supplying the Field Controllers shall provide documentation for each device.

H. It is the responsibility of the Division 23 contractor to ensure that the proper Network Variable Inputs and Outputs (nvi and nvo) are provided in each IDC, as required by the pointcharts.

I. All physical points shall terminate on the same IO ports consistently by application throughout the building

29 GRAPHICAL USER INTERFACE SOFTWARE (GUI)

A. Operating System:

1. The GUI shall be provided and developed on the owner provided server.

B. The GUI shall provide standard browser access 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 not 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.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens backgrounds 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 graphic background, the GUI shall support the use of scanned pictures.
2. 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 links to other graphic screens.

3. Graphics shall support layering and each graphic object shall be configurable for assignment to a layer. A minimum of six layers shall be supported.
4. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
5. Commands to start and stop binary objects shall be done by Selecting selected object and selecting the appropriate command from the pop-up menu.
6. Adjustments to analog objects, such as set points, shall be done by Selecting the selected object and adjusting the value.
7. Graphics shall be based on the standard Niagara 4 Tridium images. Custom copyrighted graphics are not acceptable.

D. On-Line Help. Provide a context sensitive, on-line help system to assist the operator in operation of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen.

E. System Diagnostics. The system shall automatically monitor the operation of all workstations, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the alarm console.

F. Alarm Console
1. 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 acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
2. 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.

2.10 SYSTEM PROGRAMMING

A. Programmer shall use the latest version of the Niagara 4 programming tool.

2.11 OTHER CONTROL SYSTEM HARDWARE

A. Space Temperature Wall Module.
1. Space temperature sensors shall be thermistor sensor and accurate to plus or minus one F degree.
2. Where specified, space temperature sensors shall have a setpoint knob calibrated for warmer-cooler adjustments (option: calibrated to allow plus or minus adjustments to a software setpoint) and/or override capability.

B. Control Valves: (Characterized Ball Valves). All control valves up to 2" shall be characterized ball valves. Control valves ½ to 2 inches shall be 2-way or 3-way forged brass screwed pattern as shown constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.
1. Two-position valves shall be 'line' size. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings).
2. Two-way water valves shall have equal percentage flow characteristics and three-way valves shall have equal percentage flow characteristics straight through and linear flow through the bypass.
3. Leakage rate shall be ANSI Class IV (no more than 0.01% of Cv).
4. Valves shall be rated for no less than 350 psig at no less than 250 degrees F.
5. Provide a removable handle to operate valves manually during actuator power loss or failure.
6. Two-way valves shall close off against 100 psi minimum, and three-way valves shall close off against 40 psi minimum.
7. Valves shall have stainless-steel or chemically nickel-plated brass stem and throttling port.

8. Valves shall be tagged with Cv rating and model number.

C. Butterfly Control Valves: Where specified butterfly control valves over 2" in size shall be cast iron body type for 2-way or 3-way applications specified constructed for tight shutoff and shall operate satisfactory against system pressures and differentials.
   1. Valves shall have tapped lugs for standard flange connection and designed for isolation and removal of downstream piping at full rated pressure.
   2. Two-position valves shall be 'line' size.
   3. Proportional control valves shall be sized for a maximum pressure drop of 5.0 psi at rated flow (except as may be noted on the drawings).
   4. Valves shall be rated for bubble tight shutoff at no less than 150 psi.
   5. Valve disc shall be aluminum bronze.
   6. Valve stems shall be stainless steel, with inboard top and bottom bronze bearings, and an external corrosion resistant top bearing to absorb actuator side thrust.

D. Duct Mount, Pipe Mount and Outside Air Temperature Sensors: Temperature sensors with an accuracy of + 0.3° F. Temperature sensors shall be Honeywell.
   1. Outside air sensors shall include an integral sun shield.
   2. Duct sensors shall have sensor approximately in center of the duct, and shall have selectable lengths of 6, 12, and 18 inches.
   3. Multipoint averaging element sensors shall be provided where specified and shall have a minimum of one foot of sensor length for each square foot of duct area (provide multiple sensors if necessary).
   4. Pipe mount sensors shall have copper, or stainless-steel separable wells.

E. 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 shall be provided where specified. Current switches shall include an integral LED for indication of trip condition and a current level below trip set point. Provide VFD rated where used with VFD.

F. Water Flow Meters: Water flow meters shall be axial turbine style flow meters whichtranslate liquid motion into electronic output signals proportional to the flow sensed.
   1. Flow sensing turbine rotors shall be non-metallic and not impaired by magnetic drag.
   2. Flow meters shall be 'insertion' type complete with 'hot-tap' isolation valves to enable sensor removal without water supply system shutdown.
   3. Accuracy shall be + 2% of actual reading from 0.4 to 20 feet per second flow velocities.

G. Low Temperature Limit Switches. Limit switches shall be Honeywell. Safety low limit dual contact shall be manual reset twenty-foot limited fill type responsive to the coolest section of its length.

H. High Temperature Limit Switches. Limit and Safety switches shall be Honeywell. Safety high limit (firestats) shall be manual reset type.

I. CO2 Sensors. CO2 sensors shall be Honeywell.
   1. Carbon Dioxide sensors shall be 0-10 Vdc analog output type, with corrosion freegold-plated non-dispersive infrared sensing, designed for duct mounting.
   2. Sensor shall incorporate internal diagnostics for power, sensor, analog and output checking, and automatic background calibration algorithm for reducedmaintenance. Sensor range shall be 0-2000 PPM with +/- 50 PPM accuracy.

J. Humidity Sensors. Humidity sensors shall be Honeywell.
   1. Duct and room sensors shall have a sensing range of 5% to 95%.
   2. Duct sensors shall be provided with a sampling chamber.
   3. Outdoor air humidity sensors shall have a sensing range of 20% to 95% RH. They shall have a compensated ambient temperature range of -40°F to 170° F.

K. Enthalpy Sensors. Enthalpy sensors shall be Honeywell. Duct mounted enthalpy sensor shall include a temperature sensor and a humidity sensor constructed to close an electrical contact upon a drop-in enthalpy (total heat) to enable economizer modes of operation where specified.

   1. Where specified provide duct mounted sensor including solid state temperature and humidity sensors with electronics which shall output a 4-20 ma signal input to the controller upon a

varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

L. Annular Pitot Tube Flow Meter. Annular pitot tube shall be averaging type differential pressure sensors with four total head pressure ports and one static port made of austenitic stainless steel.
   1. Sensor shall have an accuracy of ± .25% of full flow and a repeatability of ± .05% of measured value.
   2. Transmitter shall be electronic and shall produce a linear output of 4 to 20 mAdc corresponding to the required flow span.
   3. The transmitter shall include noninteracting zero and span adjustments.

M. Temperature Control Panels: Furnish temperature control panels of code gauge steel with locking doors for mounting all devices as shown. Control panels shall meet all requirements of Title 24, California Administrative Code. 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.

N. Field devices and components shall be as scheduled on the drawings or required Contract Documents and have a UL/ETL 508 listing.

   1. Analog Input Sensors: Should provide other manufacture numbers
      a. TR Series - Space Temperature Sensor with Set point.
      b. C7 Series - Duct Temperature Sensor.
      c. C7 Series - Mixed Air Averaging Temperature Sensor 144".
      d. C7 Series - Water Temperature Sensor (must order well separately)
      e. 50001774-001 - Water Temperature Sensor Well
      f. H7635B1004 - Duct Humidity/Temperature Sensor & Cover (mA)
      g. C7232B1014 - Return Air CO2 Sensor 4-20Ma
      h. C7 Series - OA Temperature Sensor.
      i. P7640A Building Static Pressure Transducer 4-20mA (or equivalent)
      j. P7640B Duct Static Pressure Transducer 4-20mA (or equivalent)
      k. MMCPR274-R3-mA - Duct static transducers (mA) (or equivalent)
      l. MMCPR274-R2-mA - Building space static/return air static sensor (or equivalent)
      m. H7635C1002 - System outside air humidity/temp sensor (mA)
      n. PhotoCell (Analong Input)
      o. MMCPR264-R1-mA - Water differential pressure sensor (orequivalent)
      p. MMCPR264-R2-mA - Water differential pressure sensor (orequivalent)
      q. MMCPR264-mA - Water differential pressure sensor to measure water flow (or equivalent)
      r. MMCPR264-R1-mA - Water pressure sensor

   2. Digital Input Sensors: (Provide Honeywell.)
      a. TDIAP521030 - Duct High/Low Limit Pressure Safety Switch (or equivalent)
      b. Adjustable, MCSP-A .7-250A - Run Status
      c. Adjustable, CSP-O-F10-001 1.5-250A - Run Status.
      d. Adjustable Functional Devices, Inc. R1BXGTF.35-150A - Run Status.
      e. Adjustable Functional Devices, Inc. R1BXGTA.75-150A - Run Status.
      f. RIBU1C - Field Relay for Bypass Input
      g. DH100ACDCLP - Duct smoke detector
      h. ST-3 - Duct smoke detector sampling tube
      i. L482A - Low Limit (or equivalent)
      j. RIBU1C - Remote Field Mounted Relay
      k. RH2B-UL-24VAC - Idec 24VAC Relay
      l. SH2B-05 - Relay Socket
      m. BND1000 - Din Rail
      n. MS8120A1007 - 2 Position Spring Return Damper Actuator 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each damper controlled.) Provide damper actuator of equal or greater quality.

o. MN6120A1002 - 2 Position Non-Spring Return Damper Actuator 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each damper controlled.) Provide damper actuator of equal or greater quality.
p. RIB2401D - Remote field mounted relay (DPDT)

3. Analog Output Devices: (Provide Honeywell.)
   a. MS7520A2007 - Modulating Damper Motor - Spring Return (16VA) - 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.
   b. MN7220A2007 - Modulating Damper Motor - Non Spring Return (6VA) - 175 in-lb. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.
   c. VGF21LSxx - 2-Way globe valve. Size valve according to valve schedule.
   d. 3-Way globe valve. Provide Honeywell. Size valve according to valve schedule.
   e. ML7421A1032 - Globe valve actuator - non-spring return (12VA) or equivalent. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.
   f. VB2-XX-CV-SD - 2-Way ball valve w/MS7505A2008 actuator (13 VA) or equivalent. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality.
   g. VB3-XX-CV-SD - 3-Way ball valve w/MS7505A2008 actuator (13VA).
   h. Spyder (should provide additional controller names) or Equivalent - CFCU fan coil controller
   i. C7 Series - Duct temperature sensor with 6” probe.
   j. TR Series - Space Temperature Sensor with Set point
   k. TR100VA002 - 100VA Transformer
   l. VB2xySA & VB3xySA - VAV box reheat valve (ball valve w/ML6161B2024) or equivalent. (Model number specified is only a family part number recommendation. Determine model number/quantities and size actuators for each valve controlled.) Provide valve actuator of equal or greater quality. Honeywell 3-way ball valves do not have stainless steel trims.
   m. 24VAC/100 VA transformer panel housing

PART 3 EXECUTION

3.1 INSTALLATION

A. All work described in this section shall be performed by system integrators or contractors that have a successful history in the design and installation of integrated control systems. The installing office shall have a minimum of five years of integration experience and shall provide documentation in the submittal package verifying the company's experience.

B. Acceptable Installers:

- Harris Mtn West – (208)681-9130

C. Install system and materials in accordance with manufacturer’s instructions, and as detailed on the project drawing set.

D. Drawings of the BMS and BMS network are diagrammatic only and any apparatus not shown but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

E. Low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by this contractor in accordance with these

specifications.

F. Equipment furnished by the HVAC Contractor that is normally wired before installation shall be furnished completely wired. Control wiring normally performed in the field will be furnished and installed by this contractor.

G. Shop fabricate and assemble all control Panels. Mount and wire BMS field devices for DDC systems. Make a complete installation. Such devices include, but are not limited to:
   1. Direct Digital Control (DDC) of air and water temperature, static and differential pressure sensing and control, damper and valve actuation, variable volume box control, electric relays, switches, transformers, and any and all other devices needed to make a complete system
   2. Furnish and install wire, conductors, cables, control devices, panels, conduit etc. required for complete installation of BMS devices. Make terminations. Check all installation for wiring and termination integrity.
   3. Provide control system related materials and installation related to HVAC controls.
      a. Provide new controls for all air handlers, exhaust fans, and HVAC mechanical systems related equipment.

3.2 WIRING

A. All electrical control wiring and low voltage wiring to the control panels, BMS, computers and network components shall be the responsibility of this contractor.

B. The electrical contractor (Div. 26) shall furnish all power wiring to electrical starters, motors & control panels.

C. All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. BMS wiring shall be installed in the as specified in the Project Electrical Specifications (Division 26,27). Do not combine with other systems cabling.

3.3 WARRANTY

A. Equipment, materials, programming and workmanship incorporated into the work shall be warranted for a period of one year from the time of system acceptance.

B. Within this period, upon notice by the Owner, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this contractor at no expense to the Owner

3.4 WARRANTY ACCESS

A. The Owner shall grant to this contractor, reasonable access to the BMS during the warranty period.

B. The owner shall allow the contractor to access the BMS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

3.5 SOFTWARE LICENSE

A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

B. The owner, or his appointed agent, shall receive ownership of all job specific software configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code and documentation for all configuration and programming that is generated for a given project and /or configured for use within the BMS. Any and all required ID's and passwords for access to any component or software program shall be provided to the owner.

3.6 ACCEPTANCE TESTING

A. Upon completion of the installation, this contractor shall load all system software and start-up the system. This contractor shall perform all necessary calibration, testing and de-bugging and perform all required operational checks to ensure that the system is functioning in full accordance with these specifications.

B. This contractor shall perform tests to verify proper performance of components, routines, and

points. Repeat tests until proper performance results. This testing shall include a point-by- point log to validate 100% of the input and output points of the DDC system operation.

C. System Acceptance: Satisfactory completion is when this contractor and the Division 26 contractor have performed successfully all the required testing to show performance compliance with the requirements of the Contract Documents to the satisfaction of the Owner's Representative. System acceptance shall be contingent upon completion and review of all corrected deficiencies.

