BID # 16-29

L' HOMMEDIEU HALL, NORTH HALL and PERFORMING ARTS CENTER HVAC UPGRADES

SECTION "C" TECHNICAL SPECIFICATIONS

OWNER

Board of Trustees
Middlesex County College
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SECTION C - TECHNICAL SPECIFICATIONS

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1. SCOPE OF WORK

The purpose of these specifications is the completion of a contract. This work will be performed at the main Middlesex County College campus in Edison, New Jersey, at buildings known as L' Hommedieu Hall (LH), North Hall (NH) and Performing Arts Center (PA).

The contractor shall provide all of the necessary labor, materials, tools and equipment required to complete the work described on the drawings and in these specifications as follows:

a. L' Hommedieu Hall – Scope of work involves refurbishing existing AHU by application of a coating on the interior surfaces of the existing AHU, cleaning exterior casing as indicated and repair, patch and replace section of insulation as shown and specified.

b. North Hall – Scope of work involves removing existing window AC units and installing new central HVAC system with a split AC Unit. New AC System shall consist of split DX Air Handling Unit and Outdoor Condensing Unit. New hot water condensing boiler shall be installed for heating hot water. New Louvers shall be provided for ventilation air. New supply and return ductwork shall be provided with terminal VAV boxes with hot water reheat coils and associated hot water piping. New shafts shall be built for new ductwork. Plumbing work shall include relocating existing pipe in basement. Install new building control system and connect to MCC's existing central Building Management System.

c. Performing Arts Center - Scope of work involves replacing existing Air Cooled Condenser and associated DX cooling coil with new air cooled chiller and associated chilled water cooling coil. New chilled water supply and return piping shall be provided. Structural support shall be provided as shown. As part of this project the supply and return ductwork shall be cleaned and the filters will be replaced. New Controls for chiller, cooling coil and demand control ventilation shall be provided as specified.

The contractor shall apply for and secure all required permits.

The contractor shall be required to attend a pre-construction meeting on Campus at a time to be scheduled after the contract is awarded and other job progress meetings as required by the College and the Engineer.

The following is a list of drawings that are attached and are a part of these specifications and contract:

A0.00

North Hall

A0.10, A0.30, A1.01, A1.02, A2.01,S101, M001, M010, M011, M051, M101, M102, M103, M201, M301, M302, M401, M402, E001, E101, E102, E103

Performing Arts Center

A0.10, A1.01, S101, M001, M010, M051, M101, M102, M103, M301, M401 E001, E101

L' Hommedieu Hall

M001, M101

2. MATERIALS

The materials used under this contract shall be as specified on the drawings and in the specifications, be of a quality acceptable to the Engineer and meet applicable codes.

3. COMPLIANCE

The Contractor shall comply with all of the College' s safety and work rules when performing work at the college. All contractor employees, subcontractors, etc. shall sign-in daily at the Facilities Management Building upon arrival on campus to be issued a contractors identification badge. It is expected that all contractor employees will conduct themselves in a professional manner.

Prior to performing any excavation work, the contractor shall call for a utility mark out AND notify the College. Public utilities will be marked out by the appropriate utility and the college will mark out the college utilities.

The college campus in Edison, New Jersey is located on a section of the Former Raritan Arsenal (FRA) which operated from 1918 through 1963. The Army Corps of Engineers (ACE) has completed investigations and remediation activities related to unexploded ordnance (UXO) materials on the campus. While there are no known UXO' s at this time, there remains a possibility that they can be discovered when excavating on campus. The ACE has

provided an information safety sheet which advises anyone excavating on the FRA to practice the " 3R' s" . They are **Recognize, Retreat and Report**. If any material is discovered that appears to be ordnance, the contractor shall immediately stop work, leave the area, call 911, and notify the college. A procedure has been established for emergency responders and military personnel to safely address such a situation.

Middlesex County College is a smoke-free campus. Smoking is only permitted inside a person' s personal vehicle. Smoking is not permitted anywhere else on campus or in any construction equipment. The College Police will issue summonses with fines to anyone found in violation of this policy.

Contractor shall have an escort flagman for any vehicles that will be driving on any Campus walkways. See " Sheet Note" # 3 on Drawing A 0.00.

4. SITE CLEANUP

The work area shall be thoroughly cleaned on a daily basis. Any items remaining shall be secured and surrounded with safety tape and/or barriers. Any damage caused by the contractor shall be repaired at no cost to the college.

The contractor is to remove all trash, excavated materials, and other waste off site and disposed of it in accordance with current regulations. Provide the college with weight tickets for any materials that can be recycled. The cost for the testing of any materials prior to the removal from the campus as required by regulatory agencies is the responsibility of the contractor.

5. TIME CONSTRAINTS

If the Board of Trustees of Middlesex County College has approved an award 10 days prior to November 30, 2015, the contractor shall complete the work in accordance with the following schedule:

Performing Arts Center

All work must be completed by April 1, 2016. The following work must be completed between March 7th and March 11th 2016 (the building will be unoccupied during this time period):

The existing Trane unit located on the roof must be removed.

Place on the roof all material that will be needed for the installation of the replacement unit that will require crane use for placement.

Coil Replacement.

All required duct cleaning.

In order for the College to make arrangements for the building to be unoccupied, the Contractor shall advise the College at least 48 hours in advance of the date the replacement unit is to be placed on the roof.

North Hall – Between May 18 and August 12, 2016

L' Hommedieu Hall – Fridays and Saturdays only between May 20 and June 18, 2016. The air handling equipment must be operational from Monday thru Thursday during this time period, as the building will be occupied.

If the Board has not approved the award by 10 days prior to November 30, 2015, then the College will advise the contractor of an alternate schedule. All work schedules must be met. If additional fees are required for expedited delivery, the fees shall be included in the Contractors Bid.

These time constraints include up to calendar 30 days to obtain permits from the Township of Edison. The contractor must submit the permit applications within 7 calendar days of the Notice of Award. This 7 day period is excusive of the 30 days.

6. WORK HOURS

Except as noted, all work is to be performed during normal work hours 8:00 am to 4:30 pm in accordance with the above listed Time Constraints. If additional work hours are required, they shall be included in the contractor's bid price and approval of the College shall be requested by the contractor in writing 48 hours prior to the desired work date. Excluding the March 7th thru March 11th 2016time period, disruptive work in the Performing Arts Center building shall be done after 10:00 PM.

The work hours in this section take precedent over, and will supersede any conflicting references to hours of work elsewhere in these plans and specifications.

7. WARRANTY

All materials and workmanship shall be replaced at no cost for a period of one year from the date of final payment unless noted otherwise.

a. Hydronic Pumps, see specification section 23 21 23
b. HVAC fans, see specification section 23 34 16
c. Condensing Boilers, see specification section 23 52 16
d. Air Cooled Condensing Units, see specification 23 62 13
e. Air Cooled Water Chillers, see specification 23 64 23
f. Air Handling Unit, see specification 23 73 13

8. PERMITS

The contractor shall apply for and secure all required building permits from Edison Township. It is anticipated that the time to obtain a permit could be up to calendar 30 days. The contractor shall allow for this when preparing the project schedule. The fee will be waived by Edison when a letter provided by the College is submitted with the application. As part of the permit process, Edison also requires a Contractor's License. This fee is the responsibility of the contractor. The contractor is also responsible for obtaining and paying for a fire permit or any other such permit that may be required by the Township of Edison.

The contractor is also responsible for coordinating and obtaining all inspections, approvals and the final Certificate of Occupancy or Approval. Final payment will not be made until all work is completed and the final Certificate and all close-out documents described in these specifications are received.

9. ADDITIONAL INFORMATION

Additional information may be obtained from the following individuals:

Facility/specifications:

Randolph R. Larate
Director, Facilities Engineering
732-906-7780
732-906-4199 Fax
Rlarate@MiddlesexCC.edu

Mitul Patel, PE
Principal
KeRi Engineering PC
Tel: 973.866.KeRi (5374)
mpatel@keriengineering.com

Proposal:

David Fricke
Director, Purchasing & Inventory
732-906-2519
732-906-4236 Fax
DFricke@MiddlesexCC.edu

SECTION 22 34 50 - NATURAL GAS PIPING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements of the following Division 23 Sections apply to this Section:

1. Section 23 05 11: Basic Mechanical Requirements.

2. Section 23 05 12: Basic Mechanical Materials and Methods.

3. Section 23 05 13: Electrical Requirements for Mechanical Equipment.

4. Section 23 05 48: Vibration controls for HVAC Electrical and Plumbing.

1.02 SUMMARY

A. This Section includes distribution piping for natural gas from connection to existing piping to all equipment requiring natural gas as shown on drawings:

1. Pipes, fittings, valves and specialties;

B. Gas pressures for systems specified in this section are limited to 5 psig.

1.03 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Size (NPS).

B. Gas Distribution Piping: A pipe within the building, which conveys gas from connection to existing piping to points of usage.

1.04 SUBMITTALS

A. Product data for each gas piping specialty and special duty valves. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Installation and replacement of gas piping, gas utilization equipment or accessories, and repair and only a qualified installer shall perform servicing of equipment. The term qualified is defined as experienced in such work (experienced shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with precautions required, and has complied with the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Architect.

B. Regulatory Requirements: Comply with the requirements of the following codes:

1. NFPA 54 - National Fuel Gas Code, for gas piping materials and components, gas piping installations, and inspection, testing, and purging of gas piping systems.

2. BOCA Basic National Mechanical Code.

1.06 SEQUENCING AND SCHEDULING

A. Notification of Interruption of Service: Except in the case of an emergency, notify all affected users when the gas supply is to be turned off.

B. Work Interruptions: When interruptions in work occur while repairs or alterations are being made to an existing piping system, leave the system in safe condition.

1.07 EXTRA MATERIALS

A. Valve Wrenches: Furnish to Owner, with receipt, 2 valve wrenches for each type of gas valve installed, requiring it.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide gas piping system products from one of the following:

1. Gas Cocks:

a. Jenkins Bros.

b. Lunkenheimer Co.

c. NIBCO, Inc.

d. Powell Co.

e. Stockham.

2.02 PIPE MATERIALS

A. Steel Pipe: ASTM A 53, Schedule 40, seamless, black steel pipe, beveled ends.

B. Flexible connections to gas equipment shall be Dormont Model B with Model V valve at each piece of equipment.

2.03 FITTINGS

A. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

2.04 JOINING MATERIALS

A. Joint Compound: suitable for natural gas.

2.05 PIPING SPECIALTIES

A. Unions: ANSI B16.39, Class 150, black malleable iron; female pattern; brass to iron seat; ground joint.

B. Dielectric Unions: ANSI B16.39, Class 250; malleable iron and cast bronze; with threaded or soldered end connections suitable for pipe to be joined; designed to isolate galvanic and stray current corrosion.

C. Protective Coating: When piping will be in contact with material or atmosphere exerting a corrosive action, pipe and fittings shall be factory-coated with polyethylene tape, having the following properties:

1. Overall thickness; 20 mils;

2. Synthetic adhesive;

3. Water vapor transmission rate, gallons per 100 square inch: 0.10 or less.

4. Water absorption, percent: 0.02 or less.

D. Prime pipe and fittings with a compatible primer prior to application of tape.

2.06 VALVES

A.

1. 2 Inch and Smaller: 150 PSI, WOG, bronze body, straightaway pattern, square head, threaded ends.

2. 2½ Inch and Larger: 150 PSI, WOG, cast steel, flanged ends, bolted bonnet.

B. Solenoid Valves: aluminum body, 120 volts AC, 60 Hz, Class B continuous duty molded coil; NEMA 4 coil enclosure; electrically opened/electrically closed; dual coils; normally closed; UL and FM approved and labeled.

2.07 Not Used.

PART 3 - EXECUTION

3.01 PREPARATION

A. Precautions: Before turning off the gas to the premises, or section of piping, turn off all equipment valves. Perform a leakage test as specified in "FIELD QUALITY CONTROL" below, to determine that all equipment is turned off in the piping section to be affected.

B. Conform to the requirements in NFPA 54, for the prevention of accidental ignition.

3.02 PIPE APPLICATIONS

A. Install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

3.03 PIPING INSTALLATIONS

A. General: Conform to the requirements of NFPA 54 - National Fuel Gas Code.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Drips and Sediment Traps: Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.

D. Construct drips and sediment traps using a tee fitting with the bottom outlet plugged or capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.

E. Use fittings for all changes in direction and all branch connections.

F. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

G. Install piping free of sags or bends and with ample space between piping SUPPORTS to permit proper insulation applications.

H. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

I. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

J. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

K. Hanger, supports, and anchors are specified in Division 23 Section "Basic Mechanical Materials and Methods." Conform to the table below for maximum spacing of supports:

1. Steel Pipe:

SIZE (NPS)	SPACING IN FEET	MIN. ROD SIZE INCHES
1/2	5	3/8
3/4 to 1-1/4	6	3/8
1-1/2 to 3 (horizontal)	16	1/2

L. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

M. Install dielectric unions where pips of dissimilar metals are joined.

3.04 PIPE JOINTS

A. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for field threading steel pipe.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to male pipe threads only.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

B. Damaged Threads: Do not use pipe with threads, which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

3.05 VALVE INSTALLATIONS

A. Install valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems supplied.

3.06 TERMINAL EQUIPMENT CONNECTIONS

A. Install flexible connector with gas cock upstream and within 6 feet of gas appliance.

B. Sediment Traps: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a

minimum of 3 pipe diameters in length.

3.07 ELECTRICAL BONDING AND GROUNDING

A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 - "National Electrical Code."

B. Do not use gas piping as a grounding electrode.

C. Conform to NFPA 70 - "National Electrical Code," for electrical connections between wiring and electrically operated control devices.

3.08 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF SECTION 22 34 50

SECTION 23 01 30 - HVAC AIR DISTRIBUTION SYSTEM CLEANING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes cleaning HVAC air-distribution equipment, ducts, plenums, and system components.

1.3 DEFINITIONS

A. ASCS: Air systems cleaning specialist.

B. NADCA: National Air Duct Cleaners Association.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For an ASCS.

B. Strategies and procedures plan.

C. Cleanliness verification report.

1.5 QUALITY ASSURANCE

A. ASCS Qualifications:

1. Certification: Contractor shall be ASCS certified by NADCA on a full-time basis to be qualified to perform the work of ductwork cleaning.

B. UL Compliance: Comply with UL 181 and UL 181A for fibrous-glass ducts.

C. Cleaning Conference: Conduct conference at site.

1. Review methods and procedures related to HVAC air-distribution system cleaning including, but not limited to, review of the cleaning strategies and procedures plan.

2. Coordinate the schedule of work and area of work with the owner to minimize disruption with normal business.

3. Coordinate with mechanical contractor and owner to shutdown the corresponding HVAC system

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine HVAC air-distribution equipment, ducts, plenums, and system components to determine appropriate methods, tools, and equipment required for performance of the Work.

B. Perform "Project Evaluation and Recommendation" according to NADCA ACR 2006.

3.2 PREPARATION

A. Prepare a written plan that includes strategies and step-by-step procedures. At a minimum, include the following:

1. Supervisor contact information.
2. Work schedule including location, times, and impact on occupied areas.
3. Methods and materials planned for each HVAC component type.
4. Required support from other trades.
5. Equipment and material storage requirements.
6. Exhaust equipment setup locations.

B. Use the existing service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and for inspection.

C. Comply with NADCA ACR 2006, "Guidelines for Constructing Service Openings in HVAC Systems" Section.

3.3 CLEANING

A. Comply with NADCA ACR 2006.

B. Remove visible surface contaminants and deposits from within the HVAC system.

C. Systems and Components to Be Cleaned:

1. Air devices for supply and return air.
2. Air-terminal units.
3. Ductwork:

   a. Supply-air ducts, including turning vanes and reheat coils, to the air-handling unit.
   b. Return-air ducts to the air-handling unit.
   c. Exhaust-air ducts.

4. Air-Handling Units:

   a. Interior surfaces of the unit casing.
   b. Coil surfaces compartment.
   c. Condensate drain pans.
   d. Fans, fan blades, and fan housings.

5. Filters and filter housings.

D. Collect debris removed during cleaning. Ensure that debris is not dispersed outside the HVAC system during the cleaning process.

E. Particulate Collection:

1. For particulate collection equipment, include adequate filtration to contain debris removed. Locate equipment downwind and away from all air intakes and other points of entry into the building.
2. HEPA filtration with 99.97 percent collection efficiency for particles sized 0.3 micrometer or larger shall be used where the particulate collection equipment is exhausting inside the building,

F. Control odors and mist vapors during the cleaning and restoration process.

G. Mark the position of manual volume dampers and air-directional mechanical devices inside the system prior to cleaning. Restore them to their marked position on completion of cleaning.

H. System components shall be cleaned so that all HVAC system components are visibly clean. On completion, all components must be returned to those settings recorded just prior to cleaning operations.

I. Clean all air-distribution devices, registers, grilles, and diffusers.

J. Clean visible surface contamination deposits according to NADCA ACR 2006 and the following:

1. Clean air-handling units, airstream surfaces, components, condensate collectors, and drains.
2. Ensure that a suitable operative drainage system is in place prior to beginning wash-down procedures.
3. Clean evaporator coils, reheat coils, and other airstream components.

K. Duct Systems:

1. Create service openings in the HVAC system as necessary to accommodate cleaning.
2. Mechanically clean duct systems specified to remove all visible contaminants so that the systems are capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).

L. Debris removed from the HVAC system shall be disposed of according to applicable Federal, state, and local requirements.

M. Mechanical Cleaning Methodology:

1. Source-Removal Cleaning Methods: The HVAC system shall be cleaned using source-removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and to safely remove these contaminants from the facility. No cleaning method, or combination of methods, shall be used that could potentially damage components of the HVAC system or negatively alter the integrity of the system.

    a. Use continuously operating vacuum-collection devices to keep each section being cleaned under negative pressure.

b. Cleaning methods that require mechanical agitation devices to dislodge debris that is adhered to interior surfaces of HVAC system components shall be equipped to safely remove these devices. Cleaning methods shall not damage the integrity of HVAC system components or damage porous surface materials such as duct and plenum liners.

2. Cleaning Mineral-Fiber Insulation Components:

a. Fibrous-glass thermal or acoustical insulation elements present in equipment or ductwork shall be thoroughly cleaned with HEPA vacuuming equipment while the HVAC system is under constant negative pressure and shall not be permitted to get wet according to NADCA ACR 2006.

b. Cleaning methods used shall not cause damage to fibrous-glass components and will render the system capable of passing the HVAC System Cleanliness Tests (see NADCA ACR 2006).

c. Fibrous materials that become wet shall be discarded and replaced.

N. Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. See NADCA ACR 2006, "Coil Surface Cleaning" Section. Type 1, or Type 1 and Type 2, cleaning methods shall be used to render the coil visibly clean and capable of passing Coil Cleaning Verification (see applicable NADCA ACR 2006).
3. Coil drain pans shall be subject to NADCA ACR 2006, "Non-Porous Surfaces Cleaning Verification." Ensure that condensate drain pans are operational.
4. Electric-resistance coils shall be de-energized, locked out, and tagged before cleaning.
5. Cleaning methods shall not cause any appreciable damage to, cause displacement of, inhibit heat transfer, or cause erosion of the coil surface or fins, and shall comply with coil manufacturer's written recommendations when available.
6. Rinse thoroughly with clean water to remove any latent residues.

O. Antimicrobial Agents and Coatings:

1. Apply antimicrobial agents and coatings if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified. Apply antimicrobial agents and coatings according to manufacturer's written recommendations and EPA registration listing after the removal of surface deposits and debris.

2. When used, antimicrobial treatments and coatings shall be applied after the system is rendered clean.
3. Apply antimicrobial agents and coatings directly onto surfaces of interior ductwork.
4. Sanitizing agent products shall be registered by the EPA as specifically intended for use in HVAC systems and ductwork.