3.7 DAA CONTROL AND GRAPHIC SUMMARY

A. General:

1. List of hardware points for each DDC controller appears on Mechanical Drawings. Graphics showing these points, along with appropriate pseudo points (i.e. set points, etc.) shall be incorporated into operational graphics.

a. Provide software graphics and programming required to accomplish detailed sequence of operations.

PART 4 SEQUENCE OF OPERATIONS

4.1 DETAILS

END OF SECTION 23 0933

SECTION 23 2113 - HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. This Section includes 216 stainless steel heating piping, special-duty valves, makeup water for these systems; blowdown drain lines; and condensate drain piping.

B. This section includes a steam pressure reducing assembly.

1.3 SUBMITTALS

A. Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.

B. Shop Drawings: Detail fabrication of pipe anchors, hangers, special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

C. Welding Certificates: Copies of certificates for welding procedures and personnel.

D. Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:
1. Test procedures used.
2. Test results that comply with requirements.
3. Failed test results and corrective action taken to achieve requirements.

E. Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 23.

F. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.4 QUALITY ASSURANCE

A. Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

C To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

1.5 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

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

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping specified in Division 7 Section "Through-Penetration Firestop Systems" for fire and smoke wall and floor assemblies.

1.6 EXTRA MATERIALS

A. Water Treatment Chemicals: Furnish sufficient chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Grooved Mechanical-Joint Fittings and Couplings:
      a. Central Sprinkler Company; Central Grooved Piping Products.
      b. Grinnell Mechanical Products.
      c. Victaulic Company of America.
   2. Calibrated Balancing Valves:
      a. Griswold Controls.
      b. ITT Bell & Gossett; ITT Fluid Technology Corp.
   3. Safety Valves:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. Conbraco Industries, Inc.
      d. ITT McDonnell & Miller Div.; ITT Fluid Technology Corp.
   4. Automatic Flow-Control Valves:
      a. Flow Design, Inc.
      b. Griswold Controls.
   5. Expansion Tanks:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. ITT Bell & Gossett; ITT Fluid Technology Corp.
   6. Air Separators and Air Purgers:
      a. Amtrol, Inc.
      b. Armstrong Pumps, Inc.
      c. ITT Bell & Gossett; ITT Fluid Technology Corp.

2.2 PIPING MATERIALS

A. General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

2.3 STAINLESS STEEL PIPE AND FITTINGS

A. Schedule 40-316 stainless steel piping and fittings rate at 500 psi.

B. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors

shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

C. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

D. Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

E. Gasket Material: Thickness, material, and type suitable for fluid to be handled; and design temperatures and pressures.

2.4 VALVES

A. Gate, globe, check, ball, and butterfly valves are specified in Division 23 Section "Valves."

B. Calibrated Balancing Valves, NPS 2 and Smaller: Stainless steel body, ball type, 500-psig working pressure, 250 deg F maximum operating temperature, and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

C. Calibrated Balancing Valves, NPS 2-1/2 and Larger: 316 Stainless steel body, ball type, 500-psig working pressure, 250 deg F maximum operating temperature, and having flanged connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

D. Pressure-Reducing Valves: Diaphragm-operated, bronze or brass body with low inlet pressure check valve, inlet strainer removable without system shutdown, and noncorrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve shall be factory set at operating pressure and have capability for field adjustment.

E. Furnish and install a complete pilot operated steam pressure reducing station as detailed on the drawings complete with reducing valve from 125 # to 40 # and all valves, traps, gauges and strainers.

F. Safety Valves: Diaphragm-operated, bronze or brass body with brass and rubber, wetted, internal working parts; shall suit system pressure and heat capacity and shall comply with the ASME Boiler and Pressure Vessel Code, Section IV.

G. Automatic Flow-Control Valves: Stainless steel body, factory set to maintain constant flow with plus or minus 5 percent over system pressure fluctuations, and equipped with a readout kit including flow meter, probes, hoses, flow charts, and carrying case. Each valve shall have an identification tag attached by chain, and be factory marked with the zone identification, valve number, and flow rate. Valve shall be line size and one of the following designs:
   1. Gray-iron or brass body, designed for 175 psig at 200 deg F with stainless-steel piston and spring.
   2. Brass or ferrous-metal body, designed for 300 psig at 250 deg F with corrosion-resistant, tamperproof, self-cleaning, piston-spring assembly easily removable for inspection or replacement.
   3. Combination assemblies, including bronze ball valve and brass alloy control valve, with stainless-steel piston and spring, fitted with pressure and temperature test valves, and designed for 300 psig at 250 deg F.

2.5 HYDRONIC SPECIALTIES

A. Manual Air Vent: Bronze body and nonferrous internal parts; 150-psig working pressure; 225 deg F operating temperature; manually operated with screwdriver or thumbscrew; with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

B. Automatic Air Vent: Designed to vent automatically with float principle; bronze body and nonferrous internal parts; 150-psig working pressure; 240 deg F operating temperature; with NPS 1/4 discharge

connection and NPS 1/2 inlet connection.

C. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested with taps fabricated and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1. Include the following fittings and accessories:
   1. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Design tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
   2. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; designed to admit air to compression tank, drain water, and close off system.
   3. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.

D. Expansion Tanks: Welded carbon steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Separate air charge from system water to maintain design expansion capacity by a flexible bladder securely sealed into tank. Include drain fitting and taps for pressure gage and air-charging fitting. Support vertical tanks with steel legs or base; support horizontal tanks with steel saddles. Factory fabricate and test tank with taps and supports installed and labeled according to the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

E. Tangential-Type Air Separators: Welded black steel; ASME constructed and labeled for 125-psig minimum working pressure and 375 deg F maximum operating temperature; perforated stainless-steel air collector tube designed to direct released air into expansion tank; tangential inlet and outlet connections; threaded connections for NPS 2 and smaller; flanged connections for NPS 2-1/2 and larger; threaded blowdown connection. Provide units in sizes for full-system flow capacity.

F. In-Line Air Separators: One-piece cast iron with an integral weir designed to decelerate system flow to maximize air separation at a working pressure up to 175 psig and liquid temperature up to 300 deg F.

G. Air Purgers: Cast-iron body with internal baffles that slow the water velocity to separate the air from solution and divert it to the vent for quick removal. Maximum working pressure of 150 psig and temperature of 250 deg F.

H. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
   1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

I. Y-Pattern Strainers: 500 psi stainless steel, flanged ends for NPS 2-1/2 and larger bolted cover, perforated stainless-steel basket, and bottom drain connection.

J. Flexible Connectors: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150-psig minimum working pressure and 250 deg F maximum operating temperature. Connectors shall have flanged- or threaded-end connections to match equipment connected and shall be capable of 3/4-inch misalignment.

K. Spherical, Rubber, Flexible Connectors: Fiber-reinforced rubber body with steel flanges drilled to align with Classes 150 and 300 steel flanges; operating temperatures up to 250 deg F and pressures up to 150 psig.

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
   1. Shutoff Duty: Gate, ball, and butterfly valves stainless steel.
   2. Throttling Duty: Globe, ball, and butterfly valves stainless steel.

B. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

C. Install calibrated balancing valves in the return water line of each heating element and elsewhere as required to facilitate system balancing.

D. Install check valves at each pump discharge and elsewhere as required to control flow direction.

E. Install safety valves on hot-water generators and elsewhere as required by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

F. Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

3.2 PIPING INSTALLATIONS

A. Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.

B. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

C. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

D. Install piping at a uniform grade of 0.2 percent upward in direction of flow.

E. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

F. Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming out the bottom of the main pipe. For up-feed risers, install the takeoff coming out the top of the main pipe.

G. Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

H. Anchor piping for proper direction of expansion and contraction.

3.3 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.

B. Install the following pipe attachments:
   1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
   2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer. cal runs at roof, at each floor, and at 10-foot intervals between floors.

3.4 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install stainless steel automatic air vents in mechanical equipment rooms only at high points of system piping, at heat-transfer coils, and elsewhere as required for system air venting.

C. Install dip-tube fittings in boiler outlet. Install piping to expansion tank with a 2 percent upward slope

toward tank. Connect boiler-outlet piping.

D. Install in-line air separators in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install drain valve on units NPS 2 and larger.

E. Install combination air separator and strainer in pump suction lines. Install piping to compression tank with a 2 percent upward slope toward tank. Install blowdown piping with gate valve; extend to nearest drain.

F. Install bypass chemical feeders in each hydronic system where indicated, in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main, using globe valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

G. Install expansion tanks above air separator. Install gage glass and cocks on end of tank. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
   1. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, and fittings, plus weight of a full tank of water. Do not overload building components and structural members.

H. Install expansion tanks on floor. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system design requirements.

3.5 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be same as for equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure and temperature gages at coil inlet connections.

3.6 CHEMICAL TREATMENT

A. Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:

B. Fill system and perform initial chemical treatment.

3.7 FIELD QUALITY CONTROL

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

PART 4 - Testing

4.1 Perform the following tests on hydronic piping:
   1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
   2. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
   3. Check expansion tanks to determine that they are not air bound and that system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components and repeat hydrostatic test until there are no leaks.
6. Prepare written report of testing.

4.2 ADJUSTING

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

B. Perform these adjustments before operating the system:
1. Open valves to fully open position. Close coil bypass valves.
2. Check pump for proper direction of rotation.
3. Set automatic fill valves for required system pressure.
4. Check air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
5. Set temperature controls so all coils are calling for full flow.
6. Check operation of automatic bypass valves.
7. Check and set operating temperatures of boilers, chillers, and cooling towers to design requirements.
8. Lubricate motors and bearings.

4.3 CLEANING

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

END OF SECTION 23 2113

SECTION 23 2116 – HOT WATER HEATING SYSTEM SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install hot water heating specialties as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUAL AIR VALVES

A. On each coil or piece of equipment wherever an air pocket can form.

B. On each high point of piping or as shown on plans.

C. Approved Manufacturers:
   1. Hoffman #500 or equal complete with #550 air chamber stainless steel.

2.2 AUTOMATIC AIR ELIMINATORS

A. Furnish and install at the high point of each zone piping, or wherever an air pocket can form because of obstructions in the piping, a 3/4" float operated automatic air eliminator, Hoffman #79 stainless steel.

2.3 BALANCING FITTINGS

A. Automatic flow regulator kits complete with ball valve and strainer with capacity shown. Provide P/T test valves.
   1. Approved Manufacturers:
      a. Griswold
      b. Auto flow

B. Manual balance valves with capacity shown. Provide with PT gage taps stainless steel.
   1. Approved Manufacturers:
      a. Bell & Gossett circuit setters
      b. Armstrong

2.4 COMPRESSION TANKS

A. Welded steel compression tanks of sizes shown, ASME Code for 30 lb. W.P., made of steel plate.

B. Provide a water column with water gauge and gauge cocks on ends of tanks.

C. Tanks to be furnished with three 3/4-inch I.P.S. female thread connections, one at either end and one in the middle.

D. Approved Manufacturers
   1. B&G

2.5 AIR SEPARATORS

A. Furnish and install as shown on plans, air separator with tangential nozzles. The air separator shall be fitted with an NPT vent connection to facilitate installation of piping to connect a compression tank.

B. An NPT tapping shall be provided on the bottom of the air separator to facilitate blowdown.

C. The air separator shall also be equipped with a steel system strainer with a free area of not less than four times the cross-sectional area of the connecting piping.

D. Air separators shall be fabricated steel with flanged connections, designed and constricted for 165 psig @ 375F, and in accordance with Section VIII Division I of ASME Boiler & Pressure Vessel Code.

E. Approved Manufacturers
   1. B&G Rollairtrol
   2. Armstrong VAS

2.6 PRESSURE GAUGES

A. Cases shall be black enameled cast aluminum with back flange for surface or line mounting.

B. Gauges shall be of the repairable type with sturdy brass movements and phosphor bronze tubes.

C. Range shall be selected so that normal operating pressure shall be approximately at the center of the dial.

D. 3-1/2-inch figure bourdon tube type pressure gauge.

E. Install on inlet of each pressure gauge a No. 38, 1/4-inch consolidated brass "T" handle gauge cock.

F. Approved Manufacturers:
   1. U. S. Gauge
   2. Trerice

2.7 BOILER FITTINGS & COMPRESSION TANK FITTINGS

A. Boiler fittings as detailed on plans.
   1. Approved Manufacturers:
      a. Bell & Gossett Airtrol

B. Compression Tank Fittings:
   1. Install according to detail and manufacturer's instructions.
   2. Fitted for diameter tanks shown.
   3. Tank fittings to be connected with 1-inch black pipes pitched up to tanks.
   4. Compression tanks fitted with 3/4-inch drain piped to floor of boiler room to permit draining of tanks.
   5. Approved Manufacturers:
      a. Bell & Gossett ATFL Airtrol

2.8 SELF-FILLING VALVES

A. 3/4 inch reducing valves (self-filling)

B. Brass body and bronze interior

C. Install on water service to boiler.

D. Approved Manufacturers:
   1. Bell & Gossett No. 12
   2. Or equal

2.9 BOILER RELIEF VALVE

A. ASME Code relief valve.

B. Approved Manufacturers:

1. Bell & Gossett
2. Or Equal

2.10 THERMOMETERS AND ACCESSORIES

A. Red reading, mercury, separable socket, 7 inch cast, adjustable with 3 1/2 inch stem.

B. Range: Heating 30 degrees to 240 degrees F.

C. Provide other accessories as shown.

D. Approved Manufacturers:
1. Weiss
2. Trerice
3. Palmer

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install pressure gauges on each side of each pump and elsewhere as shown on plans.

B. Install "T" handle gauge cock on the inlet of each pressure gauge.

END OF SECTION 23 2116

SECTION 23 2123 – CIRCULATING PUMPS AND ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 22 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install circulating water pumps and accessories as described in the Contract Documents.

PART 2 - PRODUCTS

2.1 BASE MOUNTED PUMPS

A. Packless flexible coupled, end suction vertically split case design to facilitate servicing all internal components without disturbing pump, volute or motor. The pump volute shall be supplied with plugged vent, drain, and gage tappings. The pump casing shall be of Class 30 cast iron, suitable for 175 PSI working pressure.

B. The pump and motor shall be mounted or a common base plate of heavy structural steel design and securely welded cross members and open grouting area. Securely bolted to isolation base as specified and to the 6-inch high concrete base. Weight of piping shall not be supported on pumps. The pump shall be factory tested before shipment.

C. The motor shall beet NEMA specifications and shall be the size, voltage and enclosure called for on the plans. Pump and motor shall be factory aligned, and shall be realigned by the Contractor after installation prior to start up.

D. 1750 rpm with bronze impeller, wearing rings, stainless steel shaft, and ceramic seal. The pump bearings shall be the regreasable camlock ball bearing type with provision for purging or flushing through the bearing surface, and capable of being inspected by removing the bearing cover. The shaft shall be of 18-8 stainless steel on standard mechanical seal models.

E. Internally-flushed seals shall be mechanical type with ceramic seal and carbon ring, suitable for continuous operation at 225 deg. F. The seals shall be capable of being serviced without disconnecting the pump from piping.

F. Impeller shall be of the enclosed end-suction type in bronze construction and shall be dynamically balanced for quiet operation. Impeller shall be shaved to provide exact operating point specified on drawings. Motor size shall be as shown on drawing but if an alternate pump is supplied that could operate in the overload range, a large motor shall be furnished. Motor shall not operate overloaded. Any additional electrical cost for oversized motor shall be borne by pump manufacturer's representative.

G. A flexible, Center Drop-out spacer type coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor. Coupler shall be shielded by a Coupler Guard securely fastened to the base.

H. Approved Manufacturers:
   1. Bell & Gossett
   2. Armstrong
   3. Grundfos

2.2 PUMP SUCTION DIFFUSERS:

A. Match system pipe size and pump inlet size shall be furnished and installed where shown on drawings.

B. Angle type body with inlet vanes and combination diffuser-strainer-orifice cylinder.

C. Approved Manufacturers:
   1. Bell & Gossett
   2. Armstrong
   3. Or approved equal

2.3 TRIPLE DUTY VALVES

A. Place on each pump discharge. Valve serves as a non-slam check valve with spring loaded disk check, calibrated adjustable and lockable balance valve and full shutoff valve with memory stop. Valve shall be back-seated so as to allow repacking under full line pressure.

B. Cast iron body

C. Bronze disk and seat with stainless steel stems and springs.

D. Teflon packing

E. Maximum valve working pressure of 175 psig and a maximum operating temperature of 300 deg. F.

F. Approved Manufacturers:
   1. Bell & Gossett
   2. Armstrong

2.4 EXPANSION JOINT PUMP CONNECTORS

A. Precision machine molded neoprene and nylon construction internal reinforced by means of steel wire.

B. Cadmium steel floating flanges tapped to mate with 150# ASA companion flanges.

C. Capable of operating at a temperature of 20 deg. F. thru 220 deg. F. and at a pressure ranging from 10" HG vacuum thru 150 psi working pressure.

D. Capable of 15 deg. angular deflection.

E. Twin quiet-sphere design with control rods.

F. Approved Manufacturers:
   1. Vibration Mountings & Controls, Inc.
   2. Metraflex

2.5 IN-LINE CIRCULATORS

A. Bronze fitted with ceramic seal, spring coupling, and 1750-rpm, drip-proof motor with overload protection.

B. Substantially supported in piping with a full size leg to floor.

C. Approved Manufacturers:
   1. Bell & Gossett
   2. Armstrong
   3. Grundfos

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturers instructions.

B. Align pump and motor shafts in accordance with manufacturers requirements before starting equipment. Provide report in the M&O manual regarding pump alignment.

C. Remove start-up filter screen on suction diffuser after system has been cleaned and flushed. Leave main filter screen in place.

END OF SECTION 23 2123

SECTION 23 2125 - CLEANING AND FLUSHING WATER CIRCULATING SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish labor and materials to thoroughly clean water circulating systems as described in Contract Documents.

B. Mechanical contractor shall procure the services of an independent treatment contractor as described in this specification.

1.3 QUALITY ASSURANCE

A. System Additives: This Contractor shall not add any water treatment chemicals or "stop-leak" compounds to the system.

PART 2 - EXECUTION

2.1 FIELD QUALITY ASSURANCE

A. Water circulating systems for project shall be thoroughly cleaned before placing in operation to rid system of dirt, piping compound, mill scale, oil, and other materials foreign to water being circulated.

B. During construction extreme care shall be exercised to prevent dirt and other foreign matter from entering pipe or other parts of system. Pipe stored on project shall have open ends capped and equipment shall have openings fully protected. Before erection, each piece of pipe, fittings, or valve shall be visually examined and dirt removed.

C. Hydronic Closed Loop Cleaning
   1. Prior to any introduction of fluids to the closed loop system the Mechanical Contractor shall close isolation valves at each heat pump and open the bypass valve to prevent flow through the strainer, flow control device and heat pump during the initial flushing and subsequent cleaning.
   2. The Mechanical Contractor shall fill each hydronic system with clean fresh water prior to cleaning and thoroughly leak check system piping. A cleaning and passivating agent supplied by the Chemical Treatment Contractor shall be added to the system at the direction of the Treatment Contractor during the leak check process to minimize initial corrosion. If the system is filled multiple times during the leak check and repair process the Mechanical Contractor shall coordinate with the Treatment Contractor to maintain this initial protection. The Treatment Contractor is responsible for providing chemical for up to two refills of the system. If additional chemical is required due to multiple refillings the Mechanical Contractor shall be responsible for the additional time and chemical.
   3. Following leak check the closed system shall be flushed by the Mechanical Contractor until the leaving water runs clear. All primary runs shall be flushed at their ends to obtain maximum sweep of debris from the system. The inlet screens on the circulating pumps must be kept clear during this initial cleaning process and inspected following cleaning. When flushing is complete the system is to be left full.
   4. Prior to flushing the Mechanical Contractor shall coordinate with Treatment Contractor so that the Treatment Contractor can be available immediately following flush and final refill to add cleaning chemical within 4 hours to prevent initial corrosion.
   5. Following initial flushing the Chemical Treatment Contractor shall refill all systems with cleaning and passivating agents raising the PH to a minimum of 10, circulate and flush until thoroughly clean. All primary piping runs shall be flushed at the ends during this cleaning process. When boiler operation is available the loop temperature should be raised to 110 to 120° to accelerate

cleaning. Cleaning with availability of boiler operation should be anticipated to last 7 to 10 days or longer depending on initial loop conditions. If boiler operation is unavailable loop cleaning duration should be expected to double. The Chemical Treatment Contractor shall verify and adjust cleaning chemistry, and inspect side stream filter bags at a minimum of every two days, exception for weekends. Filter bags shall be changed as required during this cleaning process. Cleaning shall continue until these bags no longer show signs of debris.

6. Following cleaning process the Treatment Contractor shall close the bypass valves at each heat pump and open isolation valves for normal operation and check for leaks of local piping connections. Any leaks found shall be referred to the Mechanical Contractor for repair. The bypass valve handle shall be removed and tied to the valve. The system shall then be charged with final operating chemical to control long term corrosion and a clean bag filter shall be installed in the system.
7. The Treatment Contractor shall provide final inspection report for inclusion in the Operation and Maintenance Manual. Additionally the Treatment Contractor shall take loop samples approximately 12 months following completion, add or adjust chemical as required and provide a post construction report to the owner prior to warranty closeout. Chemical required is the responsibility of the Treatment Contractor.

END OF SECTION 23 2125

SECTION 23 2126 - SPLIT SYSTEM A/C UNITS

PART 1 - GENERAL

1.1 SUMMARY

A. Includes But Not Limited To
   1. Furnish and install heat pumps as described in Contract Documents.

B. Related Sections
   1. Section 02776 - Concrete pads
   2. Section 23 0100 - Common HVAC Requirements

1.2 SUBMITTALS

A. Quality Assurance / Control - Equipment check-out sheets

1.3 QUALITY ASSURANCE

A. Requirements of Regulatory Agencies - Each unit shall be UL or ETL labeled.

1.4 WARRANTY

A. Provide five year warranty on compressors beginning from date of start-up. Record start-up date on warranty certificate for each unit.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Heat Pumps
   1. Indoor Units -
      a. Compact wall mounted units.
      b. Cabinet finish as selected by Architect.
      c. Isolate moving parts from cabinets to reduce noise.
   2. Outdoor Units -
      a. Compressor shall be of rotary or scroll design.
      b. Fans shall be direct driven and discharge horizontally.
      c. Casing shall be fully weatherproof for outdoor installations.
      d. Microprocessor Controls shall be factory wired with field installed remote pendant station.
      e. Refrigerant shall be R-410A.
      f. Isolate moving parts from cabinets to reduce noise.
      g. Use precharged tubing for connection of unit's refrigerant system and roof mounting pipe support.
   3. Approved Products -
      a. Carrier Corp, Syracuse, NY (800) 227-7437 or (315) 432-6000 www.carrier-commercial.com
      b. Friedrich Air Conditioning Co, Austin, TX (800) 541-6645 or (210) 225-2000 www.friedrich.com
      c. Mitsubishi Electronics America Inc, HVAC Div, Norcross, GA (800) 421-1140 or (770) 448-1268
      d. Sanyo Air Conditioning Products, Chatsworth, CA (818) 998-7322 www.sanyo.com
      e. L.G. Electronics, USA, Englewood Cliffs, NJ (201) 585-0018, www.lghvac.com

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Manufacturer's Field Service - Units shall be started up, checked out, and adjusted by Unit Manufacturer's authorized factory trained service mechanic. Use equipment check-out sheet provided by Manufacturer. Complete and sign all items on sheet.

END OF SECTION 23 2166

SECTION 23 2500 – CHEMICAL WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Procure services of Water Treatment Service Organization which will:
   1. Furnish and install required chemical feeding equipment and perform other related services as described in Contract Documents.
   2. Perform initial cleaning and flushing procedures.
   3. Provide chemicals required for cleaning and flushing systems.

B. Related Work Specified Elsewhere:
   1. Owner will supply operating chemicals after start-up chemicals have been exhausted.

1.3 SUBMITTALS

A. Quality Control:
   1. Submit written recommended treatment procedures, chemicals, chemical feeding equipment, and basic water analyses test equipment, based on its experience and chemical analysis of representative sample of water supply.

1.4 MAINTENANCE

A. Test Equipment:
   1. Provide water analysis test kit and adequate supply of reagents suitable to control treatment chemical dosage requirements.

PART 2 - PRODUCTS

2.1 HOT WATER SYSTEMS

A. Two Gallon bypass feeder complete, including piping, valves, and accessories.
   1. Provide adequate supply of Dearborn Aqua-Serv B-547 liquid borate-nitrite based corrosion inhibitor.

B. Approved Manufacturers:
   1. M. A. Fleckenstein
   2. Neptune
   3. Wingert

2.2 STEAM SYSTEM

A. 30 gallon automatic feed system with chemical metering pump to assure uniform distribution. Provide automatic system with electromic timer to control pumping system into the boiler feed water tank.

B. Furnish 30 gallons of “Parker Boiler, EMS Boiler, Water Treatment #633 Special” which is specifically formulated for meat packing plants.

C. Follow all recommended operation and dilution requirements of the manufacturers.

D. Free lab analysis is available from the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide initial start up and adjustment of all chemical systems.

B. Provide instruction to owner in the use and operation of the test kit.

C. Provide (2) two additional trips to the site during the warrantee period to check and adjust the chemical treatment system.

END OF SECTION 23 2500

SECTION 23 3114 - LOW-PRESSURE STEEL DUCTWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install above-grade ductwork and related items as described in Contract Documents.

PART 2 - PRODUCTS

2.1 DUCTS

A. Fabricate of zinc-coated lockforming quality steel sheets meeting requirements of ASTM 653A/653M, "Specification for Sheet Steel Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock Forming Quality", with G 60 coating.

B. Round galvanized metal ductwork may be used in area 1 as shown on drawings

C. Round stainless steel supply duct must be used in all “Product Process Areas”.

2.2 DUCT JOINTS

A. Ducts with sides up to and including 36 inches shall be as detailed in the SMACNA manual.

B. Duct sizes over 36 inches shall be fabricated using SMACNA T-24 flange joints or pre-fabricated systems as follows:
   1. Ducts with sides over 36 inches to 48 inches:
      a. transverse duct joint system by Ductmate/25, Nexus, Ward, or WDCI (Lite) (SMACNA "E" or "G" Type connection).
   2. Ducts 48 inches & larger:
      a. Ductmate/35, Nexus, or WDCI (Heavy) (SMACNA "J" Type connection).
   3. Approved Manufacturers:
      a. Ductmate Industries Inc, 10760 Bay Meadows Drive, Sandy, UT 84092 (801) 571-5308
      b. Nexus, Exanno Corp, P O Box 729, Buffalo, NY 14206 (716) 849-0545
      c. Ward Industries Inc, 1661 Lebanon Church Road, Pittsburg, PA 15236 (800) 466-9374
      d. WDCI, P O Box 10868, Pittsburg, PA 15236 (800) 245-3188

2.3 ACCESS DOORS IN DUCTS

A. At each manual outside air damper and at each motorized damper, install factory built insulated access door with hinges and sash locks. Locate doors within 6 inches of installed dampers. Construction shall be galvanized sheet metal, 24 ga minimum.

B. Fire and smoke damper access doors shall have a minimum clear opening of 12" x 12" or as specified on Drawings to easily service fire or smoke damper. Doors shall be within 6 inches of fire and smoke dampers and in Mechanical Room if possible.