3.4 CLEANLINESS VERIFICATION

A. Verify cleanliness according to NADCA ACR 2006, "Verification of HVAC System Cleanliness" Section.

B. Verify HVAC system cleanliness after mechanical cleaning and before applying any treatment or introducing any treatment-related substance to the HVAC system, including biocidal agents and coatings.

C. Perform visual inspection for cleanliness. If no contaminants are evident through visual inspection, the HVAC system shall be considered clean. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible shall be re-cleaned and subjected to re-inspection for cleanliness.

D. Additional Verification:

1. Perform surface comparison testing or NADCA vacuum test.
2. Conduct NADCA vacuum gravimetric test analysis for nonporous surfaces.

E. Verification of Coil Cleaning:

1. Measure static-pressure differential across each coil.
2. Coil will be considered clean if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection.

F. Prepare a written cleanliness verification report. At a minimum, include the following:

1. Written documentation of the success of the cleaning.
2. Site inspection reports, initialed by supervisor, including notation on areas of inspection, as verified through visual inspection.
3. Surface comparison test results if required.
4. Gravimetric analysis (nonporous surfaces only).
5. System areas found to be damaged.

G. Photographic Documentation: Comply with requirements in Section 013233 "Photographic Documentation."
   1. Contractor shall take picture before cleaning and after cleaning for same areas and submit report with before and after pictures of areas cleaned.

3.5 RESTORATION

A. Restore and repair HVAC air-distribution equipment, ducts, plenums, and components according to NADCA ACR 2006, "Restoration and Repair of Mechanical Systems" Section.

B. Restore service openings capable of future reopening. Comply with requirements in Section 233100 "Metal Ducts." Include location of service openings in Project closeout report.

C. Replace fibrous-glass materials that cannot be restored by cleaning or resurfacing. Comply with requirements in Section 233100 "Metal Ducts".

D. Replace damaged insulation according to Section 230710 "Duct Insulation" .

E. Ensure that closures do not hinder or alter airflow.

F. New closure materials, including insulation, shall match opened materials and shall have removable closure panels fitted with gaskets and fasteners.

G. Reseal fibrous-glass ducts. Comply with requirements in Section 233116 "Nonmetal Ducts."

END OF SECTION 23 01 30

SECTION 23 05 11 - BASIC MECHANICAL REQUIREMENTS

PART 1- GENERAL

1.01 RELATED DOCUMENTS

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

B. This section applies to all other sections of Division 23

C. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230513 - Electrical Requirements for Mechanical Equipment
Division 23 - Section 230512 - Basic Mechanical Materials and Methods
Division 23 - Section 232113 - Basic Piping Materials and Methods
Division 23 - Section 230548 - Vibration control for HVAC, Electrical and Plumbing

1.02 SECTION INCLUDES

A. Following administrative and procedural requirements for mechanical installations are included in this Section to expand the requirements specified in Division 1:
1. Codes and Standards
2. Intent
3. Drawings
4. Interpretation of Drawings and Specifications
5. Visiting the Site
6. Submittals
7. Deliveries, Storage and Handling
8. Rough-ins
9. Mechanical installations
10. Cutting and patching

1.03 CODES AND STANDARDS

A. IBC International Building Code 2006 as adopted by New Jersey with technical amendments

B. IMC International Mechanical Code 2006 as adopted by New Jersey with technical amendments.

C. International Fuel Gas Code 2006 as adopted by New Jersey with technical amendments.

D. NFPA National Fire Protection Association

E. ASME American Society of Mechanical Engineers

F. ANSI American National Standards Institute

G. ASTM American Society for Testing Materials

H. AWWA American Water Works Association

I. IBR Institute of Boiler and Radiator Manufacturers

J. NEMA National Electrical Manufacturers Association

K. ASHRAE American Society of Heating, Refrigeration and Air Conditioning Engineers

L. SMACNA Sheet Metal and Air Conditioning Contractors National Associations, Inc.

M. AHRI Air Conditioning Heating and Refrigeration Institute

N. UL Underwriters' Laboratories

O. AMCA Air Movement and Control Association

P. ADC Air Diffusion Council

Q. AABC Associated Air Balance Council

R. National Standard Plumbing Code 2006 as adopted by New Jersey with technical amendments.

S. Local Water Company Rules and Regulations

T. NFPA-90A Air Conditioning and Ventilation Systems

U. National Electrical Code 2008 as adopted by New Jersey with technical amendments.

1.04 INTENT

A. It is the intention of the Specifications and Drawings to call for finished work, tested, and ready for operation. All materials, equipment, and apparatus shall be new and of first-class quality.

B. Any apparatus, appliance, material, or work not shown on Drawings, but mentioned in the Specifications, or vice versa, or any incidental accessories, or minor details not shown but necessary to make the work complete and perfect in all respects and ready for operation, even if not particularly specified, shall be provided without additional expense to the Owner.

1.05 DRAWINGS

A. The Drawings are generally diagrammatic and are intended to convey the scope of work and indicate general arrangement of equipment; ducts, conduits, piping, and fixtures.

B. The locations of all items shown on the Drawings or called for in the Specifications that are not definitely fixed by dimensions are approximate only. The exact locations necessary to secure the best conditions and results must be determined at the project and shall have the approval of the Engineer/ Architect before being installed. Do not scale Drawings.

C. Follow Drawings in laying out work and check Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom and space conditions appear inadequate, Engineer/ Architect shall be notified before proceeding with installation. This contractor is responsible to

coordinate with electrical installation to prevent conflict with clearances and maintenance space requirements of electrical equipment. Mechanical equipment, duct work, piping or supports for mechanical equipment shall not be installed in the dedicated electrical space above electrical equipment, including switchboards, panel boards, transformers and control panels. Dedicated electrical space is the space directly above the electrical equipment and from the top of the electrical equipment to the structural deck of floor above. Similarly, mechanical equipment, ductwork, piping or supports for mechanical equipment shall not be installed in the dedicated working space directly in front of the electrical equipment, minimum 30" wide or equal in width of the electrical equipment, 3' -0" deep and from floor to the structural deck of floor above or the ceiling.

D. If directed by the Engineer/Architect, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

E. Piping or ductwork connected to equipment may require different size connection than indicated on the Drawings. The Contractor shall provide transition pieces as required at the equipment.

1.06 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. Any questions or disagreements arising as to the true intent of this Specification or the Drawings or the kind and quality of work required thereby shall be decided by the Engineer/ Architect, whose interpretations thereof shall be final, conclusive, and binding on all parties.

B. In case of disagreement between Drawings and Specifications, or within either document itself, the better quality, greater quantity or more costly work shall be included in the Contract Price and the matter referred to the Engineer/ Architect's attention for decision and/or adjustment.

C. Maintain an awareness to avoid space conflict with other trades.

D. Purchase the equipment and material required in accordance with field measurements taken at the proper time during the construction progress.

1.07 VISITING THE SITE

A. Before submitting the final proposal, examine the site of the proposed work to determine the existing conditions that may affect the work, as this Section will be held responsible for any assumptions in this regard.

1.08 SUBMITTALS

A. List of Manufacturers:

1. Within twenty (20) working days after the acceptance of the proposal, and prior to the submission of any shop drawings for review, a complete list of manufacturers shall be submitted to the Engineer/Architect of all equipment and materials proposed for the work. No reviews will be rendered on shop drawings submitted before the complete list of manufacturers is reviewed.

2. If material or equipment is installed before the Contractor obtained " No Objections" comment from Engineer/Architect, and/or in the opinion of the Engineer/ Architect

the material or equipment does not meet the intent of the Drawings and Specifications, the removal and replacement shall be made at no extra cost to the Owner.

3. The materials, workmanship, design, and arrangement of all work installed under the Contract shall be subject to the approval of the Engineer/Architect.

B. Shop Drawings:

1. Prior to delivery to job site, but sufficiently in advance of requirements necessary to allow Engineer/ Architect ample time for review, submit six copies (as stated in "General Conditions") of shop drawings of all equipment, materials, piping, sleeves, conduit, ductwork, and wiring diagrams, and further obtain written comments "Approved" or "Approved as Noted" for same from the Engineer/ Architect, before installing any of these items.

2. For piping, sheet metal, sleeve layout and reflected ceiling plan shop drawings, submit a sepia transparency. After the transparency is notated and corrected by the Engineer/ Architect, it will be returned. Then the required number of corrected prints will be prepared.

3. Shop drawings shall consist of manufacturer's certified scale drawings, cuts, or catalog sheets, including descriptive literature and complete certified characteristics of equipment, showing dimensions, capacity, code requirements, motor and drive testing, as indicated on the Drawings or Specifications.

4. Certified performance curves for all pumping and fan equipment shall be submitted for review.

5. Samples of materials or equipment, when requested by the Engineer/Architect shall be submitted for review.

6. Samples, drawings, specifications, catalog sheets, etc., submitted for review, shall be properly labeled indicating project name, specific service for which material or equipment is to be used, Section and Article number of Specifications.

7. Catalogs, pamphlets, or other documents submitted to describe items on which review is being requested, shall be specific and identification in catalog, pamphlet, etc., of item submitted shall be clearly made in ink. Data of a general nature will not be accepted.

8. The comments "Approved" or "approved as Noted" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, said review does not in any way relieve Contractor of responsibility, or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications.

9. "Approved as Noted" means, unless otherwise noted on the drawings approved for construction, fabrication and/or manufacture subject the provision that the work shall be carried out in compliance with all annotations and/or corrections indicated on the shop drawings and in accordance with the requirements of the Contract Documents. If also marked "RESUBMIT", "Approved as Noted" is invalid and a corrected submittal of the drawing is required.

10. Failure to submit shop drawings in ample time for checking shall not entitle an extension of Contract time, and no claim for extension by reason of such default will be allowed.

11. Prior to submission of shop drawings, thoroughly check each shop drawing, reject those not conforming to the Specifications, and indicate (by signature) that the shop drawings submitted meet Contract requirements.

12. All shop drawings showing routing of ductwork, piping and conduit, shall be not less than 3/8" = 1'-0" scale.

13. Label resubmitted shop drawings with a stamp indicating the submittal number, for example: SECOND SUBMISSION; THIRD SUBMISSION, etc. and send separate transmittals for each item being submitted so that one transmittal does not cover more than one specific item or group of items from one manufacturer.

14. Before request for acceptance and final payment for the work, write a letter to the Engineer/ Architect stating that all shop drawings are brought to a condition "No Exception" or "Exception as Noted". Any outstanding shop drawings must be cleared with the Engineer/Architect.

C. Coordination Drawings:

1. Submit coordination drawings before submitting any shop drawing, in accordance with Division 1 Section "PROJECT COORDINATION", to scale of 3/8"=1'-0" or larger; detailing major elements, components and systems of mechanical equipment and materials in relationship with other locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

   a. Indicate the proposed locations of piping, ductwork, equipment, and materials. Include the following:
      i. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
      ii. Equipment connections and support details.
      iii. Exterior wall and foundation penetrations.
      iv. Fire-rated wall and floor penetrations.
      v. Sizes and location of required concrete pads and bases.
      vi. Valve stem movement.

   b. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.

   c. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

   d. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.

D. Record Drawings

1. During construction keep an accurate record of all deviations between the work as shown on the Drawings and that which is actually installed.

2. Secure from the Engineer/ Architect, a complete set of Mylar transparencies of the Drawings and note thereon all changes. Make a complete record of all changes and revisions in the original design, which exist, in the complete work. The cost for the Mylar transparencies shall be paid for by each trade.

3. Furnishing above transparencies and preparing these Record Drawings shall be at no additional cost to the Owner. When all revisions showing the work as finally installed are made, the corrected Mylar transparencies shall be submitted for review by the Engineer/Architect.

4. After review of the "Record Drawings" transparencies by the Architect, provide the Owner with one set of black-line prints and Mylar transparencies, at no additional cost to the Owner.

E. Operation and Maintenance Manuals

1. Prepare maintenance manuals in accordance with Division 1 Section "PROJECT CLOSEOUT." In addition to the requirements specified in Division 1, include the following information for equipment items:

a. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.

b. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.

c. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.

d. Servicing instructions and lubrication charts and schedules.

1.09 DELIVERY, STORAGE, AND HANDLING

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

B. Take all necessary precaution in storing and handling equipment and materials. Replace damaged equipment and material at no cost to the Owner.

PART 2 - EXECUTION

2.01 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with the requirements of the equipment to be connected.

B. Refer to equipment specifications in Divisions 2 through 16 for rough-in requirements.

2.02 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer/Architect.

9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

10. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

11. Install access panel or doors where units are concealed behind finished surfaces. Access panels and doors shall be as specified in Division 15 Section "BASIC MECHANICAL MATERIALS AND METHODS".

12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

2.03 CUTTING AND PATCHING

A. General: Perform cutting and patching in accordance with Division 1 Section "CUTTING AND PATCHING". In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting and patching of mechanical equipment and materials required to:

1. Uncover Work to provide for installation of ill-timed Work.

2. Remove and replace defective Work.

3. Remove and replace Work not conforming to requirements of the Contract Documents.

4. Remove samples of installed Work as specified for testing.

5. Install equipment and materials in existing structures.

6. Upon written instructions from the Architect, uncover and restore Work to provide for Architect/Engineer observation of concealed Work.

7. Cut, remove and legally dispose of selected mechanical equipment, components, and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new Work.

8. Protect the structure, furnishings, finishes, and adjacent materials not indicated or scheduled to be removed.

9. Provide and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

10. Patch existing finished surfaces and building components using new materials matching existing materials and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

11. Patch finished surfaces and building components using new materials specified for the original installation and experienced Installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

END OF SECTION 23 05 11

SECTION 23 05 12 - BASIC MECHANICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.01. RELATED DOCUMENTS

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

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 - Basic Mechanical Requirements
Division 23 - Section 230548 - Vibration controls for HVAC, Electrical and Plumbing.

1.02. SECTION INCLUDES

A. This Section includes limited scope general construction materials and methods for application with mechanical installations as follows:

1. Mechanical equipment nameplate data.

2. Miscellaneous metals for support of mechanical materials and equipment.

3. Joint sealers for sealing around mechanical materials and equipment; and for sealing penetrations in fire and smoke barriers, floors, and foundation walls.

4. Access panels and doors in walls, ceilings, and floors for access to mechanical materials and equipment.

5. Selective demolition

1.03. SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1

B. Product data for the following products: Access panels, doors and Joint sealers.

C. Shop drawings detailing fabrication and installation for metal fabrications, and wood supports and anchorage for mechanical materials and equipment.

D. Coordination drawings for access panel and door locations in accordance with Division 23 Section "Basic Mechanical Requirements."

E. Samples of joint sealer, consisting of strips of actual products showing full range of colors available for each product.

F. Welder certificates, signed by Contractor, certifying that welders comply with requirements specified under "Quality Assurance" article of this Section.

G. Schedules indicating proposed methods and sequence of operations for selective demolition prior to commencement of Work. Include coordination for shut-off of utility services and details for dust and noise control.

H. Coordinate sequencing with construction phasing and Owner occupancy specified in Division 1 Section "Summary of Work".

1.04. QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer for the installation and application joint sealers, access panels, and doors.

B. Qualify welding processes and welding operators in accordance with AWS D1.1 "Structural Welding Code - Steel."

C. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

D. Fire-Resistance Ratings: Where a fire-resistance classification is indicated, provide access door assembly with panel door, frame, hinge, and latch from manufacturer listed in the UL "Building Materials Directory" for rating shown.

E. Provide UL Label on each fire-rated access door.

1.05. DELIVERY, STORAGE, AND HANDLING

A. Deliver joint sealer materials in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

B. Store and handle joint sealer materials in compliance with the manufacturers' recommendations to prevent their deterioration and damage.

1.06. PROJECT CONDITIONS

A. Conditions Affecting Selective Demolition: The following project conditions apply:

1. Protect adjacent materials indicated to remain. Install and maintain dust and noise barriers to keep dirt, dust, and noise from being transmitted to adjacent areas. Remove protection and barriers after demolition operations are complete.

2. Locate, identify, and protect mechanical services passing through demolition area and serving other areas outside the demolition limits. Maintain services to other areas outside the demolition limits. When services must be interrupted, install temporary services for affected areas.

1.07. SEQUENCE AND SCHEDULING

A. Coordinate the shut-off and disconnection of utility services with the Owner and the utility company.

B. Notify the Architect at least 5 days prior to commencing demolition operations.

PART 2 - PRODUCTS

2.01. MECHANICAL EQUIPMENT NAMEPLATE DATA

A. Nameplate: For each piece of power operated mechanical equipment provide a permanent operational data nameplate indicating manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and similar essential data. Locate nameplates in an accessible location.

2.02. MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.

D. Steel Pipe: ASTM A 53, Schedule 40, welded.

E. Non-shrink, Non-metallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, nongaseous grout, recommended for interior and exterior applications.

F. Fasteners: Zinc-coated, type, grade, and class as required.

2.03. JOINT SEALERS

A. Fire-Resistant Joint Sealers: Two-part, foamed-in-place, silicone sealant formulated for use in through-penetration fire-stopping around cables, conduit, pipes, and duct penetrations through fire-rated walls and floors. Sealants and accessories shall have fire-resistance ratings indicated, as established by testing identical assemblies in accordance with ASTM E 814, by Underwriters' Laboratories, Inc., or other testing and inspection agency acceptable to authorities having jurisdiction.

B. Available Products: Subject to compliance with requirements, products, which may be incorporated in the Work, include, but are not limited to, the following:

C. Products: Subject to compliance with requirements, provide one of the following or approved equal:

"Dow Corning Fire Stop Foam, "Dow Corning Corp.
"Pensil 851," General Electric Co.

2.04. ACCESS DOORS

A. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush with adjacent surfaces.

B. Frames: 16-gage steel, with a 1-inch-wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling.

1. For installation in masonry, concrete, ceramic tile, or wood paneling: 1 inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
2. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
3. For full-bed plaster applications: galvanized expanded metal frame.

C. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.

1. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.

D. Locking Devices: Flush, screwdriver-operated cam locks.

E. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Bar-Co., Inc.

J.L. Industries.

Karp Associates, Inc.

Milcor Div. Inryco, Inc.

PART 3 - EXECUTION

3.01. EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of joint sealers and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02. SELECTIVE DEMOLITION

A. General: Demolish, remove, demount, and disconnect abandoned mechanical materials and equipment indicated to be removed and not indicated to be salvaged or saved.

B. Materials and Equipment To Be Salvaged: Remove, demount, and disconnect existing mechanical materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.

C. Disposal and Cleanup: Remove from the site and legally dispose of demolished materials and equipment not indicated to be salvaged.

D. Mechanical Materials and Equipment: Demolish, remove, demount, and disconnect the following items:

1. Inactive and obsolete piping, fittings and specialties, equipment, ductwork, controls fixtures, and insulation.

2. Piping and ducts embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Remove materials above accessible ceilings. Drain and cap piping and ducts allowed to remain.

3. Perform cutting and patching required for demolition in accordance with Division 1 Section "Cutting and Patching".

3.03. APPLICATION OF JOINTS SEALERS

A. General: Comply with joint sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Comply with recommendations of ASTM C 962 for use of elastomeric joint sealants.

C. Comply with recommendations of ASTM C 790 for use of acrylic-emulsion joint sealants.

D. Tooling: Immediately after sealant application and prior to time shinning or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

E. Installation of Fire-Stopping Sealant: Install sealant, including forming, packing, and other accessory materials, to fill openings around mechanical services penetrating floors and

walls, to provide fire-stops with fire-resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

3.04. INSTALLATION OF ACCESS DOORS

A. Set frames accurately in position and securely attached to supports, with face panels plumb and level in relation to adjacent finish surfaces.