C. Identify each door with 1/2" high letters reading “smoke damper” or “fire damper”.

D. Approved Manufacturers:
   1. AirBalance - Fire/Seal #FSA 100
   2. Air Control Products - HAD-10
   3. Cesco-Advanced Air - HAD-10

4. Elgen - Model 85 A
5. Kees Inc - ADH-D.
6. Louvers & Dampers - #SMD-G-F
7. Nailor-Hart Industries Inc - Series 0831
8. National Controlled Air Inc - Model AD-FL-1

2.4 FLEXIBLE EQUIPMENT CONNECTIONS

A. 30 oz closely woven UL approved glass fabric, double coated with neoprene.

B. Fire retardant, waterproof, air-tight, resistant to acids and grease, and withstand constant temperatures of 250 deg F.

C. Approved Manufacturers:
1. Cain - N-100
2. Duro Dyne - MFN
3. Elgen - ZLN
4. Ventfabrics - Ventglas

2.5 CONCEALED CEILING DAMPER REGULATORS

A. Approved Manufacturers:
1. Cain
2. Duro Dyne
3. Metco Inc
4. Vent-Lock - #666
5. Young - #303

2.6 VOLUME DAMPERS

A. In Main Ducts:
1. 16 gauge galvanized steel, opposed blade type with 3/8 inch pins and end bearings. Blades shall have 1/8 inch clearance all around.
2. Damper shall operate within acoustical duct liner.
3. Provide channel spacer equal to thickness of duct liner.
4. Approved Manufacturers:
   a. Air Balance - Model AC-2
   b. Air Control Products - CD-OB
   c. American Warming - VC-2-AA
   d. Greenheck - VCD-1100
   e. NCA, Safe Air
   f. Vent Products - 5100

B. In Sheet Metal Branch Ducts:
1. Extruded aluminum, opposed blade type. When in open position, shall not extend beyond damper frame.
2. Maximum blade length 12 inches.
3. Damper Regulator shall be concealed type with operation from bottom or with 90 deg miter gear assembly from side.
4. Approved Manufacturers:
   a. Air Control Products - TCD-OB
   b. Air Guide - OB
   c. Arrow - OBDAF-207
   d. CESCO - CDA
   e. Reliable Metals - OBD-RO
   f. Tuttle & Bailey - A7RDDM
   g. Safe Air
   h. Young - 820-AC

C. Dampers above removable ceiling and in Mechanical Rooms shall have locking quadrant on bottom or side of duct. Otherwise, provide concealed ceiling damper regulator and cover plate.

2.7 BACKDRAFT DAMPER

A. Backdraft blades shall be nonmetallic and shall be neoprene coated fiberglass.

B. Stop shall be galvanized steel screen or expanded metal, 1/2 inch mesh.

C. Frame shall be galvanized steel or extruded aluminum alloy.

D. Approved Models & Manufacturers:
1. Air Control Products - FBD
2. American Warming - BD-15
3. CESCO - FBD 101
4. Ruskin - NMS2
5. Safe Air

2.8 DUCT HANGERS

A. 1" x 18 gauge galvanized steel straps or steel rods in area 1 an S.S. straps and hanger rod in Product Process Area as shown on Drawings, and spaced not more than 8 feet apart. Do not use wire hangers.

B. Attaching screws at trusses shall be 1-1/2 inch No. 10 round head wood screws. Nails not allowed.

2.9 DUCT SEALER

A. Cain - Duct Butter or Butter Tak

B. Design Polymerics - DP 1010

C. DSC - Stretch Coat

D. Duro Dyne - S2

E. Hardcast - #601 Iron-Grip or Peel-N-Seal Tape
1. Kingco - 15-325
2. Mon-Eco - 44-41

PART 3 - EXECUTION

3.1 INSTALLATION

A. Ducts:
1. Straight and smooth on inside with joints neatly finished unless otherwise directed.
2. Duct panels through 48 inch dimension having acoustic duct liner need not be crossbroken or beaded.
3. Crossbreak unlined ducts and duct panels larger than 48 inch or bead 12 inches on center.
4. Securely anchor ducts to building structure with specified duct hangers attached with screws. Do not hang more than one duct from a duct hanger.
5. Brace and install ducts so they shall be free of vibration under all conditions of operation.
6. Ducts shall not bear on top of structural members.
7. Make duct take-offs to branches, registers, grilles, and diffusers as detailed on Drawings.
8. Ducts shall be large enough to accommodate inside acoustic duct liner. Dimensions shown on Drawings are net clear inside dimensions after duct liner has been installed.
9. Properly flash where ducts protrude above roof.
10. Install internal ends of slip joints in direction of flow. Make joints air tight using specified duct sealer.

11. Cover horizontal and longitudinal joints on exterior ducts with two layers of Hardcast tape installed with Hardcast HC-20 adhesive according to Manufacturer's recommendations.
12. Paint ductwork visible through registers, grilles, and diffusers flat black.

B. Install flexible inlet and outlet duct connections to each fan, fan coil unit, and air handling unit.

C. Install concealed ceiling damper regulators.
1. Paint cover plates to match ceiling tile.
2. Damper regulators will not be required for dampers located directly above removable ceilings or in Mechanical Rooms.

D. Provide each take-off with an adjustable volume damper to balance that branch.
1. Anchor dampers securely to duct.
2. Install dampers in main ducts within insulation.
3. Dampers in branch ducts shall fit against sheet metal walls, bottom and top of duct, and be securely fastened. Cut duct liner to allow damper to fit against sheet metal.
4. Where concealed ceiling damper regulators are installed, provide a cover plate.

E. Install grilles, registers, and diffusers.

F. Air Turns:
1. Permanently installed, consisting of single thickness curved metal blades with one inch straight trailing edge to permit air to make abrupt turn without appreciable turbulence, in 90 degree elbows of above ground supply and return ductwork.
2. 4-1/2 inch wide minimum vane rail. Do not use junior vane rails.
3. Double thickness vanes not acceptable.
4. Quiet and free from vibration when system is in operation. See SMACNA Manual

G. Install motorized dampers.

END OF SECTION 23 3114

SECTION 23 3318 - SMOKE DETECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Ionization smoke detector mounted in supply air streams or as shown on drawings. Detector to operate on 120 volts AC.

PART 2 - PRODUCTS

2.1 SMOKE DETECTORS

A. Approved Manufacturers & Models:
   1. Series 2650-450 ionization type, duct mounted smoke detector, by Robertshaw
   2. MS Series ionization type duct mounted smoke detector by Air Products Controls Ltd.
   3. Model DH400 ACDC duct mounted smoke detector by System Sensor, a Division of Pittway
   4. Model 0550 duct smoke detector by Maple Chase Co.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install on systems greater than 2000 CFM and interlock with motor control to shut down fan systems upon smoke detection.

END OF SECTION 23 3318

SECTION 23 3346 - FLEX DUCT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install supply air branch duct runouts to diffusers as described in Contract Documents.

PART 2 - PRODUCTS

2.1 DUCTS

A. Formable, flexible, circular duct which shall retain its cross-section, shape, rigidity, and shall not restrict air flow after bending.

B. Nominal 1-1/2 inches thick, 3/4 lb/cu ft density fiberglass insulation with air-tight, polyehtylene or polyester core, sheathed in seamless vapor barrier jacket factory installed over flexible assembly.

C. Assembly, including insulation and vapor barrier, shall meet Class I requirement of NFPA 90A and be UL 181 rated, with flame spread of 25 or less and smoke developed rating of 50 or under.

D. Length of flexible ductwork shall not exceed 8'-0".

2.2 APPROVED MANUFACTURERS

A. ANCO-FLEX - 4625

B. Flex-Aire - PF/UPC #090

C. Hart & Cooley - F114

D. Thermaflex - G-KM

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install duct in fully extended condition free of sags and kinks.

B. Make duct connections by coating exterior of duct collar for 3 inches with duct sealer and securing duct in place over sheet metal collar with 1/2 inch wide metal cinch bands and sheet metal screws.

END OF SECTION 23 3346

SECTION 23 3400 - EXHAUST FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install exhaust fans as described in Contract Documents.

1.3 QUALITY ASSURANCES

A. Requirements of Regulatory Agencies:
   1. Bear AMCA seal and UL label.

PART 2 - PRODUCTS

2.1 CEILING MOUNTED EXHAUST FANS

A. Acoustically insulated housings.

B. Sound level rating of 4.6 sones maximum for fan RPM and CFM listed on Drawings.

C. Include chatterproof integral back-draft damper with no metal to metal contact.

D. True centrifugal wheels.

E. Entire fan, motor, and wheel assembly shall be easily removable without disturbing housing.

F. Suitably ground motors and mount on rubber-in shear vibration isolators.

G. Provide wall or roof cap, as required.

H. Approved Manufacturers:
   1. Cook-Gemini
   2. Greenheck Sp
   3. Pace
   4. Penn Zephyr
   5. Twin City

2.2 ROOF MOUNTED EXHAUST FANS

A. Direct drive or have adjustable pitch V-belt as noted on Drawings.

B. Wheels shall be backward curved and housing shall be removable or hinged aluminum.

C. Isolate motor with vibration dampeners.

D. Provide quiet type back-draft dampers.

E. Insulated, pre-fabricated metal roof curb shall be for flat or sloped roof as shown on Drawings.

F. Approved Manufacturers:
   1. Fans:
      a. Penn
      b. Centri-Master

c. Cook
d. Greenheck G, GB
e. Twin City

2. Standard curbs:
   a. Penn
   b. Cook
   c. Greenheck
3. Sound attenuating curbs:
   a. Penn
   b. Greenheck

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor fan units securely to structure or curb.

END OF SECTION 23 3400

SECTION 23 3713 - AIR OUTLETS & INLETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install wall supply registers, transfer grilles, return air grilles, soffit grilles, ceiling diffusers, louvers connected to ductwork, and registers as described in Contract Documents.

B. All grills, registers, diffusers, etc. are to be used in “Product Process Area” to be stainless steel to match the ductwork.

C. Refer to schedule on drawings.

PART 2 - PRODUCTS

2.1 GRILLES & REGISTERS

A. Approved Manufacturers:
   1. Price
   2. Anemostat
   3. Krueger
   4. Titus
   5. Tuttle & Bailey

2.2 SPIN-IN FITTINGS

A. Low pressure round take-offs to diffusers in area 1 shall be made with spin-in fittings. They shall incorporate a manual balancing damper. The damper shall be spring loaded and a positive locking wing nut shall secure the damper position.

B. Approved Manufacturers:
   1. Sheet metal fittings: Genflex DB-1DEL, Hercules

2.3 Louvers

A. Extruded aluminum, with blades welded or screwed into frames and ½ inch 16 gauge aluminum bird screen.

B. Frames shall have mitered corners.

C. Louvers shall be recessed, flanged, stationary, or removable as noted on Drawings.

D. Approved Manufacturers:
   1. Airolite
   2. American Warming
   3. Arrow
   4. Industrial Louvers
   5. Ruskin
   6. Vent Products

PART 3 - EXECUTION

3.1 INSTALLATION

A. Anchor securely into openings.

B. Install with screws to match color and finish of grilles and registers.

C. Touch-up any scratched finish surfaces.

D. Install in accordance with manufacturer's instructions.

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

F. Install diffusers to ductwork with air tight connection.

G. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly. Any devices in product process area are to be stainless steel.

END OF SECTION 23 3713

SECTION 23 4100 – DISPOSABLE FILTERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install filters used in mechanical equipment.

PART 2 - PRODUCTS

2.1 FAN COIL UNIT FILTERS

A. Filters shall be one inch thick throw-away type as recommended by Fan Coil Unit Manufacturer.

2.2 AIR HANDLING UNIT FILTERS

A. 2 inch thick, medium efficiency, disposable type pre-formed pleated design, having at least 4.5 sq ft of filtering media per sq ft of face area.

B. Media shall be reinforced non-woven cotton fabric, treated with adhesive similar to "Vyclad B" and continuously laminated to supporting steel wire grid conforming to configuration of pleats.

C. Media pack shall be sealed in a chipboard frame or beverage board.

D. Filters shall have rated average efficiency of 25 to 30% on ASHRAE Test Standard 52-76 and be capable of operating with variable face velocities up to 500 FPM without impairing efficiency.

E. Initial resistance shall not exceed 0.30 inches w.g. at 500 FPM or 0.14 inch w.g. at 300 FPM. Filter shall be listed Class 2 by UL.

F. Approved Manufacturers:
1. Type 30/30 by Farr Co
2. Mark 80 by Serv-Aire
3. HC Type 40 by Envopleat
4. DP2-40 by Air Guard

END OF SECTION 23 4100

SECTION 23 4146 – AIR CURTAIN

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of contract, including general and supplementary conditions and section 23 0100 apply to this section.

1.2 SUMMARY

A. Furnish and install complete air curtains as described in the contract documents

B. All parts, pieces, and accessories required for proper operation shall be included.

PART 2 - PRODUCTS

2.1 AMBIENT (UNHEATED) AIR CURTAINS

A. See schedule on drawings.

B. Unit shall be stainless steel construction. 14 inches high x 15 inches deep x length as scheduled. Three speed motors with factory installed fan speed switch.

C. Furnish S.S. washable filter and stainless steel wall support as detailed on drawing.

2.2 MANUFACTURE

A. Bermer International – New Castle, Pennsylvania, 16101, (800)-245-4455, www.bermer.com

B. Commercial high performance 10 ambient air curtain.

END OF SECTION 23 4146

SECTION 23 5134 – FLUES AND FRESH AIR INTAKE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install flues as described in Contract Documents.

B. This applies to domestic hot water heaters and condensing heating boilers.

C. Fresh air intake ducting only on condensing heating boilers.

PART 2 - PRODUCTS

2.1 FLUES AND INTAKE DUCTS

A. Stainless steel as recommended by boiler manufacturer.

2.2 VENT CAPS

A. Non-backdraft type on exhaust flues only.

B. Intake ducts will use a rain cap with intake screen or 180 degree turn with intake screen.

2.3 ROOM COMBUSTION AIR

A. Combustion air requirements for the steam boilers and the quick domestic water boilers will be provided by exterior wall louvers and dampers for each boiler controlled by the boiler operation.

B. Combustion air will be ducted to the ceiling and floor as required by the code.

END OF SECTION 23 5134

SECTION 23 5239 – STEEL GAS-FIRED STEAM BOILER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install two forced draft firetube steel factory packaged boilers for natural gas, complete with fuel burning equipment, safety and operating controls, and appurtenances as hereinafter specified and as described in Contract Documents.

B. The two boilers, boiler blow down separator deaerator and feed water assembly as well as chemical tanks with pumps shall be mounted on a 3-section skid base pre-wired and piped ready for external connections as required. The piping and wiring shall have unions and electrical boxes for connections where each section joins.

1.3 QUALITY ASSURANCE

A. Manufactured in strict accordance with the ASME Heating Boiler Code, Section IV.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Boiler units shall be Superior Boiler UTE 150 or approved equal for 125 psi steam. See plans for sizes. Packaged boiler to be skid mounter with all devices mounted and piped and wired.

B. Boiler pressure vessel shall be constructed, tested, and marked in accordance with the ASME code for high pressure boilers and shall be registered with the National Board of Boiler and Pressure Vessel Inspectors. Each boiler to be factory fire tested.

C. The units shall be of 2-pass down fire vertical firebox design. All tubes shall be roller expanded at each end and shall be flared. Units shall be sealed for pressurized firing, shall be welded on skid base with factory installed firebox floor insulation, gas-tight flue door, and gas-tight rear smokebox with top outlet. A Pyrex glass observation port shall be provided

D. Units shall be provided with factory installed high temperature enamel finish 22-gauge galvanized jacket, and not less than 2-inch-thick mineral wool. 8-pound density insulation. Removable bottom lid and turbulators.

E. Trim and controls for steam boilers shall be consist of steam pressure gauge with shutoff and gauge cocks ASME safety valves, water column with water level gauge glass, low water cutoff, pump control, blowdown valve, operating pressure control, high limit control with manual reset, firing rate control, control circuit terminal strips and auxiliary low water cutoff probe type and low and high gas pressure controls.

F. Fuel Burning Equipment: The burners shall be factory installed and wired, shall incorporate all necessary devices and controls to make a complete fuel burning system for the natural gas as specified, and shall bear the listing label of Underwriters Laboratories, Inc. and Factory Mutual evidencing compliance with requirements of UL-795 for gas burners.

1. Gas burners shall be of the forced draft multi-jet type modjulating suitable for burning natural gas with heat content of 100,000 BTU per cubic foot and specific gravity of seven (7) inches w.c. Burner shall be complete with integral motor driven blower, ignition assembly, Honeywell

RM7895C combustion safeguard, motor starter, complete gas train, including gas pressure regulator and dual gas valves, and all necessary controls for safe and efficient operation in accordance with UL requirements and FM requirements.

2. Provide one Honeywell S7800 keyboard display module to the Owner for his use.

G. Electrical supply to the boilers will be 230 volts, 60 hz, 1 phase. All control circuits shall be 120 volts, 6 hz, 1 phase, with all switches in the ungrounded leg. Fuse protection for the control circuit shall be provided.

H. Contractor will need to put the connecting piping and electrical together after the 3 packaged sections are assembled in place.

I. See mechanical drawings for all required external piping connections to the steam packaged system.

J. Contractor to install and insulate the steam header supplied loose to connect the 2 boilers a steam sensor supplied with the package will also need to be installed in the boiler header and wiring run to the central control panel.

K. The relief valve from each boiler shall be installed full size up through the roof with proper flashing.

L. There will be a single gas connection to the package.

END OF SECTION 23 5239

SECTION 23 5240 – DEAERATOR AND FEED WATER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install a complete factory assembled deaerator and feed water on a skid, pre-piped and wired to match the boiler assembly as specified in 23 5239.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Unit shall be Superior Boiler.

B. The deaerator system shall include a stainless-steel tank, 3 boiler feed water pumps, water level controls, and all needed controls.

C. A two-stage design where supply water is sprayed onto a pan to preheat inlet water and provide partial deaeration, followed by the 2nd stage where water is forced into the scrubber part to remove oxygen to .005 cc/liter.

D. NEMA 4 single point UL listed industrial electrical enclosure.

2.2 FIELD PIPING

A. Pipe 4” vent pipe from top of deaerator up through roof with proper flashing.

B. Pipe ½” cold water line with valve to deaerator.

END OF SECTION 23 5239

SECTION 23 5241 – BLOWDOWN SEPARATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install a complete factory assembled blowdown separator and aftercooler with legs, pre-piped and wired to match the boiler specified assembly as in 23 5239.

PART 2 - PRODUCTS

2.1 BLOWDOWN SEPARATOR

A. Construction
1. Codes: Comply with ASME BPVC Section VIII, Division 1.
2. The ASME Section VIII, Division 1 vessel.
3. The BDS shall have 11-guage, 304 stainless steel strike place at the point of inlet impingement.
4. Floor Stand

B. Connections:
1. The inlet connection shall be NPT.
2. The vent size shall be 150# flanged.
3. The drain shall be 150# flanged. The drain shall be connected to the aftercooler.
4. There shall be two (2) inspection ports.
5. Aftercooler connections:
   a. The discharge connection shall be flanged.
   b. The water connection shall be NPT.
   c. There shall be 1” temperature bulb connection.
   d. There shall be ½” temperature gauge connection.

2.2 BLOWDOWN SEPARTOR TRIM

A. The following items shall be integral to the blowdown separator:
1. Provide a Watson Mcdaniel W91 self-operating temperature regulating valve.
2. Provide a Nibco T-453B Check Valve.
3. Provide a Grinnell 171N shutoff valve.
4. Provide a Keckley style B strainer.
5. Provide a Precision B3B6 temperature gauge.
   a. Type: bimetal thermometer.
   b.. 3” dial with 6” stem.

2.3 SUPERIOR BOILER WORKS

A. Pipe the 4” drain connection to local floor drain.

B. Pipe 4” vent pipe from top of separator up through roof with proper flashing.

C, Pipe 1 ¼” clod water line with valve to separators.

END OF SECTION 23 5241

SECTION 23 5315 – HEATING BOILERS (LAARS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install heating boilers as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Boiler shall be AGA design certified for a minimum boiler efficiency of 95% and bear appropriate seal. The Boiler shall modulate 20-100% of full fire and shall be constructed to comply with the efficiency requirements of the latest addition of ASHRAE Std. 90.1.

B. The unit(s) shall be design-certified to comply with the current edition of the Harmonized ANSI Z21.13 / CSA 4.9 Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers. The unit(s) shall be designed and constructed in accordance with ASME Boiler & Pressure Vessel Code, Section IV requirements for 160 psi (1103 kPa) maximum working pressure and shall bear the ASME “h” Stamp and be listed by the National Board. The boiler shall be equipped with an ASME certified pressure relief valve set at 75psi 517 (kPa).

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Equipped for natural gas.

B. Approved Manufacturers:
1. Magnatherm HTD

C. The water tube heat exchanger shall be stainless steel, rated for 160psi working pressure. The heat exchanger shall be a low water volume design, welded construction, with no gaskets, O-rings or bolts in the header. Heat exchanger shall be accessible for visual section and cleaning of all internal surfaces. The boiler shall be fully condensing design with built-in condensate drain and trap. The heater exchanger shall have a limited ten-year warranty.

D. Each boiler shall be fully test fired, (with water, gas, and venting connected), and all safety components tested, at the factory.

E. The boiler shall be sealed combustion, and removal of jacket panels shall not affect the combustion seal. The boiler jacket shall be a unitized shell finished with acrylic thermo-set baked at not less than 325°F (163°C). The frame shall be constructed of galvanize steel for strength and protection. Chamber shall include a sight glass for viewing flame. Boiler shall be certified for zero clearance to combustible surfaces.

F. All water, gas, vet, and air connections are located in the back for ease of installation

G. Boiler shall operate on 4-13” w.c. gas pressure and shall need no component changes to operate at high altitude, up to 10,000 feet.

H. 20:1 turndown gas train with high accuracy ari gas control valve system using the Laars Tru Trac oxygen combustion control system.

I. The boiler shall be designed for vertical or horizontal Category IV venting, up to 100 equivalent feet with stainless-steel vent material. Combustion air will be ducted directly to the boiler, using up to 100 equivalent feet of S.S. vent material.

J. Unit shall be 120VAC, single phase. The control circuit shall be 24VAC.

K. Unit Controls:
1. The boiler control shall be an integrated electronic PID temperature and ignition control with large color touchscreen display and shall control the boiler operation and firing rate. The boiler display shall be visible without the removal of any jacket panels or control panels.
2. When a display or control is field replaced, the device shall have the ability to read parameter setpoints from the original set-up, so the system does not have to be re-programmed.
3. The control shall have the ability to control the boiler pump, system pump, and indirect domestic water pump, each with delay features. The control shall be able to cascade and lead-lag with other NeoTherm controllers, without additional system controllers.
4. The control shall have built-in outdoor resent feature with customizable reset curves, based on the outdoor temperature and desired system water temperature. The boiler shall be shipped with the outdoor reset sensor, as standard equipment.
5. The control shall have the ability to accept a 4-20mA or 0-10VDC input connection from an external control or building automation system, to modulate the flame. The control shall have dry alarm contacts for ignition failure.
6. The control shall monitor flue gas temperature and shall stop the boiler from firing if temperature is excessive.
7. The control shall have a cleaning mode that allows the user to wipe the screen without activating any functions from the touchscreen.
8. The control shall have a variable speed boiler pump control option.
9. The control shall have installer-level password, and verification feature to ensure that safety-related parameters are not altered by mistake.

L. Multiple Boilers:
1. In multiple boiler systems the boilers shall be controlled to keep each one in the lowest firing rate possible, based on system demand, to maximize efficiency. For example, the master control shall choose to bring on all boilers at low firing rates, instead od one boiler at a high rate, to meet the system needs.
2. A control that is chosen as master in a system with multiple controllers shall display an icon of each of the controls that it is controlling. The color of the icon shall indicate if the control is in normal operation, in lockout, in standby mode, in a hold state, or if there is a communication error. In addition to adjustable parameters, the master display shall also be able to show information for each boiler it is monitoring.

M. See section 23 5134 for Flue and Combustion Air Specifications.

N. Furnish and install on each boiler a JJM alkaline technologies acid condensate neutralizer sized for these boilers. Provide all recommended connection to the boiler condensation line. Provide a 6 month supply of the neutralizer material needed.

END SECTION 23 5315

SECTION 23 5533 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division-1 Specification Sections, and Section 23 05 00 apply to this Section.

1.2 SUMMARY

A. Furnish and install unit heaters as described in Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Heavy steel casings with reinforcement ribs, rounded corners, fan venturi and threaded hanger brackets. Metal shall be treated to prevent rusting and shall be finished in baked enamel.

B. Condensers shall be serpentine or circular design with horizontal tubes, vertical fins and center supply and return connections on top and bottom of unit.
   1. Tubes shall be copper with aluminum fins mechanically bonded and brazed joints.
   2. Tubes shall have individual expansion bends and be rated for 150 psi and 375 deg. F.

C. Fans shall be aluminum secured to a steel hub and direct drive from motor shaft complete with fan guard and outlet deflectors.

D. All units located in the product processing area must be constructed of stainless steel. Including hangers and support devices.

E. All piping connections will be made with stainless steel piping.

F. Approved Manufacturers:
   1. Modine
   2. Or approved equal

END OF SECTION 23 5533

SECTION 23 5540 - ELECTRIC RADIANT WALL HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, and Section 23 0100 apply to this Section.

1.2 SUMMARY

A. Furnish and install wall heaters as described in Contract Documents.

1.3 QUALITY ASSURANCE

A. Units shall be UL listed and comply with NEC.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Fan type for recess mounting in wall.

B. 20 gauge minimum sheet metal casing.

C. Heating element shall be encased in steel finned casting and protected by thermal switch.

D. Fan motor shall be heavy duty enclosed and permanently lubricated.

E. Fan shall be precision balanced and fan-motor assembly mounted to be vibration free.

F. Units shall be controlled automatically by integral thermostat when heater is in "ON" position.

G. Heater shall have built-in fan delay.

H. Finish - Baked-on enamel.

I. Approved Manufacturers:
   1. Q' Mark
   2. Berko
   3. Thermador
   4. Markel

END OF SECTION 23 5540

SECTION 23 5721 - RADIANT SNOWMELT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0100 apply to this Section.

B. Examine all other portions of the contract documents for work or other terms and conditions related to the work of this section. Provide all work here under, as required for the support and accommodation of related work.

1.2 SUMMARY

A. All labor, materials, transportation, equipment and services to install hydronic radiant heating system where indicated on drawings supplied for the project.

PART 2 - PRODUCTS

2.1 SHOP DRAWINGS

A. Shop drawings, or descriptions of materials, and details of installation shall be submitted for approval as specified under TERMS AND CONDITIONS of contract document. No fabrication shall be performed until approval is obtained.

2.2 ALL COMPONENTS

A. Components of the buried tubing system shall be provided by one manufacturer, including: tube, fittings, manifolds, and other ancillary items required for a complete installation, as manufactured by Wirsbo Company, REHAU or approved equal.

2.3 WARRANTY

A. Tube shall carry a twenty (20) year non-prorated warranty against failure due to defect in material and workmanship. Manifolds and other ancillary components shall be warranted for eighteen (18) months from date of shipment.

2.4 MATERIALS

A. Tube:
   1. Tube shall be cross-linked polyethylene, with maximum working pressure/temperature of 100 psi @ 180°F. These temperatures and pressure ratings shall be issued by hydrostatic stress board of PPI (Plastic Pipe Institute). PPI is a division of SPI (Society of Plastics Industry).
   2. The tube shall be manufactured in accordance with ASTM standard specification F 876. The tube shall be listed to ASTM by independent third party testing laboratory.
   3. The tube shall be of cross-linked polyethylene manufactured by the "Engel Method." The tube shall have an oxygen diffusion barrier capable of limiting oxygen diffusion through the tube to no greater than .10g/m3 /day @ 104°F water temperature.
   4. The tube dimensions shall be:
      a. 3/4" nominal inside diameter (7/8" outside diameter), in accordance with ASTM standard specification, as above, or
      b. 5/8" nominal inside diameter (3/4" outside diameter), in accordance with ASTM standard specification, as above, or
      c. 1/2" nominal inside diameter (5/8" outside diameter), in accordance with ASTM standard specification, as above, or
      d. 3/8" nominal inside diameter (1/2" outside diameter), in accordance with ASTM standard specification, as above

5. The minimum bend radius for cold bending of the tube shall not be less than six (6) times the outside diameter. Bends with a radius less than stated shall require the use of a bend support as supplied by the tube manufacturer.