B. Adjust hardware and panels after installation for proper operation.

END OF SECTION 23 05 12

SECTION 23 05 13 - ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Refer to Electrical Drawing Specifications for electrical components and materials required for field installation and electrical connections are applicable to this section.

C. Division 23 - Section 23 05 48 - Vibration mountings and controls, Vibration isolation and seismic restraint specification for HVAC, Fire Protection, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. This section specifies the basic requirements for electrical components, which are an integral part of packaged mechanical equipment. These components include, but are not limited to factory-installed motors, starters, variable frequency drives, and disconnect switches furnished as an integral part of packaged mechanical equipment.

B. Specific electrical requirements (i.e. horsepower and electrical characteristic) for mechanical equipment are scheduled on the Drawings.

1.03 CODES AND STANDARDS

A. NEMA Standards MG 1: Motors and Generators

B. NEMA Standard ICS 2: Industrial Control Devices, Controllers, and Assemblies.

C. NEMA Standard 250: Enclosures for Electrical Equipment

D. NEMA Standard KS 1: Enclosed Switches

E. Comply with National Electrical Code (NFPA 70).

1.04 SUBMITTALS

A. No separate submittal is required. Submit product data for motors, starters, and other electrical components with submittal data required for the equipment for which it serves, as required by the individual equipment specification sections.

1.05 QUALITY ASSURANCE

A. Electrical components and materials shall be UL labeled.

PART 2 - PRODUCTS

2.01 MOTORS

A. Each Contractor shall provide all electric motors required for driving all motor driven equipment required to be furnished under his Section of the Specification.

B. All motors shall be designed for 3-phase, 60Hz. alternating current operation with nameplate voltage across the motor terminals, except that, unless otherwise specified herein, all motors 1/2 HP and smaller shall be designed for single phase, 60Hz. alternating current at 120 volts across the terminals. Before ordering motors, ascertain the actual voltages and other current characteristics that will be available and permissible for each motor. Report the same in writing to the Architect and obtain approval before ordering motors. The designation of current characteristics in these Specifications does not relieve the responsibility for ascertaining the actual conditions of electric service available for each motor or for the proper operation of all motors under the actual conditions.

C. The speed, horsepower, type and other essential data for each motor, if not given under paragraphs describing the various motor driven apparatus, or in schedules on the drawings shall be obtained from the manufacturer of the respective apparatus and shall be submitted to the Architect for his review. All two speed motors shall be single winding type.

D. Provide oversized motor junction box for 2 speed motors.

E. All motors shall be built in accordance with the latest rules of the National Electrical Manufacturers Assn., and of the Institute of Electrical and Electronic Engineers and also as hereinafter specified.

F. Motors 1/2 HP and larger shall be premium efficiency and have Class B insulation. All motors shall be rated for continuous duty and shall be designed for temperature rises not to exceed 55 degrees for fully enclosed type, 55 degrees C. for splash proof types and 40 degrees C. for all other motors excepting as otherwise specified herein. Motors shall be capable of withstanding momentary overloads of fifty per cent (50%) without injurious heating. They shall operate without excessive heating, flashing or sparking under any conditions within the specified capacity of load and speed. All motors shall operate quietly and shall be replaced if, in the Architect's opinion, they do not do so. All motors, which are in the airstreams of air conditioning units, shall be totally enclosed (TEFC/ TEAO) type.

G. Motors 1/2 HP and larger shall have ball or roller bearings with pressure grease lubrication, except where otherwise noted.

H. Direct connected motors shall be furnished without an adjustable base. All motors connected to driven equipment by belt shall be furnished with adjustable sliding bases, except fractional motors with slotted mounting holes.

I. All motor leads shall be permanently identified and supplied with connectors.

J. Motors shall have nameplates giving manufacturer's name, serial number, horsepower, speed, voltage, phase and current characteristics.

K. The insulation resistance between stator conductors and frames of motors at the time of final inspection shall be not less than one-half mega-ohm.

L. All motors shall be of the proper type for their proposed duty, and shall have sufficient torque to start and run the equipment to which they are connected, and starting currents and running currents shall not exceed the limits imposed by the laws or rules and regulations of the public authorities having jurisdiction or of the electrical utility company. All motors shall have sufficient horsepower capacity and rated duty to operate the apparatus to which they are connected so as to give the speeds and performances specified, but the horsepower shall be in no case be less than that started herein or shown on the drawings. A schedule giving the characteristics of the motors proposed for each type of service shall be submitted to the Architect for approval.

M. The maximum full load speed of each direct connected motor shall be suitable for the equipment it drives.

N. Except where V-belt drive is specified, the fan wheels for ventilating fans shall be mounted on the motor shafts, which shall be designed for this duty. All motors except motors furnished as an integral part of equipment and factory installed on the equipment, shall be of same manufacture.

O. Poly-phase motors shall be squirrel cage, induction, high efficiency, energy saver type, suitable for the starting torque and current requirements.

P. Single phase motors shall be of the capacitor start induction run or split phase type as required for proper operation of the driven equipment.

Q. The efficiency of energy efficient motors shall be verified in accordance with NEMA standard NG1-12.53a. Minimum acceptable efficiency shall be as follows and in accordance with N.J. Smart Start Buildings Programs:

Rating	H.P.	Efficiency
200/460 Volts	1 HP to 5 HP	86.5% to 89.5%
3-Phase, 60 Hz.	7.5 HP to 25 HP	91.0% to 93.6%
1.15 Service Factor	30 HP to 75 HP	94.1% to 95.0%
40^{O}C. Ambient	100HP to 200 HP	95.4% to 95.8%
1800 rpm		

2.02 INDIVIDUAL MOTOR STARTERS

A. Each Sub-Contractor shall furnish and turn over to the Electrical Sub-Contractor, who shall erect and provide power wiring for same, motor starting equipment for motors provided as part of the work. If motor is replaced (even same HP), provide new starter for that motor.

B. For each motor 1/3 HP or smaller, starters shall be manual, with thermal overload protection, and pilot light, except that where interlocking or automatic control (other than for unit and cabinet heaters) is required, starters shall be 120 volts combination circuit breaker and magnetic starter with pilot light.

C. For each motor 1/2 HP and over, starters shall be combination circuit breaker and magnetic across the line. All magnetic starters shall have 3 thermal over current-units. Provide

480/120-volt transformers for control circuits with a fused secondary. Confirm secondary voltage required.

D. For motors requiring electric interlock, or automatic control features, starters shall be equipped with the necessary auxiliary contacts, or terminals to provide the control features desired. Such starters shall be provided with "hand-off-auto" selector switch mounted in cover. For two speed motors, provide "high-low-off-auto" four-position selector switch. In "hand" position, all controls and safeties shall be operative.

E. In addition to any auxiliary contacts required for interlocking purposes, each magnetic starter shall be equipped with one normally open auxiliary control circuit contact either for "sealing in" or as a spare for future use.

F. Transformer type, pilot lights shall be provided for all magnetic starters and for all remote control stations. Pilot light shall be mounted on cover and shall have 6-volt bulb.

G. For two speed motors, provide a pilot light for each speed. For starters for 10 HP and over, provide adjustable 20-second time delay between Hi and Low Speed.

H. Each starter shall be clearly identified after installation by engraved nameplates. The nameplates shall be Bakelite black plates with 1/2" high white letters and shall be securely fastened to starter or to wall immediately below same. Sections furnishing starter shall provide nameplates.

I. The Electrical Contractor shall install all starting equipment except starters specified to be factory mounted and wired as part of the equipment, and shall do all wiring necessary to supply power to the starter, including connections from the starters to the motors. All selector switches and pilot lights required in accordance with the preceding information shall be flush mounted in the cover of its respective starter.

J. All enclosures shall be NEMA Type I sheet steel, with hinged cover, for general-purpose indoor application, unless otherwise indicated. Enclosures shall be arranged for equipment or wall mounting. Weatherproof NEMA Type 4X enclosures shall be provided for all outdoor starters.

K. Three phase motors under 50 horsepower shall be furnished with full voltage, combination circuit breaker and magnetic across-the-line starters unless otherwise noted.

L. Three phase motors 50 HP and over shall be furnished with combination circuit breaker disconnect and reduced voltage starter such as wye-delta unless otherwise noted.

M. Stainless steel flush mounted starter and enclosures shall be provided for all starters located in kitchen and dishwasher areas.

N. All starters, except those furnished as an integral part of equipment and factory installed on the equipment, shall be of the same manufacturer.

2.03 MOTOR CONTROL CENTERS

A DESCRIPTION OF WORK

1. This Section describes the motor control centers, including starters, disconnecting devices and controls, assembled as complete and fully operational units.

2. All microprocessor-based or other computer equipment shall be certified by the manufacturer(s) to be year-2002 compliant.

B RELATED WORK SPECIFIED ELSEWHERE

1. Codes, Regulations and Standards - Division 1

2. Building Management Controls System - Section 230900

3. Raceways and Installation Components- Section 260533

4. Wires and Cables- Section 260519

5. Safety and Disconnect Switches- Section 262816

6. Fuses - Section 262813

C REFERENCE CODES AND STANDARDS- COMPLY WITH THE FOLLOWING IN ACCORDANCE WITH DIVISION 1

1. International Electrical Testing Association (NETA)

2. National Electrical Manufacturers Association (NEMA)

3. National Fire Protection Association (NFPA) 70
   National Electrical Code (NEC)

4. National Electrical Code (NEC)

5. Underwriters Laboratories, Inc. (UL) 845 Motor Control Centers Labeling and Listing Requirements.

D SUBMITTALS

1. The work of this Section shall be coordinated with the work of all other Contracts and shall be so arranged that there will be no delay in the proper installation and completion of all work.

2. Submit shop drawings of motor control centers, including wiring diagrams, and scaled front view (outline) and plan view drawings.

3. Submit manufacturer' s product data on all motor starter sizes and accessories, including motor circuit protector or thermal magnetic circuit breaker, trip sizes and overload sizes for each motor. Frame sizes are not acceptable.

4. Submit detailed control wiring diagrams indicating control power transformers, fuses, relays, coils, contacts, pilot lights and H-O-A switches.

5. Submit list of heater elements (by type and size) used.

6. Submit VA rating for each control power transformer.

7. Submit certified field test report.

8. Submit certification(s) from the manufacturer(s) that all microprocessor-based or other computer equipment is year-2002 compliant.

E APPROVED MANUFACTURERS- THE FOLLOWING MANUFACTURERS ARE APPROVED FOR USE.

1. Allen-Bradley, Rockwell Automation.

2. Square D, Schneider Electric.

3. Cutler-Hammer/Eaton.

F MOTOR CONTROL CENTERS

1. Provide 480 volt, 3 phase, 3 wire (with ground) 60 Hertz Motor Control Centers consisting of vertical, unitized sections, complete with draw out type starter unit for each motor in accordance with the schedules on the drawings.

2. The enclosure shall be NEMA Type 1A, completely enclosed and with gaskets. Each unit shall be provided with a draw-out type base on which shall be mounted a combination type starter. Each vertical section shall be approximately 90 inches high and 20 inches deep for front access units. Units shall be Class I, Type " B" construction, with wiring of each unit brought to individual terminal blocks. Vertical and horizontal wiring channels shall be provided in each section. Coordinate with the DDC System Installer for required control point terminals.

3. The external operating handle of each disconnecting device shall be interlocked with the respective door so that the handle must be in the " off' position before the door can be opened, and shall prevent applying power while the door is open. The handle shall include provision for padlocking in the " off' position with one (1) to three (3) padlocks. The door interlock shall be capable of being released with a screwdriver with the disconnect device in the " on" position.

4. Provisions shall be made for adding future sections at each end.

5. Insert unit-wiring diagrams in a protective pocket inside of the compartment for each starter.

6. Verify the ratings and acceleration times of the high-efficiency motors actually installed, and provide starters, motor circuit protectors or thermal magnetic circuit breakers and thermal over-current elements to suit these ratings.

7. Motor control centers shall be provided with a continuous horizontal and vertical copper grounding bus, which shall be bonded to the grounding system.

8. Horizontal and vertical buses shall be copper and rated as required by the Contract Documents. The buses shall be braced for 65,000 RMS symmetrical amperes. Minimum bus capacity for vertical bus shall be 400 amperes.

   Provide nameplates as specified in Section 260000. Nameplates for each starter and branch circuit breaker shall include the load identification number and description as shown on the drawings, the motor control center compartment number, and the load watts or horsepower. Each motor control center shall have a 2-inch high laminated phenolic master nameplate, with 1 inch high letters, located in the upper left-hand corner of the main circuit breaker door. Master nameplate shall indicate motor control center name and power source name. Nameplates shall be screwed to enclosure. Provide nameplates for each spare and space.

9. Provide isolating barriers between the power bus and the wire ways and Insulation/isolation of all vertical power buses. Provide rodent barriers.

10. Compartments designated, as "space" on drawings shall contain bus, hardware and doors for future starters. Sizes shall be as shown on drawings.

11. The motor control center shall have a UL-listed short-circuit current rating of 65,000 RMS symmetrical amperes or higher.

12. Provide an isolating shutter mechanism for vertical bus stab openings.

13. Include variable-frequency drives (VFD) as scheduled as an integral part of the motor control center. The VFD units shall be UL 508C listed for the motor control center short-circuit current rating. VFD keypads, LED and operator controls shall be door mounted. Control power transformer with 100 VA extra customer capacity, in addition to that required for 120 volt control power and ventilation fans (as required), shall be provided for each unit. Line reactors, shall be included. Bypass starters as scheduled or specified shall be NEMA-rated and provided in a barrier arrangement so that VFD and starter are physically and electrically isolated from each other. Motors 30HP or greater shall have a harmonic filter to reduce harmonics, Series D Matrix Harmonic Filter.

14. Include wye-delta starter for each motor rated at 50 horsepower and above.

15. The motor control center shall be seismically braced and have bolt-down provisions for Seismic Zone 2.

16. Eaton is the basis of design and Motor Control Center shall not exceed 17'W x 16" D x 90" H for MCC-1 and 18'W x 16"D x 90"H for MCC-2.

G. SECONDARY METERING

1. Provide each motor control center incoming line section with a panel-mounted microprocessor-based monitoring device to match the unit specified for the low-voltage switchgear. The unit shall provide a digital readout of the following electrical parameters, selectable via a front-mounted display selector and indicator.
   a. AC current, all three phases.
   b. AC voltage, phase-to-phase and phase-to-neutral.
   c. Breaker status — open, closed, trip.

2. The unit shall be equipped with a RS-485 communication port for communication over a twisted-pair data line.

3. Inputs to the unit shall be 5-ampere current transformer secondary leads and fused bus potential leads. Current and potential ratios shall be selectable via field-accessible DIP switches to provide readouts in primary values.

4. Provide potential transformers (PTs) as required to monitor bus voltage for all three phases and current transformers (CTs) as required to monitor current for all three phases.

H. INSTALLATION AND WIRING (BY DIVISION 26, ELECTRICAL CONTRACTOR)

1. Install all motor control centers in locations shown or as directed by the Design Professional. Provide concrete housekeeping pads.

2. Wire completely each motor control center.

3. Wire the starting equipment to the motors and control devices in accordance with the wiring diagrams furnished by the equipment manufacturer.

4. Provide one (1) spare set of heaters (thermal overcurrent element) for each different size heater used.

5. Provide the Owner with a neatly typed list of all types and sizes of heater elements used, including references to motor and starter identification.

6. For motor connection requirements, see Section 260000.

7. For motors furnished with power factor correction, provide motor overloads sized to suit the change in full-load current due to the capacitor installation.

8. Coordinate with the DDC System Installer for installation of control wiring.

I. IDENTIFICATION

1. Provide permanent nameplates as specified in Section 260000.

2. Furnish permanent identification of cable color codes as specified in Section 260519.

J. STARTUP AND FIELD TESTING

1. After installation, the equipment shall be started up and field-tested to ensure that it functions in accordance with the specifications.

2. As a minimum, the field tests shall include the following:

   a. Ensure that all shipping members have been removed.

   b. Check for damage (dents, scratches, frame misalignment, damage to panel devices, missing hardware, etc.).

   c. Ensure that interiors are free of foreign materials, tools and dirt.

   d. Check each motor for proper rotation.

   e. Check switches, pilot lights, pushbuttons, starters, contactors, etc. for proper operation by exercising all active components.

   f. Check each motor control center for proper circuit breaker and overload sizes.

   g. Before starter units are installed, megger test the motor branch circuits phase-to-phase and phase-to-ground.

h. Set time delay relay for each motor starter.

i. Verify appropriate anchorage, required area clearances and correct alignment.

j. Verify that the circuit breakers correspond to the drawings and approved short-circuit electrical coordination study.

k. Verify tightness of accessible bolted electrical connections.

l. Verify correct barrier and shutter installation and operation.

m. Verify that filters are in place and/or vents are clear.

n. Inspect control power transformers for damage (cracked insulation, broken leads, tightness of connections, overall general condition, etc.).

o. Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground.

p. Perform functional testing on each control device.

q. Verify operation of space heaters.

3. Results of the field tests shall be on standard test report forms. The certified report shall be submitted upon completion of the tests.

2.04 MOTOR CONTROLLERS

A. Furnish Pilot devices, which are not integral to starter and, required for remote control of motors. These stations include devices for motor control, such as pushbuttons, switches, etc.

B. Unless otherwise noted, motor controllers shall be housed in NEMA Type 1 general-purpose enclosure located in electric closet or mechanical room. Outdoor controllers shall be provided with weatherproof NEMA Type 4X enclosures.

C. The controllers to be installed in finished areas shall be flush mounted.

D. The Electrical Contractor shall install and provide wiring for motor controllers.

2.05 VARIABLE FREQUENCY DRIVES

A. Variable Frequency Drives (VFD) shall be suitable for the voltage specified on drawings. VFD Power Factor shall be 0.96 or better, Efficiency 96% minimum VFD shall be in NEMA-1 enclosure, 65KAIC Interrupt Rating and shall be suitable for operation in 95% Relative Humidity (non condensing). Provide 3-Contactors, Electronic Bypass, Disconnect Switch (Handle thru door) with Input Fuses and Bypass Fuses, Line reactor, filtering to minimize noise, ventilation fan within enclosure, microprocessor logic control with parameter settings, 2 Normally open and 2 Normally closed contacts in Bypass contactor, digital Keypad, minimum of 4 programmable critical frequency lockout ranges.

B. VFD shall be UL Listed and 1EEE 519 compliant.

C. VFD shall be equipped with the following protection features:

1 Under voltage trip @ -35%

2. Over voltage trip @ +30%

3. Motor Overload in both drive and bypass modes.

4. VFD overload

5. Short Circuit

6. Stall prevention

7. Locked rotor

8. Motor over-temperature

9. VFD over-temperature

10. Input transients

11 Phase failure in both drive and bypass modes.

D. VFD shall have the following capability:

1. RS-485 communication.

2. Serial Communication capability for PID control adjustments, current limit and acceleration/deceleration time adjustments.

3. Allow BMS to monitor output speed/frequency, current, power (kW) and kilowatt hours (resettable), operating hours (resettable), digital inputs and diagnostic warning and fault information.

4. Following readouts shall be available at the display:
   a. Status of drive
   b. Motor Speed
   c. Output Frequency
   d. Output Voltage
   e. Motor Current
   f. Calculated Motor Power (kW)
   g. KWh meter (resettable)
   h. Digital input status
   i. Analog input values
   j. Calculated Motor Torque
   k. DC Bus Voltage
   l. Heatsink Temperature (° F)
   m. Analog Output Value
   n. Elapsed Time Meter (resettable)
   o. Digital Output Status

2.06 ELECTRIC HEAT TRACING

A. GENERAL:

1. Furnish and install a complete UL Listed, CSA Certified, or FM Approved system of heating cables, components, and controls to prevent pipes from freezing.