B. Manifolds:
   1. Manifolds shall be of cast brass construction, manufactured of alloys to prevent dezincification, and shall have integral circuit balancing valves. Manifolds shall be able to vent air from the system, and shall be provided with support brackets and tube bend supports. Manifolds shall be isolated from supply and return tubing with valves that are suitable for isolation and balancing.

C. Fittings:
   1. Fittings shall be manufactured of dezincification resistant brass. These fittings must be supplied by the tube manufacturer. The fittings shall consist of a compression fitting with insert, compression ring and a compression nut.

D. Supply and return piping to manifolds:
   1. Piping shall be metal pipe or cross-linked polyethylene tube with an integral oxygen diffusion barrier. Cross-linked polyethylene tube should only be used when specifically approved by the local building inspector for supply and return piping applications.
   2. Fittings shall be compatible to the piping material used. Fittings used with the cross-linked polyethylene tube shall not permit excessive oxygen permeation.

E. There will be no control provided with this system. The owner will provide the hot water source and make the necessary connections to the snow melt system in the main piping manifold boxes.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Hydronic radiant heat tubing loops shall be installed in accordance with the manufacturer's recommendations and the details as shown on the contract drawings.

B. All fittings should be accessible for maintenance. Tubing loops shall be installed without splices, as a minimum, from the point at which the tubing enters the panel to the point at which it exits the panel.

C. Installation shall follow the shop drawings for tubing layout, tube spacing, manifold configuration, manifold location, and controls. All notes on the drawing shall be followed.

D. The tubing system shall be pressurized, with water or air, in accordance with applicable codes, or to a pressure of 60 psig 24 hours prior to encasement in the radiant panel. The tubing system shall remain at this pressure during the panel installation and for a minimum of 24 hours thereafter to ensure system integrity. The contractor shall provide the water or air for the pressurization of the tubing system. The contractor assumes all liabilities for suitable safety precautions and testing, including the use of compressed air, when applicable.

E. At start up time, the contractor shall: follow the manufacturer's recommendations for system water and temperature balancing, record balance settings at each manifold location, and deliver to the owner a complete record of these settings for inclusion in the operation and maintenance manuals.

END OF SECTION 23 5721

SECTION 23 6220 – ROOFTOP HEATING-COOLING UNIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 QUALITY ASSURANCE

A. Unit shall be AGA certified.

1.3 WARRANTY

A. Provide five-year warranty on compressors.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Unit shall be one piece combination air-to-air DX mechanical cooling system and gas fired heating system complete with automatic controls.

B. Equipment shall be shipped completely assembled, pre-charged, piped and wired internally ready for field connections.

C. Roof mounting frame shall be furnished and installed. Frame shall be steel and mate to bottom perimeter of equipment. When flashed into roof, it shall make a unit mounting curb and provide weather-proof duct connection and entry into conditioning area.

D. Power Saver: (Fresh Air Dampers)
1. Provide complete with all controls and air mixing damper assembly, including fresh air, recirculated air, and exhaust air dampers.
2. Fresh air section shall be equipped with air filters.
3. Mixing box sections shall contain low leakage dampers with edge seals and inflatable blade seals.

E. Cooling System:
1. Coils shall be non-ferrous construction with aluminum fins mechanically bonded to seamless copper tubes.
2. Condenser coil shall have sub-cooling rows.
3. Compressor shall be resiliently mounted, have built-in 3-mode crankshaft lubrication, crankcase heater, discharge temperature limiter, current and temperature sensing motor overloads.
4. Cooling system shall be protected by high and low pressure switches and compressor timed off control.
5. Provide with hail guard over condenser coil.

F. Heating System:
1. Automatic controls furnished to give 50/50 2-stage operation.
2. Cylindrical tube and drum exchanger constructed of Duraglas coated steel or stainless steel.
3. Stainless steel burner listed for operation at low outdoor air temperatures.
4. Visual inspection of burner flame possible through observation port at rear of heat exchanger.
5. Power vented.

G. Air Movers:
   1. Twin centrifugal conditioned air blowers with permanently lubricated ball bearings, adjustable belt drive or direct drive as shown on drawings.
   2. Condenser fans shall be direct driven.
   3. Motors shall have inherent protection devices.

H. Frame and Casing:
   1. Frame shall be welded construction.
   2. Casing shall be galvanized panels with baked-on outdoor enamel finish.
   3. Entire cabinet shall be insulated with 1" thick fiberglass.
   4. Provide coil guards on exposed condenser coils.

I. Furnish two sets of 2" throw away filters.

J. Approved Manufacturers:

   1. Lennox
   2. Trane
   3. Carrier
   4. York
   5. Daikin

PART 3 – EXECUTION

3.1 FIELD QUALITY CONTROL

A. Provide manufacturer’s startup and warranty

END OF SECTION 23 6220

SECTION 23 7230 – DEDICATED OUTDOOR H/C UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 REFERENCES

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

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

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices

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

G. AMCA 500 - Test Methods for Louver, Dampers, and Shutters

H. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils

I. ARI 430 - Central Station Air Handling Units

J. ARI 435 - Application of Central Station Air Handling Units

K. ARI 610 - Central System Humidifiers

L. NEMA MG1 - Motors and Generators

M. NFPA 70 - National Electrical Code

N. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

O. UL 900 - Test Performance of Air Filter Units

1.3 SUBMITTALS

A. Supply an ICE direct fired Variable Air Volume make-up unit designed for outdoor installation. The capacity and configuration shall be as detailed on the drawings. The unit shall be CGA and ETL certified and listed to be in compliance with the current ANSI Z83.18 standard.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.

C. The line burner, gas train and controls are to be in accordance with ANSI requirements. (FM, IRI, and FM/IRI gas trains optional.)

D. Product Data:
   1. Provide literature, which indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics and connection requirements.
   2. Provide data on filter media, filter performance data, filter assembly, and filter frames.
   3. Provide fan curves with specified operating point clearly plotted.

4. Submit sound power level data for fan unit outlet, inlet and casing radiated at rated capacity and specified pressure.
5. Submit electrical requirements for power supply including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.
6. Submit performance and vibration test results of the fan for review prior to any air handling unit shipment to the jobsite.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of General Conditions and Division 1 as applicable.

B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.

C. Manufacturer's Installation Instructions.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience, which issues complete catalog data on total product.

1.6 EXTRA MATERIALS

A. Provide one (1) extra set, fan belts and filters for each unit.

1.7 QUALITY ASSURANCE

A. Conform to all information documented in approved submittal package and construction notes.

B. The entire unit shall be hooked up and tested at the factory to verify proper operation. Copy of test results to be submitted to the owner.

1.8 PRODUCTS

A. Manufacturers:
1. ICE
2. Or Approved Equal

1.9 AIR HANDLING UNIT

A. Unit Construction
1. The following sections describe in detail construction requirements for the unit base, cabinet, access doors, insulation and paint finish. Unit shall be built for indoor installation.
2. The unit is to be completely factory test fired to verify proper operation. The unit capacity is to be validated with an instantaneous flow meter. A complete electrical circuit analysis is to be conducted and all systems operated and measured. A combustion analyzer is to be employed while unit is operating at full capacity to verify combustion emissions. Burner combustion must be clean and odorless and no aliphatic aldahydes are to be detectable. Combustion efficiency must limit the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide.

B. Unit Casing
1. Unit construction is to be of industrial quality heavy gauge bonderized G90 steel. The unit design shall incorporate a full base pan supported by an integral welded channel iron base. Bases are to be of industrial welded structural iron integrity, formed sheet metal bases are unacceptable. All structural iron base supports are to be treated with an industrial epoxy primer enriched with a rust inhibitor.
2. To ensure the casings are airtight and weatherproof, all panels are to be caulked during assembly. All casings are to be hand fitted and secured with gasketed self-tapping Tek screws. Roof casing

are to feature three-break standing seam panel design. Roof casings are to be sloped on outdoor units to prevent standing water. Sloped roofs are to be ¼ in. per foot and feature full drain troughs.

3. Entire unit casing and accessories are to be double wall construction (18 ga. Exterior/22g. Liner) insulated with 1.5# density fiberglass insulation. Insulation is to be certified to fire and flamespread ratings as outlined by the ANSI code. The entire floor of the unit is to feature a steel liner sandwiching the insulation.
4. Units are to be equipped with access doors to all serviceable components. Access doors are to have full-length stainless steel piano hinges. All access doors are to be equipped with an insulation liner, positive seal latches and gasketing. Access doors are to open outward on negative pressure sections and inward on positive pressure sections. All outdoor unit access doors are to be equipped with drain troughs.
5. Units are to be finished with an industrial grade chain stop alkyd enamel paint. The medium grey finish coat is to be a mimum of 3 mils thick and provide 100% coverage.

C. Blower/Motor Section

1. Unit(s) shall be supplied with AMCA rated centrifugal forward curve DWDI statically and dynamically balanced blower. The fan shall be mounted on a heavy duty machined and polished shaft. The shafts maximum operating speed is not to exceed 75% of its first critical speed. The bearings and motor shall be mounted in the airstream. The T-frame motor shall be mounted in a motor compartment on a fully adjustable base. The bearings are to be industrial pillow block type supplied with extended grease lines. The blower is to be driven with an (adjustable) (fixed) 1.25 s.f. V-belt drive package concealed in a belt guard. Outdoor units shall have hinged door(s) to provide easy access to maintain and inspect motor, belts & bearings.

D. Burner Section

1. Each unit shall be equipped with a wide range fully modulating direct gas-fired burner capable of 30:1 turndown. The burner shall have stainless steel combustion baffles, non-clogging gas ports, spark-ignited intermittent pilot and flame safeguard system. Burner combustion must be clean and odorless. Combustion efficiency must limit the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide. The burner profile is to be equipped with adjustable profile plates. A heat treated glass observation port shall provide a full view of flame. Hinged access door(s) are to be provided to allow easy maintaince and inspection for burner, ignitor and flamerod.

E. Dampers & Filter Section

1. The dampers are to be galvanized steel (aluminum airfoil low leak) type (with seals). The dampers shall be equipped with 2-position (modulating) actuators. The filters shall be 2" pleated throwaway type with minimum of 85% arrestance and 30% efficiency. Filter access shall be through a latched and gasketed access doors located on both sides of the unit. (Final filters shall be 4 or 12 inch high efficiency cartridge filters.)

F. Control/Manifold Compartment

1. Unit control enclosure to have hinged access. Terminal strip and all wiring shall be numbered and ran in panduit. The controls for the heater shall include;
    a. Blower motor starter w/ambient compensated overloads and auxiliary contact(s).
    b. Primary to 120v control transformer
    c. 6,ooo volt ignition transformer
    d. Control circuit breaker and service switch
    e. Manual reset temperature high limit
    f. Flame safeguard relay w/ LED status and flamerod
    g. Discharge temperature control sensor
    h. Differential air proving safety switch
    i. Automatic low temperature limit
2. All wiring external to control enclosure shall be run in flex. The gas manifold shall include:
    a. Main gas pressure regulator
    b. Manual shutoff & test firing valve
    c. Main gas automatic shutoff valve
    d. Auxiliary main gas automatic shutoff valve
    e. Modulating control system
    f. Pilot pressure regulator

g. Pilot automatic shutoff valve
h. Pilot manual shutoff valve
i. Pilot needle valve
j. multiple test ports

3. Supervisory BACnet controller shall include:
   a. BACNET DDC controller w/ smart space sensor
   b. Filter monitor
   c. Modulating gas valve control output w/ discharge air sensor and temperature selector, exhaust interlock terminals

G. Evaporator Coils

1. Evaporator coils are intended for use with a wide range of applications and refrigerant types. Coils are to be designed to maximize performance under specified conditions with minimal air-side pressure drop.
2. Coils shall be UL recognized as Refrigerant Containing Component. Coils to be used with refrigerant R-410A shall have undergone cycle testing, and shall be safety listed with 750 psig rating.
3. Tubes and return bends shall be constructed from seamless UNS C12200 copper conforming to ASTM B224 and ASTM E527. Properties shall be O50 light annealed with a maximum grain size of 0.040 mm.
4. Tubes are to mechanically expanded into fins (secondary surface) for maximum heat transfer. Materials are to be 3/8" diameter x (0.014, 0.022) wall thickness, 1/2" diameter x (0.016, 0.025) wall thickness, or 5/8" diameter x (0.020, 0.025, 0.035, 0.049) wall thickness.
5. Secondary surface (fins) shall be of the plate-fin design using aluminum or copper, with die-formed collars. Fin design to be flat, waffle, or sine-wave in a staggered tube pattern to meet performance requirements.
6. Collars will hold fin spacing at specified density, and cover the entire tube surface. Aluminum properties are to be Alloy 1100 per ASTM B209, with O (soft) temper; copper is to be Alloy 11000 per ASTM B152-06 with soft (anneal) temper. Fins are to be free of oils and oxidation.
7. Headers are to be constructed of seamless UNS C12200, Type L (drawn) copper material sized to match specified connection size. Type K (drawn) copper headers shall be offered as optional material.
8. Die-formed copper end caps are brazed on the inside of the headers, unless spun-closed (for sized up to 1-3/8").
9. Evaporator coils shall be designed with brass liquid distributors (as required), and copper sweat suction connections. Distributors shall be capped using soft-solder for ease of cap removal; suction connections shall be capped.
10. Coil casing material shall be of G90 galvanized steel, 16 gauge minimum. Heavier material, stainless steel, copper, or aluminum casing are to be provided as required.
11. Intermediate tube supports are to be provided on all coils 48" and longer fin length. Coil casing on top and bottom of coils are to have double-flange construction, allowing for vertical stacking of coils.
12. All coils are to be brazed with minimum 5% silver content (BCup-3) filler material to insure joint integrity.
13. Coils shall be tested at 550 psig using dry nitrogen, submerged under water. Dual-operator verification shall determine that all coils are leak-free.
14. Coils shall be shipped with nitrogen charge to verify leak-free integrity, and to prevent moisture migration into coil.
15. Coils shall be certified to withstand 750 psig working pressure.