B. MATERIALS:

1. The self-regulating heating cable shall consist of two (2) 16 AWG nickel-copper bus wires embedded in parallel in a self-regulating polymer core that varies its power output to respond to temperature all along its length, allowing the heating cable to be cut to length in the field. The heating cable shall be covered by a radiation-crosslinked, modified polyolefin dielectric jacket. To provide a ground path and to enhance the heating cable ruggedness, the heating cable shall have a braid of tinned copper and an outer jacket of (select: modified polyolefin (-CR) or fluoropolymer (-CT)), as required per section 427-23 of the NEC-1996.

2. For installation on plastic piping, the heating cable shall be applied using aluminum tape (AT-180).

3. In order to conserve energy and to prevent overheating, the heating cable shall have a self-regulating factor of at least 90 percent. The self-regulation factor is defined as the percentage reduction, without thermostatic control, off the heating cable output going from 40° F pipe temperature operation to 150° F pipe temperature operation.

4. The heating cable shall operate on line voltages of 120 volts without the use of transformers.

5. The heating cable for metal-pipe freeze protection shall be sized according to the table below. The required heating cable output rating is in watts per foot at 50° F. (Heating cable selection based on 1-inch fiberglass insulation on metal piping).

Pipe size (inches)	Minimum Ambient Temperature	
	0°F	-20°F
3 or less	5 watts	5 watts
4	5 watts	8 watts
6	8 watts	8 watts
8	8 watts	2 strips-5 watts
10	2 strips-5 watts	2 strips-8 watts

6. Power connection, end seal, splice, and tee kit components shall be applied in the field.

7. Heating cable circuit shall be protected by a ground-fault device for equipment protection. This requirement is in accordance with section 427-22 of the NEC-1996.

C. COMPONENTS

1. All heating-cable components shall be UL Listed, CSA Certified, or FM Approved for use as part of the system to provide (choose one: pipe freeze protection, flow maintenance). Component enclosures shall be rated NEMA 4X to prevent water ingress and corrosion. Installation shall not require the installing contractor to cut into the heating-cable core to expose the bus wires. Connection systems that require the installing contractor to strip the bus wires or that use crimps or terminal blocks, shall not be acceptable. All components that make an electrical connection shall be re-enterable for servicing. No component shall use silicone to seal the electrical connections. An exception will be made in areas where a conduit transition is required.

D. SYSTEM CONTROL

1. The system shall be controlled by a line sensing thermostat AMC-F5 fixed at 40° F set at 40° F directly in NEMA-4X enclosure, 22 AMP 480 Volt SPST contact, filled bulb 2.5 FT capillary. Sensing range silicone (-30° F to 140° F).

E. EXECUTION

1. INSTALLATION.

a. System must be installed per manufacturer' s recommendations.

b. Apply the heating cable linearly on the pipe after piping has been successfully pressure-tested. Secure the heating cable to piping with cable ties or fiberglass tape.

c. Apply " Electric Traced" labels to the outside of the thermal insulation.

2. TESTS

a. After installation and before and after installing the thermal insulation, subject Heating cable to testing using a 2500-Vdc Megger, Minimum insulation resistance shall be 20 megohms or greater.

PART 3 - EXECUTION

3.01 ELECTRICAL REQUIREMENTS

A. Power Wiring:

1. The Electrical Contractor shall provide power wiring for all electrical devices, motor starters and un-mounted motors, furnished to him at the job site by other trades.

B. Control Wiring:

1. The Heating, Ventilating and Air Conditioning Contractor shall provide all HVAC control wiring including, but not limited to, Automatic Temperature Controls, Combustion Control, Burner and Boiler Control, and condenser water treatment controls, except as otherwise specified herein.

2. The Electrical Contractor shall provide all plumbing control wiring, except as otherwise specified herein.

3. The HVAC contractor shall provide all control devices for HVAC equipment, except as otherwise specified herein.

4. The Plumbing Contractor shall provide all control devices for Plumbing equipment, except as otherwise specified herein.

5. The Electrical Contractor shall provide all safety switches, except as otherwise specified herein.

6. The Electrical Contractor shall provide all fractional horsepower manual starters and toggle switches for mechanical equipment.

7. The HVAC and Plumbing Contractors shall furnish individual motor starters and VFD's for HVAC and Plumbing equipment, unless otherwise specified herein.

C. Electrically operated equipment supplied by other trades, which are required to be installed and power wired by the Electrical Contractor, shall be delivered with detailed instructions for their installation and wiring in sufficient time and proper sequence to meet the work schedule.

D. Equipment which includes a number of correlated electrical control devices mounted in a single enclosure or on a common base with equipment, shall be supplied for installation completely wired as a unit with terminal boxes and ample leads ready for external wiring.

E. All electrical items called for as part of the mechanical work shall conform to NEMA Standards, to the requirements of the National Fire Protection Association, and to the requirements of any local electrical code authority having jurisdiction. Any field modifications required to insure such conformance shall be included as part of the mechanical work.

F. The purchase and delivery of floor mounted motor starter equipment shall include the purchase and delivery of channel sills for mounting the starter equipment.

G. Whether or not shown on drawings, all return air fan motors shall have disconnect switches, provided by Electrical Contractor

H. The supplying of any and all "field instruction" diagrams deemed necessary by the Architect for the complete delineation of electrical wiring for mechanical equipment shall be included as part of the mechanical work. The above requirements shall be met regardless of any assignment between trades of the responsibility for the purchase, electric motors and associated starters and control devices.

END OF SECTION 23 05 13

SECTION 23 05 16 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Requirements of the following Division 23 Sections apply to this section:

Division 23 - Section 230511 - Basic Mechanical Requirements.
Division 23 - Section 230512 - Basic Mechanical Materials and Methods.
Division 23 - Section 232113 - Basic Piping Materials and Methods.

1.02 SECTION INCLUDES

A. Pack-less expansion joints.

1.03 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each type of pipe expansion joints specified. Submit expansion compensation schedule showing Manufacturer's figure number, size, location, and features for each required expansion joint.

C. Assembly-type shop drawings for each type of expansion compensation product, indicating dimensions, weights, required clearances, and methods of assembly of components.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Pack-less Expansion Compensators:

1. Flexonics Inc., Metal Hose and Expansion Joint Div.

2. Keflex HVAC Products, Flex-Weld, Inc.

3. Metraflex Co.

2.02 PIPE EXPANSION JOINTS, GENERAL

A. Pipe expansion joints shall provide 200 percent absorption capacity of piping expansion between anchors.

2.03 PACKLESS EXPANSION JOINTS

A. Expansion Compensators: Conform to the standards of the Expansion Joint Manufacturers Association and shall be pressure rated for 60 psi for low-pressure systems and for 175 psi for high-pressure systems. Units shall have 2-ply phosphor bronze bellows, brass shrouds, and end fittings for copper piping systems and 2-ply stainless steel bellows, carbon steel shrouds, and end fittings for steel piping systems. Expansion compensators shall have internal guides and anti-torque device and removable end clip for proper positioning.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install expansion joints where indicated and required for adequate expansion of installed piping system.

3.02 EXPANSION JOINTS

A. Install expansion joints in accordance with manufacturer's instructions.

B. Align joints to avoid end loading and torsion stress.

END OF SECTION 23 05 16

SECTION 23 05 19 - METERS AND GAUGES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this Section are:

Division 23 - Section 230511 - Basic Mechanical Requirements
Division 23 - Section 230512 - Basic Mechanical Materials and Methods
Division 23 - Section 232113 - Basic Piping Materials and Methods
Division 23 - Section 230548 - Vibration mountings and controls, Vibration isolation and seismic restraint specification for HVAC, Fire Protection, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. Temperature gauges

B. Pressure gauges

C. Flow meters

1.03 SUBMITTALS

A. Products Data: Submit product data for each type of meter and gauge. Include scale range, rating and calibrated performance curves.

1.04 QUALITY ASSURANCE

A. Comply with applicable standards of ASME and Instrument Society of America pertaining to construction and installation of meters and gauges.

B. Firms regularly engaged in manufacture of meters and gauges of types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Follow Manufactures instructions to prevent instruments from damage during storage and handling.

PART 2 - PRODUCTS

2.01 THERMOMETERS

A. Furnish and install, where indicated on the Drawings and where specified herein, separable well-type dial or 9" mercury adjustable angle type in glass stem, thermometers as manufactured by American, Terrice, Weksler, Weiss or approved equal.

B. All thermometers shall be installed in such a manner as to cause a minimum of restriction to flow in the pipes and so that they can easily be read from the floor.

C. Dial thermometers shall be 5 inch hermetically sealed, bimetal with stainless steel cases, anti-parallax dials with raised jet black figures, stainless steel stems, and brass separable sockets unless otherwise specified. Thermometers for duct mounting shall have union connections in lieu of separable sockets. Separable wells shall be stainless steel for steel pipe and brass for copper pipe. Separable wells shall be standard type for un-insulated pipe and logging extension type of proper length for insulated pipe. Stem shall extend a minimum of 2-1/2" into the fluid.

D. The accuracy of all thermometers shall be within 1% of the scale range.

E. All instrument wells for controls and indicators furnished by the temperature control manufacturer shall be installed under this Section.

F. Where conditions are such that thermometers would not be readable from the floor, remote bulb dial thermometers shall be mounted on panel boards. The thermometers shall be 5-inch dials and shall be vapor actuated. The thermometers shall have separable wells. Panel mounted thermometers shall be provided with an engraved nameplate mounted below each thermometer to identify its service. The nameplates shall be chrome plated with black filled letters.

G. A thermometer shall be installed in the hot water inlet and outlet of each heat exchanger. Additional thermometers shall be installed where indicated on the Drawings.

H. The scale range for the thermometers shall be as follows:

Service	Temperature Range
Hot Water	30^{O} to 300^{O} F
Chilled Water	0^{O} to 120^{O} F

2.02 PRESSURE GAUGES

A. Furnish and install where indicated on the Drawings and where specified herein, Bourdon spring type pressure gauges as manufactured by U.S. Gauge, Weksler, Terrice, Marsh, Ashcroft, or approved equal.

B. All gauges shall be installed so as to be easily readable from the floor. Where conditions are such that gauges on piping would not be readable from the floor, the gauges shall be installed on panel boards.

C. The gauges shall have dull, black enamel cast aluminum casings with chrome plated bezels or rims. The gauges shall have white faces with black filled engraved numerals and adjustable pointer. The diameter of the dial shall be not less than 4-1/2 inches. Gauges shall have brass bronzed brushed rotary type movement.

D. Panel mounted gauges shall be designed for flush mounting with back connections and shall be provided with an engraved nameplate mounted below each gauge to identify its service. The nameplates shall be chrome plated with black filled letters.

E. Differential pressure switches, pressure sensing pipe taps, furnished by temperature control manufacturers shall be installed under this Section.

F. The accuracy of all gauges shall be within 1% of the scale range.

G. All gauges on water lines shall be fitted with filter type pressure snubbers consisting of 3/8" dia. x 1/8" thick, micro metallic stainless steel filter, as manufactured by Operating and Maintenance Specialties or approved equal. All gauges on steam lines shall be fitted with pigtails.

H. A pressure gauge shall be installed in the suction and discharge of each hot water pump. A pressure gauge shall be installed in the inlet and outlet of each heat exchanger. Additional pressure gauges shall be installed where indicated on the Drawings.

I. The scale range of pressure gauges shall be as follows:

Service	Pressure Range
High Pressure Steam	0 to 200 psig.
Chilled Water	0 to 100 psig.
Hot Water	0 to 100 psig.
Low Pressure Steam	0 to 30 psig.

All other pressure gauges shall have a range at least twice the working pressure, but in no case less than 0 to 30 lbs. A ball valve shall be installed on the waterside of each gauge. A needle valve shall be installed on the system side of each steam gauge.

2.03 DRAFT GAUGES

A. Furnish and install at each filter, draft gauges for measuring the resistance of the air through the filters as manufactured by Dwyer or approved equal.

B. Each draft gauge shall be an inclined tube differential type for indoor units, equipped with a shut-off cock opening to atmosphere for checking zero setting, and with a shut-off cock in the lines to points where the draft is measured. The scale shall have a white background with heavy black divisions and figures; shall not be less than 8" long, and shall be graduated to read by hundredths of an inch up to resistances to be encountered. Each gauge shall be provided with a bubble level gauge and with screw adjustment for zero settings.

C. Draft gauge for rooftop units and outdoors units shall be 2000 Series Magnehelic as made by Dwyer or approved equal. Gauges shall be provided complete with two static pressure tips, case, fittings and means of mounting. Scale shall be as required. Set gauges to be easily readable from floor level.

2.04 PRESSURE AND TEMPERATURE TEST STATIONS

A. Test stations and test kit shall be manufactured by Paterson Engineering Company, Inc. or approved equal.

B. Furnish and install in each supply and return run out to each reheat coil and where indicated on the Drawings, a 1/4" MPT fitting to receive either a temperature or pressure probe 1/8" OD. Fitting shall be solid brass with valve core of Nordel (Max. 275^{O}F.), fitted with a color coded and marked cap with gasket, and shall be rated at 1000 psig.

C. In addition, the installing contractor shall supply the Owner with six pressure gauge adapters with 1/8" OD probe and 6 five inch stem pocket testing thermometers; 25-125^{O}F, for chilled water and six 50-500^{O}F, for hot water.

D. Provide one pressure and temperature test kit consisting of one 0-60 PSI, water pressure gauge and one 0-30psi water pressure gauge each with No. 500 gauge adapter attached, a 25-125°F, pocket testing thermometer, a 0-220° F, pocket test thermometer, a No. 500 gauge adapter, and a protective carrying case. Provide one additional 0-60psi pressure gauge and one additional 0-30psi pressure gauge.

E. Test kit shall be used by the Balancing Contractor to balance the systems and then it shall be turned over to the Owner.

2.05 FLOW MEASURING DEVICE

A. Provide complete Venturi flow measuring system as manufactured by Barco Division, Aeroquip Corp., or approved equal.

B. This shall be a coordinated system, including Venturi flow stations and portable master meter, supplied by one manufacturer. Each Venturi station shall be complete with pressure tap nipples, quick disconnect valves and safety shut-off valves, indented metal identification tag on chain, giving pipe side, Venturi series, station identification, and meter reading at specified flow rate. Venturi stations shall be one-piece brass screwed 1/2" through 2". Sizes 2-1/2" through 8" shall consist of plated cast iron Venturi insert held between specially machined self-centering 150# steel weld neck units. Sizes 10" and larger shall be fabricated steel plated, with welding ends. Venturi size and series shall be selected so that design flow rate shall be between 10" and 40 inches of water pressure differential on a 0-50" meter with permanent pressure loss of not more than 10% indicated flow rate differential pressure.

C. Minimum flow rates of 2-1/2 FPS are permissible. Venturi stations shall be compatible with temperatures and pressure of the system.

D. Master meter shall consist of 6" round dial, dry type meter supplied with scale reading zero to 50 inches of water differential pressure and shall be mounted in a portable water and rot-proof fiberglass carrying case complete with 10 ft. lengths of 1/4" high pressure high temperature connecting hose, quick disconnect socket valves, venting valves, installation and operating instructions and capacity curves. Master meter shall become property of the Owner.

E. Upstream pipe diameters of straight pipe shall be five (5) minimum and downstream pipe diameters shall be two (2) minimums as recommended by manufacturer.

F. For location of Venturi flow stations refer to the Drawings.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where meters and gauges are to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install meters and gauges, in accordance with manufacturer's written instructions and with recognized industry practices, to ensure that HVAC Specialties comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of meters and gauges with other components of systems.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of HVAC Specialties, test HVAC Specialties to demonstrate compliance with requirements. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units, which cannot be satisfactorily corrected.

END OF SECTION 23 05 19

SECTION 23 05 23 - HVAC PIPING AND VALVES

PART 1 – GENERAL

1.01 SECTION INCLUDES

A. Piping, valves, specialties and accessories.

1.02 Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511- Basic Mechanical Requirements.
Division 23 - Section 230512- Basic Mechanical Materials and Methods
Division 23 - Section 232113- Basic Piping Materials and Methods
Division 23 - Section 230516- Pipe Expansion Joints
Division 23 - Section 230519- Meters and Gauges
Division 23 - Section 230529- Supports, Anchors and Guides.
Division 23 - Section 230548- Vibration Mountings and Controls, Vibration Isolation and Seismic Restraint Specification for HVAC, Fire Protection, Electrical and Plumbing
Division 23 - Section 232116- Water and Steam Specialties

1.03 SUBMITTALS

A. Shop Drawings and Product Data:

1. Shop Drawings:

a. Augment ductwork shop drawings with piping systems in mechanical equipment rooms.

b. Show plans and sections of HVAC piping systems. Show and detail structural support system. Include sizes, weights, dimensions, materials, and connection methods, pertinent information required to review the support systems.

2. Product Data: Submit data for products specified. In addition, submit schedule identifying each product, its size, material, capacity and location of use.

B. Manufacturer's Installation Instructions: Submit manufacturer's installation instructions.

C. Certifications:

1. Certify that field tests have been performed and that work meets or exceeds specified requirements.

2. Welder's certification.

3. Inspection certificates for pressure vessels from Authority having jurisdiction.

D. Operation and Maintenance Data: Include assembly views, lubrication instructions and replacement parts list.

1.04 QUALITY ASSURANCE

A. Conform to ANSI/ASME B31.1, B31.5 and B31.9.

B. Conform to ANSI/ASME Boiler and Pressure Vessel Code.

C. Welding Materials and Procedures: Conform to ANSI/ASME Section 9.

D. Welder's Certification: In accordance with ANSI/ASME Section 9 and ANSI/AWS D1.1.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and protect products under provisions of Section 01600.

B. Store valves in shipping containers with labeling in place.

C. Protect flange faces from damage with wood, plastic or soft metal.

D. Protect pipe threads from damage with plastic caps.

PART 2 - PRODUCTS

2.01 PIPES, VALVES AND FITTINGS FOR INDOOR AND OUTDOOR ABOVE GROUND SYSTEMS

A. Refrigerant Piping:

1. Pipe: Seamless copper tubing, Type ACR, hard drawn; ASTM B280.

2. Fittings: Wrought copper solder joint pressure fittings; ANSI B16.22.

3. Pipe Joints:
   A. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

   B. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

   C. Soldered Joints: Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

   D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
      i. Use Type BCuP (copper-phosphorus) alloy for joining copper socket fittings with copper pipe.
      ii. Use Type BAg (cadmium-free silver) alloy for joining copper with bronze or steel.

4. Shut-off Valves: Refrigerant Ball Valve type, forged brass body and bonnet, positive back seating when fully open, raised seat with nylon seat disc, stainless steel spring, flared or soldered connections, UL listed. Henry Valve Company Type CRN or approved equal.

5. Check valves: Forged brass body, Teflon seat, guided piston, stainless steel spring, accessible internal parts, operable in all positions. Rated for 300°F and 600 psi. Henry Valve Company Magni-Chek or approved equal.

B. Chilled Water, Make-Up Water, Hot Water and Dual Temperature Water and Condenser Water (see Paragraph C for piping exposed in Mechanical Rooms)

1. Pipe:

   a. 2" and Smaller: Type L hard drawn, seamless copper; ASTM B88.

   b. 2 ½" to 10" : Schedule 40, welded or seamless steel, black; ASTM A53 or A106, Grade B.

2. Joints:

a. 2" and Smaller: Soldered.

b. 2 ½" and Larger: Butt-welded.

3. Joint Material:

a. 2" and Smaller: Grade 95 TA solder; ASTM B32.

b. 2 ½" and Larger: Welded; ANSI/AWS D1.1.

4. Fittings:

a. 2" and Smaller: Wrought copper, soldered; ANSI/ASME B16.22.

b. 2 ½" and Larger: Wall thickness as specified for pipe, butt-welded, flanged at valve and equipment connections, long radius elbows; ASTM A234, ANSI B16.9.

5. Unions:

a. 2" and Smaller: Bronze, soldered joint.

b. 2 ½" and 3" : Malleable-Iron, ground joint, threaded.

6. Flanges:

a. 2" and Smaller: Cast bronze, companion type, 150psi; ANSI B16.24.

b. 2 ½" and Larger: Raised-face, welding neck, forged steel, 150psi (flat faced when matched to 125psi flanges); ASTM A181, ANSI B16.5

7. Bolts and Nuts: Carbon steel hex head studs with heavy hex nuts; ASTM A307 Grade B, ASTM A 194 Grade 2H.

8. Gaskets: Material, thickness, pressure and temperature to suit system (ring type for raised face; full face for flat faced).

9. Dielectric Fittings: Isolation flanges, unions & couplings, Epco Sales Inc or approved equal.

10. Shut-Off Valves:

a. 2 Inch and Smaller: 400psi two-piece, bronze body ball valve, soldered joint, Grinnell Figure 3500SJ or approved equal.

b. 2 1/2 to 36 Inch: 150/200psi ductile iron, lug type, quarter turn butterfly valve, bronze aluminum disc, EPDM seat, multi-position locking handle, gear operated above 6-inch size gear operated with chain- wheel where specified, stem 316 SS with TFE bushing, Grinnell LD- 828 or approved equal.

11. Globe Valves:

a. 2 Inch and Smaller: 200psi bronze, renewable disc, rising stem, union bonnet, soldered joint, Grinnell Figure 3240SJ or approved equal.

b. 2 1/2 to 10 Inch: 200psi flanged iron body, bronze mounted, yoke top, bolted bonnet, nibco Figure F718B or approved equal.

12. Check Valves:

a. 2 Inch and Smaller: 300psi bronze, renewable disc, threaded bonnet, soldered joints, swing type, Grinnell Figure 3300SJ or approved equal.

b. 2 1/2 to 30 Inch: 150psi flanged iron body, bronze renewable seat and disc, globe style silent check, Grinnell Figures 502 1/2 to 530 or approved equal.

C. Chilled Water, Make-up Water, Hot Water, Dual Temperature Water and Condenser Water, Exposed in Mechanical Rooms:

1. Pipe:

a. 2" and Smaller: Type L hard drawn, seamless copper; ASTM B88.

b. 2 1/2 to 6 Inch: Schedule 40, welded or seamless steel, black; ASTM A53 or A106, Grade B.

c. 8 to 12 Inch: Schedule 30, welded or seamless steel, black; ASTM A53 or A106, Grade B.

d. 14 to 24-Inch: Standard weight, welded or seamless steel, black; ASTM A53 or A106, Grade B.

e. 26 to 60-Inch: 0.500-inch wall thickness, welded o.d. or spiral butt weld pipe; ASTM A139, Grade B.

2. Joints:

a. 2 Inch and Smaller: Soldered.

b. 2 1/2 to 24 Inch: Roll grooved.

c. 26 to 60 Inch: Welded.

3. Joint Material:

   a. 2 Inch and Smaller: Grade 95 TA soldered; ASTM B32.

   b. 2 1/2 Inch and Larger: Joint Lubricant.

4 Fittings:

   a. 2" and Smaller: Wrought copper, soldered; ANSI/ASME B16.22.

   b. 2 1/2 to 24 Inch: Wall thickness as specified for pipe, roll grooved mechanical joint, flanged at valve and equipment connections, long radius elbows; ASTM A234, ANSI B16.9.

   c. 26 to 60 Inch: Wall thickness as specified for pipe, butt-welded, flanged at valve and equipment connections, long radius elbows; ASTM A234, ANSI B16.9.

5. Unions (2 Inch and Smaller):

   a. 2 Inch and Smaller: Soldered joint bronze

   b. 2 1/2 to 3" : Malleable-Iron, Ground Joing, Threaded.

6. Flanges:

   a. 2" & Smaller: Cast Bronze, companion Type, 150psi; ANSI B.16.24.

   b. 2 1/2 to 24-Inch: Vic Flange, Style 741 or 742, steel, 150psi; 125psi rated when matched to 125psi flanges.

   c. 26 Inch and Larger: Raised-face, welding neck, forged steel, 150psi; ASTM A181, ANSI B16.5.

7. Bolts and Nuts: Heat treated carbon steel hex head studs with heavy hex nuts, minimum tensile 110,000psi; ASTM A183.

8. Gaskets:

   a. 2 Inch and Smaller: Material, thickness, pressure and temperature to suit system (ring type for raised face; full face for flat faced).

   b. 2 1/2 Inch and Larger: EPDM Grade E, for water service up to 230 degrees F; ASTM D2000.

9. Dielectric Fittings: Isolation flanges, unions & couplings, Epco Sales, Inc or approved equal.

10. Joint Couplings (2 1/2 Inch to 24 Inch): Roll grooved, Style 07, malleable iron, "Zero Flex" or approved equal.

11. Shut-Off Valves:

    a. 2 Inch and Smaller: 400 psi two-piece, bronze body ball valve, soldered joint, Grinnell Figure 3500SJ or approved equal.

    b. 2 1/2 to 36 Inch: 150/200 psi ductile iron, lug type, quarter turn butterfly valve, bronze aluminum disc, EPDM seat, multi-position locking handle, gear operated above 6 inch size, gear operated with chain-wheel where specified, with 316SS with TFE bushing Grinnell LD-828 or approved equal.

12. Globe Valves:

    a. 2 Inch and Smaller: 200psi bronze, renewable disc, rising stem, union bonnet soldered joint, Grinnell Figure 3240SJ or approved equal.

    b. 2 1/2 Inch to 10 Inch: 200psi flanged iron body, bronze disc, bronze mounted, yoke top, bolted bonnet, Nibco Figure F7188 or approved equal.

13. Check Valves:

    a. 2 Inch and Smaller: 300psi bronze, renewable disc, threaded bonnet, soldered joints, swing type, Grinnell Figure 3300SJ or approved equal.

    b. 2 1/2 to 30 Inch: 150psi flanged iron body, bronze renewable seat and disc, globe style silent check, Grinnell Figures 502 1/2 to 530 or approved equal.

D. Condensate Drain, In Supply or Return Air Plenums:

1. Pipe: Hard drawn seamless copper tubing, Type L; ASTM B88.

2. Joints: Soldered, Solder Grade 95 TA; ASTM B32.

3. Fittings: Wrought copper, soldered ends; ANSI B16.29.

E. Condensate Drain, Outside of Air Plenums:

1. Pipe: PVC, Schedule 40; ASTM D1785 or ASTM D2241, SDR21 or 26.

2. Joints: Solvent weld; ASTM D2855.

3. Fittings: PVC, Schedule 40; ASTM D2467.

F. Chemical Feed:

1. Pipe and Fittings: PVC Schedule 80. PVC compound shall be Type 1, Grade 1, PVC 1120 (cell class 12454-B) as identified in ASTM D 1784.

2. Jointing: Shall be solvent joints. Requirements of solvents shall comply ASTM Standards D-2564 and F-493, for primers they shall comply with ASTM Standard ASTM F-656 and for the procedure of jointing ASTM D-2855.

3. Shut-Off Valves (2 Inch and Smaller): 150psi, PVC Ball Valves, with Flouroelastomer O ring seals and self lubricating and self-adjusting TFE seats, Chemtrol Series 45HV-V Horizon Ball Valves or approved equal.

4. Check Valves (2 Inch and Smaller): 100psi, PVC Horizontal Swing Check Valves by Thermoplastic Valves Inc. or approved equal.

2.03 ADDITIONAL PIPING REQUIREMENTS

A. The system shall be supplied with valves in all branch mains and risers, at points where underground pipes enter or leave the building at all pumps, tanks, reducing and control valves, heating and cooling surfaces and at all apparatus; so located, arranged and operated as to give complete shut-off. Except where flanged valves are used, each connection to equipment shall be made with screwed or flanged unions on the equipment or discharge side of the valve.

B. All valves shall be installed with the best workmanship and are to have neat appearance and be arranged so that they are easily accessible.

C. Each valve shall have the maker's name or brand, the figure or list number and the guaranteed working pressure case on the body or stamped on the bonnet, or shall be provided with other means of easy identification.

D. Check valves installed in the horizontal position shall be swing checks; valves installed in the vertical position shall be silent checks, except that all check valves in pump discharges shall be silent checks.

E. Provide blow-off valves at all strainers, and where shown on the Drawings.

F. Provide valve operating chain on all valves in Mechanical Equipment Rooms - 4" and larger, which are more than 7'-0" above the operating floor. Unit shall be complete with adjustable sprocket, chain and guide (Crane "Babbit" type). Provide hook to keep chain out of the way.

G. All valves 2 inches in diameter and smaller shall be all bronze with bronze bodies. Valves 2 1/2 inches in diameter and larger shall have iron bodies with bronze mountings (except where otherwise noted).

H. All flanged-end valves shall have renewable metal seat rings and discs. On gate valves these parts shall be of bronze, on all globe valves they shall be of bronze and suitable for throttling service.

I. All screwed-end globe valves shall be of the union bonnet type with renewable Teflon discs.

J. All valves shall have their bonnets back-seated to provide for packing under pressure. All gate valves shall be of the solid tapered wedge type.

K. Drain valves shall be provided on tanks, receivers, risers and where they may be required or necessary, for draining the lines and equipment. Drain valves shall be provided at the low points for proper drainage. Drain valves shall be provided with threaded ends for hose connections with bronze cap and chain.

L. Valves for steel pipe up to 2 inches in diameter shall have screw ends, 2 1/2 inches in diameter and over shall have flanged ends. Valves for copper tube shall have sweat ends. Valves 2 1/2" and larger which are non- rising stem, shall have position indicators.

M. All bronze and iron valves shall be furnished with Teflon Impregnated packing.

N. All hand-wheels shall be of malleable iron.

O. No Asbestos shall be used in construction of valves including the gaskets.

P. Provide bypass piping with isolation valves to facilitate pressure testing and flushing of piping systems.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where the piping systems are to be installed and determine space conditions detrimental to proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Coordinate with other work as necessary to interface installation of piping systems with other components of systems.

B. Provide and erect in a workmanlike manner, according to the best practices of the trade, all piping shown on the Drawings or required to complete the installation intended by these Specifications.

C. The Drawings indicate schematically the size and location of piping. Piping shall be set up and down and offset to meet field conditions and to provide adequate maintenance room and headroom in the Mechanical Rooms.

D. Study the General Construction Specifications and Plans, of the exact dimension of finished work and of the height of finished ceilings in all rooms where radiation, units, equipment or pipes are to be placed and arrange the work in accordance with the Schedule of Interior Finishes, as indicated on the Architectural Drawings.

E. All exposed piping shall be run perpendicular and/or parallel to floors, interior walls, etc. Piping and valves shall be grouped neatly and shall be run so as to avoid reducing headroom or passage clearance. Provide min. 7'-6" headroom under passageway in

Mechanical Equipment Room. All valves, control and accessories concealed in furred spaces and requiring access for operation and maintenance shall be arranged to assure the use of a minimum number of access doors.

F. All pipe lines made with screwed fittings must be provided with sufficient number of flanges or unions to make possible any taking down of the pipes without breakage of fittings.

G. All piping shall be erected as to insure a perfect and noiseless circulation throughout the system. No bullhead tees will be permitted.

H. All valves and specialties shall be so placed as to permit easy operation and access.

I. Provide proper provision for expansion and contraction in all portions of pipe work, to prevent undue strains on piping or apparatus connected therewith. Provide double swings at riser transfer and other offsets wherever possible, to take up expansion. Arrange riser branches to take up motion of riser.

J. Approved bolted, casketed, flanges (screwed or welded) shall be installed at all apparatus and appurtenances, and wherever else required to permit easy connection and disconnection. Screwed unions shall be used on piping 2" or less.

K. All piping connections to coils and equipment shall be made with offsets provided with screwed or welded bolted flanges so arranged that the equipment could be serviced or removed without dismantling the piping.

L. If, after plant is in operation, any coils or other apparatus are stratified or air bound (by vacuum or pressure), they shall be re-piped with new approved necessary fittings, air vents, or vacuum breakers at no extra cost. If connections are concealed in furring, floors, or ceilings, bear all expenses of tearing up and refinishing construction and finish, leaving same in as good condition as before it was disturbed.

M. Fittings shall be of the eccentric reducing type, where changes of size occur in horizontal piping to provide for proper drainage or venting. Steel pipe bends shall be made of the very best grade open hearth, low carbon steel, leaving a smooth uniform exterior and interior surface. Pipe bends shall be made with seamless steel pipe, having a minimum radius of not less than five (5) pipe diameters.

N. Tubing shall be of the erected neatly in a workmanlike manner. Bends shall be made in soft copper tubing using benders to prevent deformation of the tubing in the bends. Approved seat-to-pipe threaded adapters shall be provided for junctions with valves and other equipment having threaded connections.

O. Vertical sections of main risers shall be constructed of pipe lengths welded together. No couplings shall be used.

P. The ends of all pipe and nipples shall be thoroughly reamed to the full inside diameter of the pipe and all burrs formed in the cutting of the pipes shall be removed.

Q. Piping shall be installed in accordance with the latest edition of the ASME Code for Pressure Piping. Pipe supports shall be seismic as indicated in Drawings SGME-1 and SGME-2.

R. All piping shall be concealed above furred ceilings in rooms where such ceilings are provided (except where specifically indicated otherwise on the drawings, or in walls or partitions, except as otherwise indicated.

S. Dissimilar piping shall be connected with dielectric connector as made by Ebco Company or approved equal.

T. Piping at all equipment and control valves shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional supports after these items are removed.

U. Screw threads shall be cut clean and true; screw joints made tight without caulking. No caulking will be permitted. A non-hardening lubricant shall be used. No bushings shall be used. Reductions, otherwise causing objectionable water or air pockets, to be made with eccentric reducers or eccentric fittings.

V. Pitch water piping upward one inch per 100 feet in direction of flow to ensure adequate flow without air binding, and to prevent noise and water hammer. Pitch drains piping 1/8 inch per foot in the direction of flow. Branch connections to mains are to be made in such a manner as to prevent air trapping and permit free passage of air. To meet job conditions, mains shall set up to maintain headroom, and clear other trades. Provide oversized float operated automatic air vent (with valve). Avoid 90 Deg. lift set-ups in

supply lines by using 45 degree ells. Where 90 Deg. lifts exceed 12" install with automatic air vent in supply lines. All lifts in return lines shall be installed with automatic air vents. Pipe outlet of all automatic air vents to an open sight drain if the vent is concealed, or to within two feet of the floor within machine rooms. All water piping shall pitch back to low points for drainage. Low points shall be provided with 3/4-inch hose cocks.

W. Provide drain valves at the heel of all interior main water risers. Provide drain valves at the hell of all perimeter water risers.

X. Miscellaneous drains, vents, relief, and overflows from tanks, equipment, piping, relief valves, pumps, etc., shall be run to the nearest open sight drain or roof drain. Provide drain valves whenever required for complete drainage of piping, including the system side of all pumps.

Y. Provide domestic water connections from valve outlets to any equipment requiring it.

Z. All drain piping from condensate drain pans shall be properly trapped in accordance with the static pressures involved. Condensate drain piping sizes shall be not less than 1-1/2".

AA. Horizontal piping shall be supported from building structural steel or auxiliary steel attached to building structure. Vertical pipes at floors shall be supported by steel angles anchored to the floor.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of piping (partial or complete) test piping to demonstrate compliance with requirements. Where possible, field correct malfunctioning piping, then retest to demonstrate compliance. Replace piping, which cannot be satisfactorily corrected. Refer to Section - Test and Balancing.

END OF SECTION 23 05 23

SECTION 23 05 29 - HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUPIMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 - Basic Mechanical Requirements
Division 23 - Section 230512 - Basic Mechanical Materials and Methods
Division 23 - Section 232113 - Basic Piping Materials and Methods
Division 23 - Section 230548 - Vibration isolation and seismic restraint specification for HVAC, Fire Protection, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. Pipe Supports

B. Equipment Supports

C. Factory Fabricated Roof Curbs

D. Duct Supports

1.03 SUBMITTALS

A. Product data: Including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.

B. Show dimensional drawing, material of construction and method of installation of roof curb.

1.04 QUALITY ASSURANCE

A. Submit product certificates signed by the manufacturer of hangers and supports certifying that their products meet the specified requirements.

B. The Contractor shall certify that welders are qualified in accordance with AWS D1.1

C. Manufacturers shall be firms regularly engaged in manufacture of roof curbs, supports and anchors of types and sizes required, whose products have been in similar service for not less than 10 years.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Follow Manufacturer's instructions in storage and handling the products to prevent them from damage.

PART 2 - PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

A. Provide necessary structural members, hangers and supports of approved design to keep piping in proper alignment and prevent transmission of injurious thrusts and vibrations. In all cases where hangers, brackets, etc. are supported from metal decking and/or concrete or penetrate waterproofing. All hangers and supports shall be capable of screw adjustment after piping is erected. Hangers supporting piping expanding into loops, bends and offsets shall be secured to the building structure in such a manner that horizontal adjustment perpendicular to the run of piping supported may be made to accommodate displacement due to expansion. All such hangers shall be finally adjusted; both in the vertical and horizontal direction, when the supported piping is hot, or chilled, as required. Hangers in contract with copper or brass pipe shall be copper plated steel.

Pipe hangers shall be clevis and pipe roll types, except where otherwise noted.

B. PIPE HANGERS SCHEDULE

1. Make and Model

Pipe	Type of Hanger	Anvil Fig. No.	F & M Fig. No.	Paterson Carpenter Fig. No.

2" & smaller (steel)	Clevis Hanger	260	239	100
2" & smaller (copper)	Adjustable Wrought Iron	CT-65	364	100 CT
2-1/2" to 4" (steel)	Adjustable Swivel Pipe Roll	174	2729	16
2-1/2" to 4" (copper)	Adjustable Wrought Ring	CT-269		
5" & above	Two Rod Roller Hanger	171	170	142

2. Beam clamps - Hangers supported from floor steel shall be attached with approved I beam clamps. I beam clamps for hangers supporting piping 2 inches and smaller shall be C & P Fig. No. 148 adjustable beam clamps. For piping 2-1/2 inches and larger, I beam clamps shall be wrought steel. C & P Fig. No.268 or equal.

3. Where piping is run near the floor and not hung from the ceiling construction but is supported from the floor, such supports shall be of pipe standards with base flange and adjustable top yoke similar to C & P Fig. 247 or equal.

4. All vertical piping shall be anchored by means of heavy steel clamps securely bolted or welded to the piping, and with end extension bearing on the building.

5. All vertical piping shall be guided at each floor by use of clamps fastened to building structure. Provide 360^{o} protective saddles at guides. Saddles shall be fastened to pipe or insulation.

6. Vertical runs of pipe not over 15 feet long shall be supported by hangers placed not over one foot from the elbows on the connecting horizontal runs.

7. Vertical runs of pipe over 15 feet long but not over 60 feet long and not over 6 inches in size, or not over 30 feet long and not over 12 inches in size, shall be supported on heavy steel clamps. Clamps shall be bolted tightly around the pipes and shall be set

securely on the building structure without blocking. Clamps shall be welded to the pipes or placed below couplings. Clamps shall be type 8, Federal Specification WW-H-171C, unless other types are approved.

8. For all chilled water dual temperature water/ and makeup water and insulated refrigerant piping, provide "Insulshield" as made by Insulcoustic Corp. or pipe covering protection shield C & P Fig. 265P with steel shield min. 9 inches long, with vapor barrier jacket. For steam, condensate, hot fuel oil and hot-water heating piping 2 inches and smaller, same as above. For steam, condensate and hot-water heating and high temperature hot water piping 2-1/2 inches and larger, provide steel pipe covering protection saddles C & P Fig. 353 series.