H. Condenser Coils

1. Condenser coils are intended for use with a wide range of applications and refrigerant types. Coils are to be designed to maximize performance under specified conditions with minimal air-side pressure drop.
2. Coils shall be UL recognized as Refrigerant Containing Component. Coils to be used with refrigerant R-410A shall have undergone cycle testing, and shall be safety listed with 750 psig rating.

3. Tubes and return bends shall be constructed from seamless UNS C12200 copper conforming to ASTM B224 and ASTM E527. Properties shall be O50 light annealed with a maximum grain size of 0.040 mm.
4. Tubes are to mechanically expanded into fins (secondary surface) for maximum heat transfer. Materials are to be 3/8" diameter x (0.014, 0.022) wall thickness, 1/2" diameter x (0.016, 0.025) wall thickness, or 5/8" diameter x (0.020, 0.025, 0.035, 0.049) wall thickness.
5. Internally enhanced rifled or cross-hatched tubes can be offered as an option.
6. Secondary surface (fins) shall be of the plate-fin design using aluminum or copper, with die-formed collars. Fin design to be flat, waffle, or sine-wave in a staggered tube pattern to meet performance requirements.
7. Collars will hold fin spacing at specified density, and cover the entire tube surface. Aluminum properties are to be Alloy 1100 per ASTM B209, with O (soft) temper; copper is to be Alloy 11000 per ASTM B152-06 with soft (anneal) temper. Fins are to be free of oils and oxidation.
8. Headers are to be constructed of seamless UNS C12200, Type L (drawn) copper material sized to match specified connection size. Type K (drawn) copper headers shall be offered as optional material.
9. Die-formed copper end caps are brazed on the inside of the headers, unless spun-closed (for sized up to 1-3/8").
10. Condenser coils shall be designed with copper sweat connections, and shall be shipped with caps on connections.
11. Coil casing material shall be of G90 galvanized steel, 16 gauge minimum. Heavier material, stainless steel, copper, or aluminum casing are to be provided as required.
12. Coils designed for hot-gas applications shall have oversized tube sheet holes for hot gas feeds to allow for free expansion and contraction of tubes during operation.
13. Intermediate tube supports are to be provided on all coils 48" and longer fin length. Coil casing on top and bottom of coils are to have double-flange construction, allowing for vertical stacking of coils.
14. All coils are to be brazed with minimum 5% silver content (BCup-3) filler material to insure joint integrity.
15. Coils shall be tested at 550 psig using dry nitrogen, submerged under water. Dual-operator verification shall determine that all coils are leak-free.
16. Coils shall be shipped with nitrogen charge to verify leak-free integrity, and to prevent moisture migration into coil.
17. Coils shall be certified to withstand 750 psig working pressure.

I. Refrigeration Compressors
1. Compressors shall be hermetic type. Compressors shall be set on resilient neoprene mounts and complete with line voltage break internal overload protection, internal pressure relief valve and crankcase heater.
2. Each unit shall have a minimum of two compressors. Whereby a unit utilizing two compressors the first stage compressor must be a digital scroll operating with a Emerson EC3 series stand-alone superheat controller with a built in synchronization control for the digital scroll.
3. Unit will provide turndown on cooling. Multiple refrigeration circuits shall be separate from each other.
4. Refrigeration circuits shall be complete with liquid line filter-driers, and service ports fitted with Schraeder fittings.
5. Units shall incorporate load compensated thermal expansion valves with external equalizers (electronic expansion valves on digital systems) and combination sight glass moisture indicators.
6. System charge will be designed for 10 degrees Fahrenheit. Each system shall be factory run and adjusted prior to shipment. Controls shall include:
    a. Compressor motor contactors
    b. Overload protection control
    c. Cooling relays
    d. Ambient compressor lockout
    e. Dual pressure controls
    f. Anti-cycle timers
    g. Electronic expansion valves to provide 40:1 cooling turndown
7. Packaged units shall operate down to 40 degrees Fahrenheit as standard. Minus 40 refrigeration systems are available as an option. Compressors shall be located on the side of the unit in a service enclosure complete with hinged access doors.

J. Electrical Requirements:
   1. Provide single source power panels (SSPP's) that are constructed according to N.E.C. regulations and carry a U.L.508 listing. The panel shall include a non-fused main disconnect switch, starters, transformer, Hand–Off–Auto switches, relays and pilot lights for complete operation of the unit. The single source power panels shall be factory wired to all factory furnished devices such as motors and interlocks.
   2. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all electrical panel assemblies supplied for the air handlers. The air handling unit manufacturer shall be a U.L. 508 listed panel shop.
   3. The main control panel shall have access door(s) for direct access to the controls. The panel shall be NEMA type 1 and shall contain a single externally operated, non-fused disconnect, suitable for copper wire up to and including 3" conduit. The electrical contractor shall bring separate 460/3/60 power to the single source power panel.
   4. Provide vapor tight marine lights in each access section, factory wired to a single weatherproof switch located on exterior of cabinet. Provide weatherproof, 15 amps, GFIC receptacle near the light switch wired to the lighting circuit. The Electrical Contractor shall bring separate 120/1/60 power to the light switch
   5. All wiring shall be run in EMT conduit, raceways are not acceptable.
   6. If the unit requires splits, junction boxes shall be furnished on each section to allow the electrical contractor to make final connections in the field. Wiring shall be clearly labeled to allow ease in final interconnections

K. Variable Frequency Drive
   1. A single manufacturer of both motors and drives shall provide, coordinate and start-up a variable speed drive system to ensure proper application of equipment to the driven load. The variable frequency drive and motor shall be manufactured by Reliance Electric Company.
   2. Motor and VFD shall be of the same manufacturer for single source responsibility. Factory warranty for a period of at least three (3) years from date of start-up shall apply for both motor and drive.
   3. VFD shall be current rated at 8 kHz carrier frequencies for VFD's 1-75 HP and 4 kHz for VFD's 100-400 HP. All HP ratings shall meet or exceed Table 430-150 of the National Electric Code. Three phase motor full load currents, HP, maximum current, and rated voltage shall appear on the drive nameplate. No derating of the VFD shall be required due to increasing the switching frequency for motor noise reduction. All drives designed at greater than 8 kHz carrier frequency (regardless of kHz rating level of VFD) shall include an output voltage rise time reduction device as part of the VFD.

L. Codes/Standards
   1. VFD and options shall be UL™ 508 listed.
   2. NEMA 12 enclosed VFD shall be UL™ approved for mounting in conditioned air ducts and plenums.
   3. The drive and options shall comply with the applicable requirement of the latest standards of ANSI, NEMA, National Electric Code NEC, NEPU-70, IEEE 519-1992, FCC Part 15 Subpart J, and CE96.

M. Quality Assurance
   1. Each drive shall be subjected to the following test and quality control procedures.
   2. Every VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase current, phase voltages, and motor speed. Correct current limit operation shall be verified by simulating a motor overload.
   3. Verification of proper factory presets by scrolling through all parameters shall be performed to ensure proper microprocessor settings. The computer port should also verify that the proper factory settings are loaded correctly in the drive.
   4. All options shall be functionally tested including operation of a motor in the bypass mode if supplied. Proper heater coil installation in motor overload, if supplied, shall be verified.

N. Service

1. The VFD manufacturer shall maintain and staff worldwide service centers. The manufacturers shall have the ability to test both the drives and motors in these service centers.
2. Start-up shall be included for each VFD provided.
3. Service engineers shall be employed by the manufacturer or be certified by the manufacturer and provide start-up service including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

O. Drive Functions
1. The VFD shall have the following basic features:
   a. An electronic overload circuit designed to protect an A-C motor operated by the VFD output from extended overload operation on an inverse time basis. This electronic overload shall be UL™ and NEC recognized as adequate motor protection. No additional hardware such as motor overload relays or motor thermostats shall be required.
2. An LED display mounted on the door of the cabinet that digitally indicates:
   a. Frequency output
   b. Voltage output
   c. Current output
   d. Motor RPM
   e. Input kW
   f. Elapsed time
   g. Time stamped fault indication

PART 2 - DC BUS VOLTS

2.1 VARIABLE FREQUENCY DRIVE

A. The VFD shall have the capability of riding through power dips up to 10 seconds without a controller trip depending on load and operating condition. In this extended ride through, the drive shall use the energy generated by the rotating fan as a power source for all electronic circuits.

B. RS232 Port and Windows™ based software for configuration, control and monitoring.

C. An isolated 0-20mA, 4-20mA or 0-4, 0-8, 0-10, volt analog speed input follower.

D. An isolated 0-10 volt or 4-20mA output signal proportional to speed or load.

2.2 PROTECTIVE CIRCUITS AND FEATURES

A. The VFD shall include the following protective circuits and features:

B. Motor current exceeds 200% of drive continuous current rating.

C. Output phase-to-phase short circuit condition.

D. Total ground fault under any operating condition.

E. High input line voltage.

F. Low input line voltage

G. Loss of input or output phase.

H. External fault (this protective circuit shall permit wiring of remote N.C. safety contact to shutdown the drive). User supplied end switches, thermal switches; fire stats, freeze stats inputs will be connected to this VFD supplied circuit.

I. Metal oxide varistors for surge suppression shall be provided at the VFD input terminals.

J. Complete contactor bypass shall be provided to allow motor to be safely transferred from VFD output to the A-C line, or from the A-C line to the VFD, while the motor is at zero speed. The contactor bypass shall utilize two motor contactors electrically interlocked. One contactor is to open and close the connection between the VFD output and the motor. The other contactor will open and close the connection between the bypass power line and the motor, providing "across the line" starting. Motor protection is to be provided in the "bypass" mode by a bi-metallic Class 20 Smart Motor Protection adjustable overload relay. Relay control logic shall also be included within the VFD enclosure to allow the same "Start/Stop" command to operate the motor in either mode. The relay logic shall be 115 volts. The bypass circuit shall include a second disconnect installed in the VFD to provide the ability to safely troubleshoot and test the controller, both energized and de-energized, while the motor is running in the "bypass" mode. A contact closure shall be provided to indicate that the drive is in the "bypass" mode. A remove/local selector switch shall also be provided to transfer control from the keypad to user wired signals. Form "C" normally open and normally closed contacts shall be provided for both run and IET/drive stopped. The entire bypass option shall be packaged with the controller enclosure and be mechanically isolated from the VFD.

K. Input line fuses shall provide protection for the input rectification circuit using Class J fuses with interrupting rating of 200,000 AIC. The series interrupting rating of the VFD and fuses shall be a minimum of 30,000 AIC and shall be stated in the VFD instruction manual as required by UL.

L. A main input disconnect shall mount within the standard NEMA 1 or NEMA 12 enclosure for positive power disconnect of the VFD. It shall have the capability for door padlocking.

M. A three phase 3% impedance input line reactor shall be provided to minimize drive harmonics on an A-C line and protect the drive from damaging electrical system transients.

2.3 UNIT MOUNTED CONTROLS

A. All controls shall be factory mounted by the Air Handling Unit manufacturer. These controls shall include all damper actuators, temperature sensors, pressure sensors, and airflow measuring sensors, filter switches, smoke and fire detectors as indicated on the control drawings.

B. Electric and electronic controls shall be wired to a terminal block in a sheet metal enclosure located at a common location mounted on the air-handling unit. All pressure sensing controls shall be piped to a common point on the unit with 1/4” compression fittings.

C. All controls shall be supplied by the temperature controls contractor and shipped to the Air Handling Unit Manufacturer for installation.

2.4 Warranty and Start-Up Service

1. Manufacturer shall provide factory start-up service for each air-handling unit. Manufacturer shall provide a one (1) year parts and labor warranty.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish. All fans must be periodically rotated during storage period per manufacturer recommendation.

3.2 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in conformance with ARI 435.

C. Assemble high-pressure units by bolting sections together. Isolate fan section with flexible duct connections.

END OF SECTION 23 7230

SECTION 23 7235 – DEDICATED OUTDOOR HEATING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, General Provisions of Contract, including General and Supplementary Conditions and Section 23 0501 apply to this Section.

1.2 REFERENCES

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

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

C. AMCA 99 - Standards Handbook

D. AMCA 210 - Laboratory Methods of Testing Fans for Rating Purposes

E. AMCA 300 - Test Code for Sound Rating Air Moving Devices

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

G. AMCA 500 - Test Methods for Louver, Dampers, and Shutters

H. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils

I. ARI 430 - Central Station Air Handling Units

J. ARI 435 - Application of Central Station Air Handling Units

K. ARI 610 - Central System Humidifiers

L. NEMA MG1 - Motors and Generators

M. NFPA 70 - National Electrical Code

N. SMACNA - HVAC Duct Construction Standards - Metal and Flexible

O. UL 900 - Test Performance of Air Filter Units

1.3 SUBMITTALS

A. Supply an ICE direct fired Variable Air Volume make-up unit designed for outdoor installation. The capacity and configuration shall be as detailed on the drawings. The unit shall be CGA and ETL certified and listed to be in compliance with the current ANSI Z83.18 standard.

B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, electrical characteristics and connection requirements.

C. The line burner, gas train and controls are to be in accordance with ANSI requirements. (FM, IRI, and FM/IRI gas trains optional.)