C. Support spacing and hanger rod diameter shall be as follows:

Pipe Size	**Rod Diameter**	**Max.Spacing**
1-1/4 inch & below	3/8 inch	6'-0"
1-1/2 and 2 inch	3/8 inch	10'-0" (copper 8'-0")
2-1/2 and 3 inch	1/2 inch	10'-0" (copper 8'-0")
4 and 5 inch	5/8 inch	12'-0"
6 inch	3/4 inch	12'-0"
8 inch & above	7/8 inch	12'-0"

D. Hanger rods shall be attached to preset concrete inserts with steel reinforcing rod through the insert and both ends hooked over the reinforcing mesh. For pipes 4 inches and larger, rods shall extend through concrete slab above where they shall be attached to steel bearing plates 6" x 6" x 1/4".

E. Piping shall not be hung from other piping ducts, conduits or from equipment of other trades and no vertical expansion shields will be permitted. Hanger rods shall not pierce ducts.

F. All water piping connected to rotating equipment within all mechanical spaces shall be isolated from the building structure by means of vibration hangers inserted in the hanger rods. The vibration hangers shall consist of a steel spring in combination with a double deflection neoprene element within a rectangular steel housing. Combined static deflection shall be 1.375" minimum. Hangers shall have capability of supporting the piping at a fixed elevation during installation and shall incorporate an adjusting device to transfer the load to the spring. Deflection shall be indicated by means of scale. Vibration hangers shall be type PCDNHS made by Mason Industries.

G. All steam condensate piping within all mechanical spaces shall be isolated from the building structure by means of double deflection neoprene vibration hangers inserted in the hanger rods. The vibration hangers shall consist of a double deflection neoprene element within a rectangular steel housing. Minimum static deflection shall be 1.375". Vibration hangers shall be type PCDNHS as made by Mason Industries.

H. Where additional steel is required for the support of hangers, furnish and install it subject to the approval of the Architect. Piping shall not be supported from concrete slab construction at ceiling.

I. All piping running on walls shall be supported by means of hanger suspended from heavy angle iron wall brackets. No wall hooks will be permitted.

J. Lateral bracing of horizontal pipe shall be provided where required to prevent side sway or vibration. The lateral bracing shall be of a type approved by the Architect and shall be installed where directed by the Architect.

2.02 ANCHORS

A. All anchors shall be separate and independent of all hangers, guides, and supports. Anchors shall be of heavy blacksmith construction suitable in every way for the work approved by the Architect. Anchors shall be welded to the pipe and fastened to the structure with bolts.

B. Anchors shall be fabricated and assembled in such a form as to secure the piping in a fixed position. They shall permit the line to take up its expansion and contraction freely in opposite directions away from the anchored points; and shall be so arranged as to be structurally suitable for particular location, and line loading. Submit details for approval

C. All Heavy piping or any combination of closely spaced pipes weighing more than 15 lb. per linear foot, shall be supported at all cross points with overhead floor beams by fastening to the flange of such beams with steel clamps or other suitable means.

D. Where such heavy piping runs parallel with the floor beams properly designed auxiliary steel must be provided. The spacing of such auxiliary steel shall in no case be greater than the spacing of the floor beams running perpendicular to the corrugations of the permanent slab steel forms.

E. Assume the responsibility for the proper transfer of the loads of the piping systems to the structure. No additional cost to the owner should be expected for any corrective work during construction.

2.03 EQUIPMENT SUPPORTS

A. Fabricate structural steel stands to suspend equipment from structure above or support equipment above or support equipment above floor.

B. Grouting: Place grout under supports for piping and equipment.

2.04 ROOF CURBS

A. ACCEPTABLE MANUFACTURER

1. Pate Company.
2. Penn Ventilator Company.
3. Thy Curb.

B. MATERIALS

1. Dimensionally coordinate curbs and supports with supporting steel and accepted equipment.

2. Curbs and Supports: Except where specified otherwise; 18 inch high, 18 gauge galvanized steel sides, treated wood-nailers, fully mitered corners with welded seams and rigid glass fiber insulation in thickness specified.

3. Roof Curbs:

i. Type A: Use with exhaust fans; 16 gauge galvanized steel, 2 inch thick insulation, Pate Model PC or Penn Ventilator Model Sonotrol [Uni-beam].

ii. Type B: Use with roof mounted utility type fume exhaust fans with stacks, and equipment exceeding 36 inches in width; custom fabricated, one-piece, internally reinforced galvanized steel base with counter flashing, 1 1/2 inch thick insulated sides and solid top. Pate Company Model SCEB [SCEB-53].

iii. Type C: Use with pipe or duct penetrations; integral base plate, 2 inch thick insulation, acrylic clad ABS plastic cover; boots and stainless steel clamps. Pate Company Model PCA.

2.05 DUCT AND PIPING SUPPORT SYSTEM FOR THE DUCTWORK AND PIPING INSTALLED ON THE ROOF

A. ACCEPTABLE MANUFACTURER

1. PHP System Design

All ductwork and piping supports exposed on the roof shall be designed by PHP System Design. Contractor shall ensure that system shall be designed for wind and snow load and shall submit drawings with calculation certified by a Professional Engineer.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Coordinate with other work as necessary to interface installation of support with other components of systems.

B. Provide and erect all supports and anchors in a workmanlike manner according to the best practices of the trade.

C. Roof Curbs shall be installed under Division 7.

END OF SECTION 23 05 29

SECTION 23 05 48 - VIBRATION CONTROLFOR HVAC, ELECTRICAL & PLUMBING

PART 1 – GENERAL

1.01 SCOPE

A. Unless otherwise noted on equipment schedules or specification, all equipment shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted structure-borne noise to the building structure. The scope of this dual purpose specification encompasses the necessary design and product specifications for the vibration isolation and seismic restraint of mechanical equipment, piping, and ductwork, and is part of the general conditions for the HVAC, plumbing, fire protection and electrical contract

1.02 REQUIREMENTS

A. All vibration mountings shall be manufactured in the United States.

1.03 INTENT

A. It is the intent of the seismic restraint portion of this specification to provide restraint of non-structural building components. Restraint systems are intended to withstand the stipulated seismic accelerations applied through the component center of gravity. The work in this section includes the following:

1. Vibration isolation elements for equipment
2. Equipment isolation bases
3. Piping flexible connectors
4. Seismic restraints for isolated equipment
5. Seismic restraints for non-isolated equipment
6. Certification of seismic restraint designs and installation supervision
7. Certification of seismic attachment of housekeeping pad

1.04 DEFINITIONS

A. The term EQUIPMENT will be used throughout this specification. It includes all non-structural components within the facility and/or serving this facility, such as equipment located in outbuildings or outside of the main structure on grade within five feet of the foundation wall. Equipment buried underground are excluded but entry of services through the foundation wall are included. The term "equipment" shall refer (but not be limited to) the following

AC units, Cabinet Heaters, Conduit, Light Fixtures, Transformers
Air Handling Units, Cable Trays, Cooling Towers, Meter, Control Centers, Unit Heaters
Air separators, Chillers, Ductwork, Piping, Unit Substations
Battery Chargers, Compressors, Electrical Panels, Pumps (all types) Unit Ventilators
Battery Racks, Comp. Rm. Units, Fans (all types), Rooftop Units, Var. Freq. Drives
Boilers, Condensers, Generators, Switching Gear, Water Heaters
Bus Ducts, Condensing Units, Heat Exchangers, Tanks (all types)

B. Life Safety systems shall be defined as:

1. All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks, and smoke exhaust systems

2. All systems involved with and/or connected to emergency power supply including all generators, transfer switches, transformers and all circuits to fire protection, and smoke evacuation.

3. All medical and life support systems.

4. Fresh air relief systems on emergency control sequence including air handlers, conduit, duct, etc.

C. Positive attachment shall be defined as a support location with a cast-in or wedge type expansion anchor, a double-sided beam clamp, a welded or through bolted connection to the structure.

D. Transverse Bracing - Restraint(s) applied to limit motion perpendicular or angular to the centerline of the pipe, duct, or conduit.

E. Longitudinal Bracing - Restraint(s) applied to limit motion along the centerline of the pipe, duct, or conduit.

1.05 RESPONSIBILITIES

A. The manufacturer of vibration isolation and seismic restraint shall determine the sizes and locations of isolators and seismic restraints, provide equipment isolation and seismic restraints as specified, guarantee specified isolation system deflections, provide installation instructions, proper drawings, and shall certify correctness of installation upon completion.

B. The Contractor shall cause all vibration isolation systems, including the isolators, seismic restraints/snubbers and flexible connectors between the isolated equipment and associated piping, ducting and/or electrical work, to be designed by a Manufacturer experienced in this type of work. This provision, however, shall not be construed as relieving the Contractor of his overall responsibility for the work. The Contractor shall provide to the manufacturer of vibration isolation products a listing of all mechanical equipment to be isolated including RPM, total weight, center of gravity, and mounting attachment points. The structural integrity of the supported equipment shall be the responsibility of the equipment manufacturer.

1.06 DESIGN - VIBRATION ISOLATION SYSTEMS

A. Vibration isolators shall be selected based on known or estimated operating weight distributions of the isolated equipment, with the quantity and location as shown on the component drawing. Isolator type shall be tabulated for each isolated piece of equipment. Isolators shall have either known non-deflected heights of spring element or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified to determine if the load is within the proper range of the isolator and if the correct degree of vibration isolation is being provided. Isolators shall function in the linear portion of the load versus deflection curve. Theoretical vertical natural frequency shall not differ from the design objectives by more than 10%

B. Substitution of internally or externally isolated and restrained equipment supplied by the equipment vendor, in lieu of the isolation and restraints specified in this section, is acceptable provided all conditions of this section are met. The Equipment manufacturer shall provide a letter of guarantee from their Engineering Department stamped and certified per the section on Seismic Restraint Design (paragraph 1.07) stating that the seismic restraints are in full compliance with these specifications

C. Letters from field offices or representatives are unacceptable. All costs for converting to the specified vibration isolation and/or restraints shall be borne by the equipment vendor in the event of non-compliance with the preceding. Internal isolation is not acceptable for:

1. Rooftop equipment over or adjacent to
   a. Patient or operating areas
   b. Theater space
   c. Office locations
   d. Assembly areas

D. Unless the equipment incorporates unit construction using an integral unit frame or is specified otherwise, each item of mechanical equipment, along with its drive unit, shall be mounted on a rigid steel or steel and concrete base. The equipment, including the base, shall be mounted on, or suspended from, vibration isolators to prevent the transmission of vibration and mechanically transmitted structure borne sound to the supporting structure.

E. Isolation hangers shall be used for all piping, in equipment rooms or for 50 feet, from vibrating equipment, whichever is greater. To avoid reducing the effectiveness of equipment isolators, at least three of the first hangers from the equipment should provide the same deflection as the equipment isolators, with a maximum limitation of 2-inch deflection. The remaining hangers shall be spring or combination spring and rubber with a minimum of 0.75-inch deflection. To prevent load transfer to the equipment flanges when the piping system is filled, the first three hangers adjacent to the equipment shall be the positioning type (specification type 5). Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use restrained vibration isolators. They should be selected according to the guidelines for hangers.

1.07 NOT USED.

1.08 SUBMITTALS

A. A seismic design Errors and Omissions insurance certificate must accompany submittals from the seismic engineer. Manufacturers product liability insurance certificates are not acceptable.

B. The manufacturer of vibration isolation products shall submit an itemized list of all isolated and non-isolated equipment with detailed schedules showing isolators and seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers. The schedule shall include the weight, center of gravity, and RPM of each piece of equipment. When equipment center of gravity is not available, assumed locations for center of gravity shall be identified in submittals.

C. Submittals for hangers and mountings shall indicate specific model numbers with complete dimensional and deflection data and color code. Base drawings for equipment shall include dimensions, structural member sizes, and support point locations.

D. Seismic calculations, signed by a qualified licensed Professional Engineer, shall be submitted showing adequacy of bolt sizing and type. Calculations shall be furnished for anchors on restraint devices, cable, isolators and rigidly mounted equipment. Calculations shall specify anchor bolt type, embedment, concrete compressive strength, minimum spacing between anchors, and minimum distances of anchors from concrete edges. All performance of products (such as strut, cable, anchors, clips, etc.) associated with restraints must be supported with manufacturer's data sheets or certified calculations. Seismic analysis must indicate calculated dead loads, derived loads, and materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or weld length.

1.09 RELATED WORK

A. Housekeeping pad design shall be by the project structural engineer. Attachment shall be designed and certified according to this section by the seismic/isolation supplier. Material and labor required for attachment and construction shall be by the concrete section contractor. Housekeeping pads shall be sized to accommodate a minimum of six (6) inches of clearance all around the equipment and its mounting package. Structural support and connections for all equipment, including roof-mounted equipment, specified in other sections shall comply with the seismic requirements of this section.

PART 2 – PRODUCTS

2.01 DESCRIPTION

All vibration isolators and seismic restraints described in this Section shall be the product of a single manufacturer. The basis of this specification is The VMC Group, including Vibration Mountings & Controls, Amber/Booth or Korfund Dynamics. Products from other nationally recognized manufacturers are acceptable provided their systems strictly comply with these specifications and have the approval of the specifying engineer. Manufacturer shall be a regular member of VISCMA (Vibration Isolation and Seismic Controls Manufacturers Association). See Form VL-1 listing other manufacturers to be considered for use on this project.

2.02 VIBRATION ISOLATION TYPES

A. Type A: Spring Isolator – Free Standing
A*

1. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded elastomeric cup or ¼" elastomeric acoustical friction pad between the bottom of isolator and the support.

2. All mountings shall have leveling bolts that must be rigidly bolted to the equipment.

3. Spring diameters shall be no less than 0.8" of the compressed height of the spring at rated load.

4. Springs shall have a minimum additional travel to solid equal to 50% of the operating deflection.

2.03 Not used

2.04 Not used

2.05 FLEXIBLE CONNECTORS

1. Type FC-2: Flexible Stainless Steel Hose

SS-FP, SS-FW, SS-PM, SS-WE

i. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples.

2. Type BC-2 connector shall be braided bronze for Freon connections.

i. Minimum lengths shall be as tabulated:

Flanged			Male Nipples
3 x 14	10 x 26	½ x 9	1 ½ x 13
4 x 15	12 x 28	¾ x 10	2 x 14
5 x 19	14 x 30	1 x 11	2 ½ x 18
6 x 20	16 x 32	1 ¼ x 12	
8 x 22			

ii. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.

PART 3 - EXECUTION

3.01 EQUIPMENT ISOLATION

A. Isolation and seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions and all submittal data. Locations of all vibration isolation products shall be selected for ease of inspection and adjustment, as well as for proper operation. Electrical and plumbing connections to vibration-isolated equipment shall be flexible. Equipment shall be isolated and restrained as indicated in the vibration isolation schedules.

B. The minimum operating clearance under bases shall be 1". All bases shall be placed in position and supported temporarily by blocks or shims prior to the installation of the equipment, isolators and restraints. Spring isolators shall be installed after all equipment is installed without changing equipment elevations. After the entire installation is complete and under full operational load, the spring isolators shall be adjusted so that the load is transferred from the blocks to the isolators. Remove all debris from beneath the

equipment and verify that there are no short circuits of the isolators or the isolation system.

3.02 PIPING AND DUCTWORK ISOLATION

A. Vibration isolation hangers shall be positioned as close as possible to the structure without coming in contact with any object (including the structure). Hanger rods shall not contact any object, which would short circuit the isolator. Parallel running pipes may be hung together on a trapeze, which is isolated from the building. Do not mix vibration isolated and non-isolated pipes on the same trapeze. Attention must be paid to movements of piping caused be expansion and contraction.

B. Type 6 hangers may be substituted for all other hangers listed below. Pre- compressed hangers shall only be used if installed along with piping.

C. Isolation hangers shall be installed for all piping in equipment rooms or for 50 ft. from vibrating equipment, whichever is greater. To avoid reducing the effectiveness of equipment isolators, at least three of the first hangers from the equipment should provide the same deflection as the equipment isolators, with a maximum limitation of 2-inch deflection. The remaining hangers shall be spring or combination spring and rubber with a minimum of 0.75-inch deflection. To prevent load transfer to the equipment flanges when the piping system is filled, the first three hangers adjacent to the equipment shall be the positioning type (specification type 5). Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use restrained vibration isolators. They should be selected according to the guidelines for hangers. Vertical riser supports for pipe 4" diameter and larger shall be isolated from the structure using type 11 and type 12 anchors and guides.

D. All ductwork over four square feet face area located in the mechanical equipment room(s) shall be isolated with type 8 hangers with a minimum of 0.75 inch deflection. Emergency generator exhaust shall be isolated with type 8 hangers with a minimum of 0.75-inch deflection.

E. Install type 14 flexible connectors at all connections of pipe to pumps and chillers and to other isolated equipment only as shown on drawings. Where they are not installed on isolated equipment, insert spool pieces on the equipment side of shutoff valves.

3.03 Not used.

3.04 Not used.

3.05 INSPECTION

A. Upon completion of installation of all vibration isolation and seismic restraint devices, a certification report prepared by the manufacturer or the qualified representative shall be submitted in writing to the contractor indicating that all systems are installed properly and in compliance with the specifications. The report must identify those areas that require corrective measures or certify that none exists. Any field coordination type changes to the originally submitted seismic restraint designs must be clearly defined and detailed in the report.

END OF SECTION 23 05 48

SECTION 23 05 53 - IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 – Basic Mechanical Requirements
All sections of Division 23 requiring identification devices specified herein

Division 23 - Section 230548 - Vibration isolation for HVAC, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. Identification of mechanical equipment and piping systems.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

1.04 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacturer of identification devices of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Seton Nameplate Corporation

B. Brady Sign mark Division

C. Craft mark Identification Systems.

2.02 MANUFACTURERS' IDENTIFICATION

A. Manufacturer's nameplate, name or trademark, shall be permanently affixed to all equipment and material furnished under this Specification. Where such equipment is in a finished occupied space, the nameplate shall be in a concealed but accessible location. The nameplate of a Subcontractor or Distributor will not be acceptable.

2.03 EQUIPMENT NAMEPLATES

A. Provide for each equipment, including air handling units, heat transfer equipment, control devices, pumps, fans, compressors, boilers, etc., a permanently attached nameplate made of black surface, white core laminated bakelite with incised letters. Subcontractor furnishing equipment shall provide nameplate. Pneumatic, electric and mechanically actuated gauges shall have a brief, but complete description of their function. Nameplates shall be a minimum of 3" long by 1-1/2" wide and shall bear the equipment name and item number of 1/4" high white letters as designated in the equipment schedule. Mounting screws shall have chrome plated acorn headed screws.

2.04 TAGS AND CHARTS

A. Furnish and attach to each valve in piping systems (except local shut -off valves), a 1-1/2" diameter brass tag with 1/2" indented numerals filled with durable black compound. Tags shall be securely attached to stems of valves with copper wire and "S" hooks.

B. Valve charts shall consist of schematic drawings of piping layouts, showing and identifying each valve and describing the function. Upon completion of the work, one (1) copy of each chart, sealed to rigid backboard with clear lacquer placed under glass and framed, shall be hung in a conspicuous location in the main equipment room, unless otherwise directed by the Architect. Two (2) additional un-mounted copies in 8-1/2" x 11" leather ring binders shall be delivered to the Architect. Also furnish three (3) copies of schematic flow chart with corresponding valve numbers noted on chart.

2.05 IDENTIFICATION

A. Provide identification for piping and ductwork and conduit for electrical work.

B. Pipe shall be lettered and valves tagged. Lettering shall be located near each valve and branch connection and at intervals of not over 40 feet (10 feet on fire lines and on piping in the Mechanical Equipment Rooms) on straight runs of pipe. Provide flow arrows for all piping at each marker. Adjacent to the legend, stencil the size of the pipe, conduit or ductwork. Letter colors shall be yellow with black letters, green with white letters, blue with white letters and red with white letters.