D. Product Data:
   1. Provide literature, which indicates dimensions, weights, capacities, ratings, fan performance, gauges and finishes of materials, electrical characteristics and connection requirements.
   2. Provide data on filter media, filter performance data, filter assembly, and filter frames.
   3. Provide fan curves with specified operating point clearly plotted.

4. Submit sound power level data for fan unit outlet, inlet and casing radiated at rated capacity and specified pressure.
5. Submit electrical requirements for power supply including wiring diagrams for interlock and control wiring, clearly indicating factory installed and field installed wiring.
6. Submit performance and vibration test results of the fan for review prior to any air handling unit shipment to the jobsite.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of General Conditions and Division 1 as applicable.

B. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists and wiring diagrams.

C. Manufacturer's Installation Instructions.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five (5) years documented experience, which issues complete catalog data on total product.

1.6 EXTRA MATERIALS

A. Provide one (1) extra set, fan belts and filters for each unit.

1.7 QUALITY ASSURANCE

A. Conform to all information documented in approved submittal package and construction notes.

B. The entire unit shall be hooked up and tested at the factory to verify proper operation. Copy of test results to be submitted to the owner.

1.8 PRODUCTS

A. Manufacturers:
1. ICE
2. Or Approved Equal

1.9 AIR HANDLING UNIT

A. Unit Construction
1. The following sections describe in detail construction requirements for the unit base, cabinet, access doors, insulation and paint finish. Unit shall be built for indoor installation.
2. The unit is to be completely factory test fired to verify proper operation. The unit capacity is to be validated with an instantaneous flow meter. A complete electrical circuit analysis is to be conducted and all systems operated and measured. A combustion analyzer is to be employed while unit is operating at full capacity to verify combustion emissions. Burner combustion must be clean and odorless and no aliphatic aldahydes are to be detectable. Combustion efficiency must limit the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide.

B. Unit Casing
1. Unit construction is to be of industrial quality heavy gauge bonderized G90 steel. The unit design shall incorporate a full base pan supported by an integral welded channel iron base. Bases are to be of industrial welded structural iron integrity, formed sheet metal bases are unacceptable. All structural iron base supports are to be treated with an industrial epoxy primer enriched with a rust inhibitor.
2. To ensure the casings are airtight and weatherproof, all panels are to be caulked during assembly. All casings are to be hand fitted and secured with gasketed self-tapping Tek screws. Roof casing are to feature three-break standing seam panel design. Roof casings are to be sloped on outdoor units to prevent standing water. Sloped roofs are to be ¼ in. per foot and feature full drain troughs.

3. Entire unit casing and accessories are to be double wall construction (18 ga. Exterior/22g. Liner) insulated with 1.5# density fiberglass insulation. Insulation is to be certified to fire and flamespread ratings as outlined by the ANSI code. The entire floor of the unit is to feature a steel liner sandwiching the insulation.
4. Units are to be equipped with access doors to all serviceable components. Access doors are to have full-length stainless steel piano hinges. All access doors are to be equipped with an insulation liner, positive seal latches and gasketing. Access doors are to open outward on negative pressure sections and inward on positive pressure sections. All outdoor unit access doors are to be equipped with drain troughs.
5. Units are to be finished with an industrial grade chain stop alkyd enamel paint. The medium grey finish coat is to be a mimum of 3 mils thick and provide 100% coverage.

C. Blower/Motor Section
1. Unit(s) shall be supplied with AMCA rated centrifugal forward curve DWDI statically and dynamically balanced blower. The fan shall be mounted on a heavy duty machined and polished shaft. The shafts maximum operating speed is not to exceed 75% of its first critical speed. The bearings and motor shall be mounted in the airstream. The T-frame motor shall be mounted in a motor compartment on a fully adjustable base. The bearings are to be industrial pillow block type supplied with extended grease lines. The blower is to be driven with an (adjustable) (fixed) 1.25 s.f. V-belt drive package concealed in a belt guard. Outdoor units shall have hinged door(s) to provide easy access to maintain and inspect motor, belts & bearings.

D. Burner Section
1. Each unit shall be equipped with a wide range fully modulating direct gas-fired burner capable of 30:1 turndown. The burner shall have stainless steel combustion baffles, non-clogging gas ports, spark-ignited intermittent pilot and flame safeguard system. Burner combustion must be clean and odorless. Combustion efficiency must limit the products of combustion to a maximum of 5 ppm carbon monoxide and 0.5 ppm nitrogen dioxide. The burner profile is to be equipped with adjustable profile plates. A heat treated glass observation port shall provide a full view of flame. Hinged access door(s) are to be provided to allow easy maintaince and inspection for burner, ignitor and flamerod.

E. Dampers & Filter Section
1. The dampers are to be galvanized steel (aluminum airfoil low leak) type (with seals). The dampers shall be equipped with 2-position (modulating) actuators. The filters shall be 2" pleated throwaway type with minimum of 85% arrestance and 30% efficiency. Filter access shall be through a latched and gasketed access doors located on both sides of the unit. (Final filters shall be 4 or 12 inch high efficiency cartridge filters.)

F. Control/Manifold Compartment
1. Unit control enclosure to have hinged access. Terminal strip and all wiring shall be numbered and ran in panduit. The controls for the heater shall include;
    a. Blower motor starter w/ambient compensated overloads and auxiliary contact(s).
    b. Primary to 120v control transformer
    c. 6,ooo volt ignition transformer
    d. Control circuit breaker and service switch
    e. Manual reset temperature high limit
    f. Flame safeguard relay w/ LED status and flamerod
    g. Discharge temperature control sensor
    h. Differential air proving safety switch
    i. Automatic low temperature limit
2. All wiring external to control enclosure shall be run in flex. The gas manifold shall include:
    a. Main gas pressure regulator
    b. Manual shutoff & test firing valve
    c. Main gas automatic shutoff valve
    d. Auxiliary main gas automatic shutoff valve
    e. Modulating control system
    f. Pilot pressure regulator
    g. Pilot automatic shutoff valve
    h. Pilot manual shutoff valve

i. Pilot needle valve
j. multiple test ports

3. Supervisory BACnet controller shall include:
   a. BACNET DDC controller w/ smart space sensor
   b. Filter monitor
   c. Modulating gas valve control output w/ discharge air sensor and temperature selector, exhaust interlock terminals

G. Electrical Requirements:
1. Provide single source power panels (SSPP's) that are constructed according to N.E.C. regulations and carry a U.L.508 listing. The panel shall include a non-fused main disconnect switch, starters, transformer, Hand–Off–Auto switches, relays and pilot lights for complete operation of the unit. The single source power panels shall be factory wired to all factory furnished devices such as motors and interlocks.
2. The air handling unit manufacturer, for the purpose of sole source responsibility, shall manufacture all electrical panel assemblies supplied for the air handlers. The air handling unit manufacturer shall be a U.L. 508 listed panel shop.
3. The main control panel shall have access door(s) for direct access to the controls. The panel shall be NEMA type 1 and shall contain a single externally operated, non-fused disconnect, suitable for copper wire up to and including 3" conduit. The electrical contractor shall bring separate 460/3/60 power to the single source power panel.
4. Provide vapor tight marine lights in each access section, factory wired to a single weatherproof switch located on exterior of cabinet. Provide weatherproof, 15 amps, GFIC receptacle near the light switch wired to the lighting circuit. The Electrical Contractor shall bring separate 120/1/60 power to the light switch
5. All wiring shall be run in EMT conduit, raceways are not acceptable.
6. If the unit requires splits, junction boxes shall be furnished on each section to allow the electrical contractor to make final connections in the field. Wiring shall be clearly labeled to allow ease in final interconnections

H. Variable Frequency Drive
1. A single manufacturer of both motors and drives shall provide, coordinate and start-up a variable speed drive system to ensure proper application of equipment to the driven load. The variable frequency drive and motor shall be manufactured by Reliance Electric Company.
2. Motor and VFD shall be of the same manufacturer for single source responsibility. Factory warranty for a period of at least three (3) years from date of start-up shall apply for both motor and drive.
3. VFD shall be current rated at 8 kHz carrier frequencies for VFD's 1-75 HP and 4 kHz for VFD's 100-400 HP. All HP ratings shall meet or exceed Table 430-150 of the National Electric Code. Three phase motor full load currents, HP, maximum current, and rated voltage shall appear on the drive nameplate. No derating of the VFD shall be required due to increasing the switching frequency for motor noise reduction. All drives designed at greater than 8 kHz carrier frequency (regardless of kHz rating level of VFD) shall include an output voltage rise time reduction device as part of the VFD.

I. Codes/Standards
1. VFD and options shall be UL™ 508 listed.
2. NEMA 12 enclosed VFD shall be UL™ approved for mounting in conditioned air ducts and plenums.
3. The drive and options shall comply with the applicable requirement of the latest standards of ANSI, NEMA, National Electric Code NEC, NEPU-70, IEEE 519-1992, FCC Part 15 Subpart J, and CE96.

J. Quality Assurance
1. Each drive shall be subjected to the following test and quality control procedures.
2. Every VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase current, phase voltages, and motor speed. Correct current limit operation shall be verified by simulating a motor overload.

3. Verification of proper factory presets by scrolling through all parameters shall be performed to ensure proper microprocessor settings. The computer port should also verify that the proper factory settings are loaded correctly in the drive.
4. All options shall be functionally tested including operation of a motor in the bypass mode if supplied. Proper heater coil installation in motor overload, if supplied, shall be verified.

K. Service
1. The VFD manufacturer shall maintain and staff worldwide service centers. The manufacturers shall have the ability to test both the drives and motors in these service centers.
2. Start-up shall be included for each VFD provided.
3. Service engineers shall be employed by the manufacturer or be certified by the manufacturer and provide start-up service including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

L. Drive Functions
1. The VFD shall have the following basic features:
a. An electronic overload circuit designed to protect an A-C motor operated by the VFD output from extended overload operation on an inverse time basis. This electronic overload shall be UL™ and NEC recognized as adequate motor protection. No additional hardware such as motor overload relays or motor thermostats shall be required.
2. An LED display mounted on the door of the cabinet that digitally indicates:
a. Frequency output
b. Voltage output
c. Current output
d. Motor RPM
e. Input kW
f. Elapsed time
g. Time stamped fault indication

PART 2 - DC BUS VOLTS

2.1 VARIABLE FREQUENCY DRIVE

A. The VFD shall have the capability of riding through power dips up to 10 seconds without a controller trip depending on load and operating condition. In this extended ride through, the drive shall use the energy generated by the rotating fan as a power source for all electronic circuits.

B. RS232 Port and Windows™ based software for configuration, control and monitoring.

C. An isolated 0-20mA, 4-20mA or 0-4, 0-8, 0-10, volt analog speed input follower.

D. An isolated 0-10 volt or 4-20mA output signal proportional to speed or load.

2.2 PROTECTIVE CIRCUITS AND FEATURES

A. The VFD shall include the following protective circuits and features:

B. Motor current exceeds 200% of drive continuous current rating.

C. Output phase-to-phase short circuit condition.

D. Total ground fault under any operating condition.

E. High input line voltage.

F. Low input line voltage

G. Loss of input or output phase.

H. External fault (this protective circuit shall permit wiring of remote N.C. safety contact to shutdown the drive). User supplied end switches, thermal switches; fire stats, freeze stats inputs will be connected to this VFD supplied circuit.

I. Metal oxide varistors for surge suppression shall be provided at the VFD input terminals.

J. Complete contactor bypass shall be provided to allow motor to be safely transferred from VFD output to the A-C line, or from the A-C line to the VFD, while the motor is at zero speed. The contactor bypass shall utilize two motor contactors electrically interlocked. One contactor is to open and close the connection between the VFD output and the motor. The other contactor will open and close the connection between the bypass power line and the motor, providing "across the line" starting. Motor protection is to be provided in the "bypass" mode by a bi-metallic Class 20 Smart Motor Protection adjustable overload relay. Relay control logic shall also be included within the VFD enclosure to allow the same "Start/Stop" command to operate the motor in either mode. The relay logic shall be 115 volts. The bypass circuit shall include a second disconnect installed in the VFD to provide the ability to safely troubleshoot and test the controller, both energized and de-energized, while the motor is running in the "bypass" mode. A contact closure shall be provided to indicate that the drive is in the "bypass" mode. A remove/local selector switch shall also be provided to transfer control from the keypad to user wired signals. Form "C" normally open and normally closed contacts shall be provided for both run and IET/drive stopped. The entire bypass option shall be packaged with the controller enclosure and be mechanically isolated from the VFD.

K. Input line fuses shall provide protection for the input rectification circuit using Class J fuses with interrupting rating of 200,000 AIC. The series interrupting rating of the VFD and fuses shall be a minimum of 30,000 AIC and shall be stated in the VFD instruction manual as required by UL.

L. A main input disconnect shall mount within the standard NEMA 1 or NEMA 12 enclosure for positive power disconnect of the VFD. It shall have the capability for door padlocking.

M. A three phase 3% impedance input line reactor shall be provided to minimize drive harmonics on an A-C line and protect the drive from damaging electrical system transients.

2.3 UNIT MOUNTED CONTROLS

A. All controls shall be factory mounted by the Air Handling Unit manufacturer. These controls shall include all damper actuators, temperature sensors, pressure sensors, and airflow measuring sensors, filter switches, smoke and fire detectors as indicated on the control drawings.

B. Electric and electronic controls shall be wired to a terminal block in a sheet metal enclosure located at a common location mounted on the air-handling unit. All pressure sensing controls shall be piped to a common point on the unit with 1/4” compression fittings.

C. All controls shall be supplied by the temperature controls contractor and shipped to the Air Handling Unit Manufacturer for installation.

2.4 Warranty and Start-Up Service

1. Manufacturer shall provide factory start-up service for each air-handling unit. Manufacturer shall provide a one (1) year parts and labor warranty.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures and finish. All fans must be periodically rotated during storage period per manufacturer recommendation.

3.2 ENVIRONMENTAL REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in conformance with ARI 435.

C. Assemble high-pressure units by bolting sections together. Isolate fan section with flexible duct connections.

END OF SECTION 23 7235

END OF DIVISION 23