C. Schedule of identification material shall be as follows:

OUTSIDE DIAMETER OF INSULATION OF PIPE (INCHES)	SIZE OF LETTERS (INCHES)
3/4 TO 1-1/4	1/2
1-1/2 TO 2	3/4
2-1/2 TO 6	1 1/4
8 TO 10	2 1/2
Over 10	3 1/2

PART 3 - EXECUTION

3.01 PREPARATION

A. Degrease and clean surfaces

3.02 INSTALLATION

A. All identification items shall be installed to the Owner's satisfaction and in accordance with manufacturer's instructions.

END OF SECTION 23 05 53

SECTION 23 05 93 - TESTING, ADJUSTING AND BALANCING

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 - Basic Mechanical Requirements

Division 23 - Section 230548 - Vibration mountings and controls, Vibration isolation and seismic restraint specification for HVAC, Fire Protection, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. Requirements and procedures for total mechanical systems testing, adjusting, and balancing to meet design specifications.

1.03 SUBMITTALS

A. Copy of AABC certification within 30 days after award of Contract.

B. Name of Agency's representative responsible for coordination with Contractor.

C. Copy of AABC National Project Performance Guarantee prior to commencing system balance.

D. List of each instrument to be used, and latest date of calibration.

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

F. Reports:

1. Submit all test reports on AABC forms. Complete all applicable parts of each form.

2. Modify forms or submit multiple forms where required for maximum and minimum flows, temporary and future conditions, or other conditions, to suit the Project.

3. Submit report for review prior to final acceptance of the Project. Provide final copies for A/E and Contractor for inclusion in operating and maintenance manuals.

4. Bind reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side.

5. Include diagrams to clarify locations of component readings within a system.

G. Certificates:

1. By Contractor: Certify that each system is prepared for testing and balancing and that products and systems meet or exceed specified requirements.

2. By Balancing Agency: Certify that instruments flow measuring primary elements and read-out meters have been calibrated to NBS Standards. Include Contractor-furnished permanently installed and portable devices.

1.04 GENERAL REQUIREMENTS

A. All piping and equipment shall be tested. Labor including standby electrician, materials, instruments and power required for testing shall be furnished unless otherwise indicated under the particular Section of the Specification.

B. Tests shall be performed in the presence of and to the satisfaction of the Architect and such other parties, as may have legal jurisdiction.

C. In no case shall piping, equipment, or accessories be subjected to pressure exceeding their ratings.

D. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Architects.

E. Any damage resulting from tests to any and all trades shall be repaired and damaged materials replaced, all to the satisfaction of the Architect.

F. The duration of tests shall be as determined by all authorities having jurisdiction, but in no case less than the time prescribed below.

G. Equipment and systems, which normally operate during certain seasons of the year, shall be tested during the appropriate season. Tests shall be performed on individual equipment, systems, and their controls. Whenever the equipment or system under test is interrelated and depends upon the operation of other equipment, systems and controls for proper operation, functioning and performance, the latter shall be operated simultaneously with the equipment or system being tested.

H. All fans and duct systems shall be completely balanced by the adjustment of sheaves, dampers, registers and other volume and diverting control devices, to obtain the air quantities indicated on the design drawings. Replace sheaves if required to meet design conditions.

I. All pumps and piping systems shall be completely balanced by the adjustment of plug cocks, globe valves or other control devices, to obtain flow quantities indicated on the design drawings.

J. Tests shall be performed in presence and to satisfaction of Engineer, and such other parties as may have legal jurisdiction. Submit completed reports for approval. If air and water balancing cannot be verified in two, four-hour tests (total of eight hours) the Contractor shall pay the Engineer or his representative for any additional time spent to balance the system.

1.05 QUALITY ASSURANCE

A. Prior to installation of the mechanical systems, engage the services of an independent air and water-balancing firm that shall be subject to the approval of the Engineer. The firm shall have no affiliation with a mechanical contracting or sheet metal company. Balancing and testing company shall be a member of the Associated Air Balance Council. The balancing firm shall have at least one member of its full time staff who is a licensed professional engineer who shall supervise the balancing work. Prior to balancing, a list of instruments to be used shall be submitted to the Engineer. All instruments shall be calibrated within six months before tests.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 - EXECUTION

3.01 FIELD TEST OF PIPING

A. During construction properly cap or plug all lines to prevent the entrance of sand, dirt, etc. The system of piping shall be blown through wherever necessary after completion (for the purpose of removing grit, dirt, sand, etc., from all equipment and piping), for as long a time as is required to thoroughly clean the apparatus.

B. Use anti-freeze solution for piping to be tested in winter.

C. All piping shall be tested as hereinafter specified. Tests shall be made after erection and before covering is applied or piping painted or concealed, and as sections of mains and groups of risers are completed. The extent of the work completed before the Architect shall determine pressure tests are made.

D. All piping, unless otherwise specified, shall be tested to a hydrostatic pressure at least 1-1/2 times the maximum designed working pressure (but not less than 50 lbs. per square inch) for a sufficiently long time to detect all leaks and defects; and after testing shall be made tight in the most approved manner. Tests shall be repeated once after leaks and defects have been repaired. When automatic control valves, equipment and similar devices which are incapable of withstanding test pressures applied to piping, such devices shall be removed, or otherwise protected during tests. After approval of such tests, devices shall be installed and tested with operating medium to operating pressures. The following shall be tested for four consecutive hours and proved tight. Leaks shall be remedied by replacing defective work.

Item	Hydrostatic Field Test
Medium pressure steam and condensate piping	300 psi
Low pressure steam and condensate piping	100 psi
Pumped low pressure condensate returns (discharge)	100 psi
Compressed Air (temperature controls)	100 psi
Overflow and drain	50 psi
Hot water heating	100 psi

Chilled water	100 psi
Chemical Treatment-Hot water	100 psi

E. Leaks appearing during the various pressure tests shall be corrected by replacing all defective materials or welds and subsequent tests shall be made until the piping is found perfect. Caulking of screwed joints or pending of welds is prohibited. Wherever it is necessary to cut out a weld and the ends of the pipe cannot be conveniently brought together, then a short piece of pipe shall be fitted in and welded as approved by the Engineer.

F. Provide all other tests required by the Building Department, Fire Department and all other authorities having jurisdiction.

3.02 RUNNING TEST OF PIPING SYSTEMS

A. When directed, any section of the work, after it has been completed and otherwise satisfactorily tested, shall be put in actual operation and operated for a period of two (2) days of 24 hours each, during which time any defects which may appear shall be remedied and any adjustment which may be necessary shall be made.

B. During the time of the tests, repack all valves, make all adjustments and otherwise put the apparatus in perfect condition for operation, and instruct the Owner's representative in the use and management of the apparatus.

3.03 TEST OF REFRIGERATION PIPING

A. Refrigeration piping shall be tested in accordance with the recommendations of the refrigeration equipment manufacturer and in the following sequence for a period of 24 hours.

High Side	- Nitrogen at 450 psi
Low Side	- Nitrogen at 150 psi
Entire System	- Freon at 5 psi

B. No visible leaks, losses in pressure or increase in vacuum occur during test period.

3.04 EQUIPMENT TEST

A. Demonstrate that all equipment and apparatus fulfill the requirements of the

Specifications and that all equipment shall be operated and tested for rated capacities and specified characteristics. Voltage and amperage readings shall be taken on all electric motors.

3.05 AIR LEAKAGE TEST FOR MEDIUM PRESSURE DUCTWORK

A. The testing of all joints for air leakage after erection and the repair of any leaks are positive requirements. Leakage must be kept to a specified minimum. The test for air leakage is divided into two phases; namely, testing of individual vertical risers and testing of all branches. Provide all required instruments.

B. Test shall be made at 6 inches water gauge static pressure. All risers, branches and run outs shall be tested after installation before insulation is applied and before the air mixing units are installed. The total allowable leakage for the entire system shall be no more than one (1) percent of the total system capacity. Submit the test report to engineer for review and approval.

C. Equipment necessary for performing this test shall include a rotary hand blower calibrated orifice section and a "U" tube gauge board complete with cocks and rubber tubing. The test hookup, as well as details for the fabrication of the orifice section shall be in accordance with the recommendation of the "High Velocity Duct Manual" of Sheet Metal and Air Conditioning Contractors National Association, Inc.

3.06 TEST PREPARATION AND PROCEDURE

A. On initial startup, prior to any tests, check the rotation and running amperage of all fan and pump motors to prevent damage to equipment by overload.

B. Final balancing must be done with all systems completely installed and operating and after the automatic temperature controls have had their final adjustment.

C. New, clean filters must be installed in all supply systems prior to balancing.

D. All water systems shall be completely filled and vented, and all strainers cleaned prior to balancing. Inspect expansion tanks for proper water level and operating of makeup water valves.

E. All main supply air ducts shall be traversed, using a pivot tube and manometer. The

manometer shall be calibrated to read two significant figures in all velocity pressure ranges.

F. A main duct is defined as either of the following:

1. A duct serving five or more outlets.
2. A duct serving two or more branch ducts.
3. A duct serving a reheat coil.
4. A zone duct from a multi-zone unit.
5. A duct emanating from a fan discharge or plenum and terminating at one or more outlets.

G. The intent of this operation is to measure by traverse the total air quantity supplied by the fan and to verify the distribution of air to zones.

H. Submit data in support of all supply fan deliveries by the following four methods:

1. By summation of the air quantity readings at all outlets.
2. By duct traverse of main supply ducts.
3. By a rotating vane traverse across a filter or coil bank.
4. By plotting RPM and static pressure readings on the fan curve. Air density corrections must be indicated.

I. For return air and exhaust fans, summation and duct traversing shall be sufficient.

J. Inspect all fan scrolls and remove objects or debris. Inspect all coils and remove debris or obstructions. Verify that all fire dampers are open.

K. The supply air systems shall be completely balanced prior to the final balancing of the water systems.

L. Upon completion of all air and water balancing, all duct dampers, plug valves and

other throttling devices shall be marked in the final adjusted position.

3.07 AIR BALANCE

A. Record the following design requirements for all fans and fan motors from the approved shop drawings.

1. Air quantities - CFM
2. Approximate fan speed - RPM
3. Fan static pressure (total or external) - inches of water.
4. Maximum tip speed - FPM
5. Outlet velocity - FPM
7. Motor horsepower
8. Volts, phases, cycles and amps at design conditions.

B. Record the following data from all fans and fan motors installed at the project:

1. Manufacturer, model and size
2. Motor horsepower, service factor and RPM
3. Volts, phases, cycles and full load amps
4. Motor starter and heaters size
5. Equipment location

C. All fans and duct systems shall be completely balanced by the adjustment of sheaves, dampers, registers and other volume and diverting control devices, to obtain the air quantities indicated on the Drawings. Outside air and return air modulating dampers shall be adjusted to admit the specified quantities of air under all cycles of operation. All final adjusted air quantities shall be within 10% of the design requirements. Replace sheaves if required to meet design conditions.

D. Record the following test data for all fans and motors installed at the Project at final balanced conditions:

1. Fan speed RPM.
2. Fan static pressure (external and total) inches of water.
3. Static pressure drop across all filters, dampers, coils and other items in the supply fan casings.
4. Motor operating amps.
5. Actual voltage

6. Fan CFM
7. Calculated brake horsepower.

E. Submit single line diagrams of all duct systems indicating all terminal outlets identified by number. Data sheets shall list all such outlets denoted by the same numbers, including the outlet's size, "K" factor, location, CFM and jet velocity.

F. Submit this data for all supply, return and exhaust air systems.

G. Adjust the outside air and return air dampers to admit the required amounts of air under both summer and winter cycles. Record and submit the outside, return and mixed air temperatures for both cycles after final adjustments.

3.08 WATER BALANCE

A. Record the following design requirements for all pumps and pump motors from the approved shop drawings:

1. Water quantity - GPM
2. Total head - feet of water
3. Pump speed - RPM
4. Impeller size
5. NPSH (if required)
6. Motor horsepower
7. Volts, phases, cycles and amps at design conditions

B. Record the following data from all pumps motors installed at the project:

1. Manufacturer, model and size.
2. Impeller size
3. Motor horsepower, service factor and RPM
4. Volts, phases, cycles and full load amps
5. Motor starter and heaters size
6. Equipment Location

C. All pumps and piping systems shall be completely balanced by the adjustment of plug cocks, globe valves or other control devices, to obtain the flow quantities indicated on the Drawings. Balancing shall be done with all controls set for full flow through coils. All automatic throttling valves shall be in the full-open position. All automatic three-

way valves shall have the bypass port closed.

D. Record the following test data for all pumps and pump motors installed at the Project:

1. Pump speed - RPM

2. Total head at shut-off or dead-end discharge - feet of water. (Plot this value on pump curve as a verification of impeller size.)

3. Suction, discharge and total head at final adjusted flow - feet of water.

E. Balance the water flow through all coils, cabinet heaters, and heat exchangers in accordance with design requirements.

F. For all Venturi type, pivot tube, or other flow measuring devices record the pipe size, manufacturer and size of device, and the direct reading or the differential pressure, and calculated final flow.

G. Flow shall be balanced through all equipment and coils by means of pressure drop. Obtain curves from the various manufacturers indicating the relationship between flow and pressure drop through the coils and equipment. Readings shall be taken on calibrated test gauges. Submit curves with the final report.

H. Upon completion of the water balance, reconcile the total heat transfer through all coils by recording the entering and leaving water temperatures and the entering and leaving air dry bulb and wet bulb temperatures.

I. Upon completion of balancing adjust all differential bypasses and three-way valve bypasses for the same pressure drop or full bypass as on full flow.

END OF SECTION 23 05 93

SECTION 23 07 00 - MECHANICAL INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 - Basic Mechanical Requirements

Division 23 - Section 230548 - Vibration controls for HVAC, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. Piping Insulation.

B. Ductwork Insulation and Lining.

C. Equipment Insulation.

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, k-value thickness, and furnished accessories for each mechanical system requiring insulation.

B. Maintenance Data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product in maintenance manual.

1.04 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of mechanical insulation products of types and manufacturer's qualifications sizes required, whose products have been in satisfactory use in similar service for not less than ten years.

B. Installer's Qualifications: A firm with at least ten years successful installation experience on projects with piping and ductwork insulation similar to that required for this project.

C. Flame/Smoke Ratings: All insulation shall have composite (including insulation jacket or facing and adhesive) fire and smoke hazard ratings as tested by procedure ASTM E-84, NFPA 255 and UL 723 not exceeding:

1.	Flame Spread	25
2.	Smoke Developed	50
3.	Fuel Contributed	50

D. Accessories such as adhesives, mastics, cements, tapes, and cloths for fittings shall have component ratings as listed above. All products shall bear UL labels.

E. Provide certifications or other data as necessary to show compliance with these Specifications and governing regulations. Include proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation and remove it from project site.

B. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory fabricated containers with the manufacturer's stamp, or label, affixed showing fire hazard ratings of the products.

C. Store insulation in original wrappings and protect from weather and construction traffic.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

1. Owens-Corning Fiberglass Corporation.

2. Armstrong World Industries Incorporation.

3. Certainteed Corporation.

4. Manville Products Corporation.

5. Pittsburgh Corning Corporation.

6. Knauf Fiberglass

2.02 INSULATION MATERIAL

A. Type A: Insulation shall be glass fiber with a maximum K factor of 0.23 at 75 degrees F. mean temperature with factory -applied all service vapor jacket. Density shall be not less than 3 lbs. per cubic foot as made by Owens-Corning Fiberglass Corp.

B. Type B: Flexible duct insulation with vapor barrier shall be 1 lb. per cu. ft. density glass fiber with a maximum K factor of 0.29 at 75 deg. F. mean temperature, with reinforced foil-faced, flame resistant kraft vapor barrier duct wrap insulation FRK-25, T 100 as made by Owens-Corning.

C. Type C: Rigid duct insulation with vapor barrier shall be 6 lbs. per cu. ft. density glass fiber with maximum K factor of 0.22 at 75 deg. F. mean temperature with fire retardant foil laminate vapor barrier facing all service jacket Owens-Corning Type 705 with ASJ 25 jacket.

D. Type D: Phenolic foam, chemically neutral; 'k' value of 0.24 at 75 degrees F.

E. Type E: Hydrous Calcium Silicate, rigid molded pipe or rigid molded block, asbestos free coded throughout material thickness and maintained throughout temperature range 'K' value 0.40 at 300 degrees F, Manville Thermo-12/Blue meeting ASTM C533.

2.03 INSULATION PIPING ACCESSORIES

A. Aluminum Jackets: ASTM B209; 0.016-inch thick, smooth finish.

B. Stainless Steel Jackets: Type 304 [316] stainless steel; 0.010 inch thick; smooth finish.

C. Metal Jacket Bands: 3/8 inch wide; 0.010-inch thick stainless steel.

D. PVC Valve and Fittings Covers: Zeston.

E. Tape: Vapor barrier, pressure sensitive.

F. Adhesive: Vapor barrier, compatible with insulation.

G. Glass Cloth: Untreated glass fiber, 9-oz./sq. yd. weight.

2.04 Not used.

2.05 EQUIPMENT ACCESSORIES

A. Bedding Compounds: Non-shrinking, permanently flexible, compatible with insulation.

B. Vapor Barrier Cement: Non-flammable, fire resistant, polymeric resin, compatible with insulation.

C. Equipment Fasteners: Corrosive-resistant metal.

D. Steel: Galvanized sheet, G60 or G90 finish, ASTM A525.

2.06 DUCTWORK ACCESSORIES

A. Adhesive: Waterproof fire-retardant type.

B. Lagging Adhesive: Fire resistive.

C. Impale Anchors: Galvanized steel, 12-gauge and self-adhesive pad.

D. Duct Tape: UL rated flame retardant, self-sealing, foil scrim Kraft laminate, vapor barrier, 3 inch wide.

E. Mastic: UL 723, I-C 551 VI-AC (Insul-Coustic).

F. Glass Cloth: Glass fiber cloth, 9-oz./ sq. yd.

2.07 MISCELLANEOUS ACCESSORIES

A. Insulating Cement: ANSI/ASTM C195; hydraulic setting mineral wool.

B. Finishing Cement: ASTM C449.

C. Tie Wire: Annealed steel, 16-gauge.

D. Wire Mesh: Corrosive-resistant metal, hexagonal pattern.

E. Foam Adhesive: Armstrong 520.

F. Foam Finish: Armstrong Armaflex finish.

2.08 PIPING INSUALTION SCHEDULE

A. Piping System Type — Insulation Thickness

1. Chilled Water Supply & Return		
Up to 4"	A	1"
Above 4"	A	1-1/2"
2. Chemical Treatment		
(Hot Water, Chilled Water)	A	1"
3. Refrigerant Suction (Below 40 F)		
Up to 2-1/2"	D	1-1/2"
Above 2-1/2"	D	2"
4. Cold Water Make-ups and Air Conditioning		
Unit Drains		
Up to 2"	A	1/2"
Above 2"	A	1"
5. Hot Water Supply and Return		
(Below 249 Degrees F.)		

Up to 2"		A	1-1/2"
2-1/2" and above	A		2"

6. Dual Temperature Supply and Return (Below 249°F)

Up to 2"		A	1-1/2"
2-1/2" and above	A		2"

2.09 Not used.

2.10 DUCTWORK INSULATION SCHEDULE

Ductwork	Type	Insulation Thickness
1. Unlined Supply air ductwork	B/C (Note 1, Note 2)	1-1/2"
2. Return air ductwork (Exposed to outside)	C (Note 2)	1-1/2"
3. Outdoor air ductwork	B/C (Note 1, Note 3)	2-1/2"
4. Outdoor air plenums	B/C (note 1)	2-1/2"
5. Blank-out panels at louvers	B	2"
6. General exhaust air ductwork	N/A	N/A

Notes:

1. Use Type B when concealed and Type C when exposed to view.
2. Weather Protective Coating for ductwork and piping exposed to outside.
   a. Externally Insulated Ductwork and Dual Temperature Water Piping:
   b Apply tack coat of mastic over insulation. Embed one layer of ‘ Duramesh Glass Fab’ open mesh glass cloth with 3-inch overlap at seams. Smooth out wrinkles and apply 1/8-inch coat of ‘ Childers’ or ‘ Fosters’ white cement coating over entire surface.

c. Internally Lined or Non-Insulated Ductwork: Apply cement coating and glass cloth to metal surfaces as specified for externally insulated ductwork.

d. All exposed to outside Dual Temperature Water Piping shall be additionally provided with Aluminum Jackets.

2.11 EQUIPMENT INSULATION SCHEDULE

	Equipment	Type	Insulation Thickness
1.	Air Separators	C	2"
2.	Expansion Tanks	C	2"
3.	Dual Temperature Pump Bodies	C (See 3.03E)	2"

PART 3 - EXECUTION

3.01 GENERAL

A. Install insulation after piping and ductwork has been pressure tested accepted.

B. Install insulation after heat tracing has been installed and accepted.

C. Clean surfaces for adhesives.

D. Install materials on clean, dry surface in accordance with manufacturer's instructions.

3.02 PIPING INSULATION

A. Do not insulate chrome plated piping.

B. Continue insulation with vapor barrier through pipe supports, hangers and sleeves.

C. Where piping is exposed to view in finished spaces, position and cover seams in least visible locations.

D. Insulate joints, fittings, valves, unions, flanges, strainers, flexible connections and expansion joints with insulation of like material and thickness as adjoining pipe and

finish with glass cloth and adhesive. The contractor has the option to use zeston pipe fitting covers up to 4" pipe sizes.

E. Where glass fiber insulation is applied to piping subject to condensation, seal longitudinal laps of jackets with adhesive and wrap butt joints with 2-inch tape.

F. Where pre-molded PVC fitting covers are used; apply multiple layers of insulation until cover is tightly packed. Hot piping covers may be initially secured with stainless steel serrated tacks. Seal the seam edges of cold piping covers with adhesive. Secure hot and cold piping covers by taping the ends to the adjacent insulation.

G. Provide an insert, not less than 12 inches long, of same thickness and contour as adjoining insulation, between support (type 40) shield and piping, but under the finish jacket, to prevent insulation from sagging at support points. Refer to Section 230529. Use cork inserts or other heavy density insulating material suitable for the planned temperature range. Factory fabricated inserts may be used.

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

I. Jackets - Indoors, Exposed to View: For pipe exposed in mechanical equipment Rooms or in finished spaces insulate piping with vapor barrier jackets factory applied.

3.03 EQUIPMENT INSULATION

A. Do not insulate factory-insulated equipment.

B. Do not insulate over nameplate or ASME stamps. Bevel and seal the insulation around these items.

C. Apply insulation as close as possible to equipment by grooving, scoring, and beveling, if required. Secure insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

D. When equipment with insulation requires periodic opening for maintenance, repair or cleaning, install insulation in such manner that it can be easily removed and replaced without damage.

E. HVAC Base Mounted Pumps: Construct minimum 20 gauge steel box section enclosures for pump. Insulate enclosure with permanently attached, rigid board insulation in thickness specified for fluid served. Form enclosure in separate mating sections for split case pumps with mating flange coinciding with the ump casing split.

3.04 DUCTWORK INSULATION

A. Where dampers have elevated regulators and access doors have outer flanges, install insulation between duct and regulator or flange.

B. Construct box sections of Type C insulation for coil headers and return bends in duct-mounted coils. Continue scheduled insulation over coil frame surfaces not requiring box sections.

C. Insulation (Type B) Application:

1. Cut insulation in lengths to provide a minimum staple lap of 3 inches.

2. Adhere insulation to ductwork with 100 percent adhesive coverage. Except where spacing around ductwork will not permit installation of mechanical fasteners, in addition to adhesive, secure insulation to underside of ductwork with mechanical fasteners on 12 inch centers when bottom dimension is 18 inches or larger.

3. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

4. Seal jacket joints, staple seams, and penetrations with tape.

D. Insulation (Type C) Application:

1. Secure insulation to ductwork with mechanical fasteners located 12-inch o.c. Install insulation with edges tightly butted. Stop and point insulation around access doors and damper operators to allow operation without disturbing the insulation. Seal fastener penetration of vapor barrier with vapor barrier adhesive.

2. Where spacing around ductwork will not permit installation of mechanical fasteners, secure insulation with 100 percent coverage adhesive and wires spaced 6 inches.

Provide metal corner pieces to prevent damage to insulation by wires at duct corners. Use mechanical fasteners on all other adjoining surfaces.

3. Provide minimum 1/2-inch thick insulation over mechanical joints, reinforcement angles and stiffeners.

4. Seal butted joints, penetrations by mechanical fasteners and all other vapor barrier penetrations with tape.

5. Use 6-lb/cu. ft. density insulation on horizontal areas, which may be subject to damage from personnel traffic.

E. Insulation (Type E) Application:

1. Insulation shall be securely banded in place, tightly butted, joints staggered and secured with 16 gauge galvanized or stainless steel wire or 1/2" x0.015" galvanized steel bands on 12" maximum centers for large areas. For round ducts use tie wire 16 gauge stainless steel with twisted ends on maximum 12 " centers.

F. Not used.

3.05 EXISTING INSULATION REPAIR

A. Repair damaged sections of existing mechanical insulation, both previously damaged or damaged during this construction period. Use insulation of same thickness as existing insulation, install new jacket lapping and sealed over existing.

3.06 PROTECTION AND REPLACEMENT

A. Replace damaged insulation, which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

END OF SECTION 23 07 00

SECTION 23 09 23 - Building management controls system

PART 1 – GENERAL

1.1 SUMMARY

A. Furnish all labor, materials, equipment, and service necessary for a complete and operating Facility Management and Control System (FMCS), utilizing direct digital controls as shown on the drawings and as described herein. Drawings are diagrammatic only. The FMCS shall be capable of total integration of the facility infrastructure systems with user access to all system data either locally, over a secure Intranet within the building or by remote access by a standard Web Browser over the Internet. This shall include HVAC control and all trending, reporting and maintenance management functions related to normal building operations, all as indicated on the drawings or elsewhere in this specification.

B. 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.

1.2 SYSTEM DESCRIPTION

A. The entire Facility Management and Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers communicating on an open protocol communication network. All information from the FMCS shall be available to local computers within the facility via local Intranet and to remote computers, or from multiple facilities via the Internet. The FMCS shall communicate to third party systems and other building management related devices with open, interoperable communication capabilities.

1.3 SUBMITTAL

A. Eight copies of shop drawings of the entire control system shall be submitted and shall consist of a complete list of equipment and materials, including manufacturers catalog data sheets and installation instructions. Shop drawings shall also contain complete wiring and schematic diagrams, software descriptions, calculations, and any other details required to demonstrate that the system has been coordinated and will properly function as a system. Terminal identification for all control wiring shall be shown on the shop drawings. A complete written Sequence of Operation and input/output point list of all connected points to the FMCS system shall be included with the submittal package.

B. Submittal shall also include a system schematic diagram depicting the Full User Interface (FUI) and Browser User Interface (BUI) computers / peripherals, Network Area Controllers (NAC), 3rd party controllers and the networking equipment required to make a complete and functional system.

C. Upon completion of the work, provide an electronic set of ' as-built' drawings, job documentation and application software on magnetic floppy disk media or compact disk. Drawings shall be provided as AutoCAD™ files. Submittal data such as sequence of operation and cut sheets shall be provided in an Adobe Acrobat™ format. Eight printed copies of the ' as-built' drawings shall be provided in addition to the documents on compact disk.

1. Provide all revisions and/or upgrades made to the system software during the one year guarantee warranty period, at no additional cost to the Owner.

1.4 AGENCY AND CODE APPROVALS

A. All products of the FMCS 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. ULC; UL - Canadian Standards Association

3. FCC, Part 15, Subpart J, Class A Computing Devices

1.5 SOFTWARE

A. Controls contractor shall provide all password including but not limited to administrative and system level password for full unrestricted access to the software programs installed under this contract.

1.6 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.

1.7 JOB CONDITIONS

A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to insure 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.

1.8 QUALITY ASSURANCE

A. The Manufacturer of the FMCS digital controllers shall provide documentation supporting compliance with ISO-9001 (Model for Quality Assurance in Design/Development, Production, Installation and Servicing). Product literature provided by the FMCS digital controller manufacturer shall contain the ISO-9001 Certification Mark from the applicable registrar.

1.9 SPECIFICATION NOMENCLATURE

A. Acronyms used in this specification are as follows:

1. FMCS Facility Management and Control System
2. NAC Network Area Controller
3. IDC Interoperable Digital Controller
4. IBC Interoperable BACnet Controller
5. FUI Full User Interface
6. BUI Browser User Interface
7. DDC Direct Digital Controls
8. LAN Local Area Network
9. PICS Product Interoperability Compliance Statement

PART 2 - MATERIALS

2.1 MANUFACTURERS

A. Basis of Design is Schneider Electric IA Series as furnished and installed by TBS Controls, LLC located in Allendale, NJ. Phone number: 201-327-9500

B. Approved manufacturers:

i. Schneider Electric
ii. Automated Logic
iii. Johnson Controls

2.2 GENERAL

A. The Facility Management Control System (FMCS) shall be comprised of a network of interoperable, stand-alone digital controllers, a computer system, web based graphical user interface software, printers, network devices and other devices as specified herein.

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

C. The desktop computer for owner interface shall be located in the facility director' s office or as directed by Director of Facilities. Coordinate final location of workstation. Provide 120 volt power and data connection (Static IP address by others)

2.3 OPEN, INTEROPERABLE, INTEGRATED ARCHITECTURES

A. The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system with the capability to integrate both the ANSI/ASHRAE Standard 135-1995 BACnet and LonWorks technology communication protocols in one open, interoperable system.

B. The programming computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. In addition, adherence to industry standards including ANSI / ASHRAE™ Standard 135-1995, BACnet and LonMark to assure interoperability between all system components is required. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device. For each BACnet device, the device supplier must provide a PICS document showing the installed device' s compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet.

C. All components and controllers supplied under this contract shall be true " peer-to-peer" communicating devices. Components or controllers requiring " polling" by a host to pass data shall not be acceptable.

D. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database or proprietary user interface programs shall not be acceptable.

E. A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a " flat" single tiered architecture shall not be acceptable.

1. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.

2. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

2.4 NETWORKS

A. The Local Area Network (LAN) shall be either a 10 or 100 Megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and CORBA IIOP for maximum flexibility for integration of building data with enterprise information systems and providing support for multiple Network Area Controllers (NACs), Browser User Interfaces (BUIs) and/or Full User Interfaces (FUIs).

B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE standard 802.3

2. Cable; 10 Base-T, UTP-8 wire, category 5

3. Minimum throughput; 10 Mbps, with ability to increase to 100 Mbps

2.5 NETWORK ACCESS

A. Remote Access.

1. For Local Area Network installations, provide access to the LAN from a remote location, via the Internet. The owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line, T1 Line or via the customer' s Intranet to a corporate server providing access to an Internet Service Provider (ISP). Owner agrees to pay monthly access charges for connection and ISP.

2. Where no Local Area Network exists, FMCS supplier shall provide the following:

a. 8 Port Ethernet hub (3Com, or equal)

b. Ethernet router (Cisco or equal)

3. The owner shall provide a connection to the Internet to enable this access via high-speed cable modem, asynchronous digital subscriber line (ADSL) modem, ISDN line or T1 Line. Owner agrees to pay monthly access charges for connection and ISP

2.6 NETWORK AREA CONTROLLER (NAC)

A. The Network Area Controller (NAC) shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the NAC. It must be capable of seamless, simultaneous interface and integration with the following protocols: Ethernet, LON, BACnet, Modbus, ASD (Barber Colman N-8000). Communication gateways are not acceptable. The NAC shall be capable of executing application control programs to provide:

1. Calendar functions

2. Scheduling

3. Trending

4. Alarm monitoring and routing

5. Time synchronization

6. Integration of LonWorks controller data and BACnet controller data

7. Network Management functions for all LonWorks based devices

B. The Network Area Controller must provide the following hardware features as a minimum:

1. One Ethernet Port -10 / 100 Mbps

2. One RS-232 port

3. One LonWorks Interface Port – 78KB FTT-10A

4. Battery Backup

5. Flash memory for long term data backup (If battery backup or flash memory is not supplied, the controller must contain a hard disk with at least 1 gigabyte storage capacity)

6. The NAC must be capable of operation over a temperature range of 0 to 55° C

7. The NAC must be capable of withstanding storage temperatures of between 0 and 70° C

8. The NAC must be capable of operation over a humidity range of 5 to 95% RH, non-condensing

C. The NAC shall provide multiple user access to the system and support for ODBC or SQL. A database resident on the NAC shall be an ODBC-compliant database or must provide an ODBC data access mechanism to read and write data stored within it.

D. The NAC shall support standard Web browser access via the Intranet/Internet. It shall support a minimum of 16 simultaneous users.

E. Event Alarm Notification and actions

1. The NAC shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.

2. The NAC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.

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 for the creation of an unlimited number of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc.

5. Provide timed (schedule) routing of alarms by class, object, group, or node.

6. 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.

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

G. Alarms shall be annunciated in any of the following manners as defined by the user:

1. Screen message text

2. Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:

a. Day of week

b. Time of day

c. Recipient

3. Pagers via paging services that initiate a page on receipt of email message

4. Graphic with flashing alarm object(s)

5. Printed message, routed directly to a dedicated alarm printer

H. The following shall be recorded by the NAC for each alarm (at a minimum):

1. Time and date

2. Location (building, floor, zone, office number, etc.)

3. Equipment (air handler #, accessway, etc.)

4. Acknowledge time, date, and user who issued acknowledgement.

5. Number of occurrences since last acknowledgement.

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

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

K. A log of all alarms shall be maintained by the NAC and/or a server (if configured in the system) and shall be available for review by the user.

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

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

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

2.7 DATA COLLECTION AND STORAGE

A. The NAC 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 NAC that shall have, at a minimum, the following configurable properties:

1. Designating the log as interval or deviation.

2. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.

3. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.

4. 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.

5. Each log 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 a relational database in the NAC and the data shall be accessed from a server (if the system is so configured) or a standard Web Browser.

D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.

E. 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

F. Systems that do not provide log data in HTML and XML formats at a minimum shall not be acceptable.

G. The NAC shall have the ability to archive its log data either locally (to itself), or remotely to a server or other NAC on the network. Provide the ability to configure the following archiving properties, at a minimum:

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 it' s user-defined capacity of data stores

4. Provide ability to clear logs once archived

2.8 AUDIT LOG

A. Provide and maintain an Audit Log that tracks all activities performed on the NAC. 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 NAC), to another NAC 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.

2.9 DATABASE BACKUP AND STORAGE

A. The NAC 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 NAC. The age of the most recently saved database is dependent on the user-defined database save interval.

C. The NAC database shall be stored, at a minimum, in XML format to allow for user viewing and editing, if desired. Other formats are acceptable as well, as long as XML format is supported.

2.10 INTEROPERABLE DIGITAL CONTROLLER (IDC)

A. Controls shall be microprocessor based Interoperable LonMark™ or LonWorks Controllers (IDC). Where possible, all Interoperable Digital Controllers shall bear the applicable LonMark™ interoperability logo on each product delivered. In general, all controllers must be native LON. Gateways are not acceptable.

B. HVAC control shall be accomplished using LonMark™ based devices where the application has a LonMark profile defined. Where LonMark devices are not available for a particular application, devices based on LonWorks shall be acceptable. For each LonWorks device that does not have LonMark certification, the device supplier must provide an XIF file for the device. Publicly available

specifications for the Applications Programming Interface (API) must be provided for each LonWorks / LonMark controller defining the programming or setup of each device. All programming, documentation and programming tools necessary to set up and configure the supplied devices per the specified sequences of operation shall be provided.

C. The LonWorks network trunk shall be run to the nearest Network Area Controller (NAC). A maximum of 126 devices may occupy any one LonWorks trunk and must be installed in buss architecture using the appropriate trunk termination device. All LonWorks and LonMark devices must be supplied using FTT-10A LonWorks communications transceivers.

D. The Network Area Controller will provide all scheduling, alarming, trending, and network management for the LonMark / LonWorks based devices.

E. The IDCs shall communicate with the NAC at a baud rate of not less than 78.8K baud. The IDC shall provide LED indication of communication and controller performance to the technician, without cover removal.

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

G. The supplier of any programmable IDC shall provide one copy of the manufacturer's programming tool, with documentation, to the owner.

2.11 INTEROPERABLE BACNET CONTROLLER (IBC)

A. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the ANSI/ASHRAE Standard 135-1995. IBCs shall be provided for Unit Ventilators, Fan Coils, Heat Pumps, Variable Air Volume (VAV) Terminals and other applications as shown on the drawings. The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals. The system supplier must provide a PICS document showing the installed systems compliance level to the ANSI/ASHRAE Standard 135-1995. Minimum compliance is Level 3. . In general, all controllers must be native BACnet. Gateways are not acceptable.

B. The IBC' s shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.

C. The IBC Sensor shall connect directly to the IBC and shall not utilize any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC Sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC Sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.

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

2.12 FULL USER INTERFACE SOFTWARE

A. Operating System:

1. The FUI shall run on Microsoft Windows NT Workstation 4.0, Service Pack 4 or later.

B. The FUI shall employ browser like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are 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 FUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating a GIF, BMP, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the FUI 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.

a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

5. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

6. Adjustments to analog objects, such as set points, shall be done by right-clicking the selected object and using a graphical slider to adjust the value. No entry of text shall be required.

D. System Configuration. At a minimum, the FUI shall permit the operator to perform the following tasks, with proper password access:

1. Create, delete or modify control strategies.

2. Add/delete objects to the system.

3. Tune control loops through the adjustment of control loop parameters.

4. Enable or disable control strategies.

5. Generate hard copy records or control strategies on a printer.

6. Select points to be alarmable and define the alarm state.

7. Select points to be trended over a period of time and initiate the recording of values automatically.

E. On-line Help. Provide a context sensitive, on-line help system to assist the operator in operation and editing of the system. On-line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext. All system documentation and help files shall be in HTML format.

F. On-line Documentation. Provide a context sensitive, on-line documentation system to assist the operator in operation and trouble shooting of each integrated system. On-line help shall be available for all applications and shall provide the relevant data for that particular monitoring screen. As a minimum, provide a link to the Sequence of Operation, input/output summary, and cut sheets in either Adobe Acrobat™ or HTML format.

G. Security. Each operator shall be required to log on to that system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

H. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.

I. 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 supercede 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.

2.13 BROWSER USER INTERFACE SOFTWARE

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

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

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

D. The Web browser client shall support at a minimum, the following functions:

1. User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.

2. Graphical screens developed for the FUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the FUI shall be supported by the Web browser interface.

3. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.

4. Storage of the graphical screens shall be in the Network Area Controller (NAC), without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.

5. Real-time values displayed on a Web page shall update automatically without requiring a manual " refresh" of the Web page.

6. Users shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:

a. Modify common application objects, such as schedules, calendars, and set points in a graphical manner.

1) Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.

2) Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.

b. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.

c. View logs and charts

d. View and acknowledge alarms

7. The system shall provide the capability to specify a user' s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to a pre-defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.

8. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator (URL) for the desired link.

2.14 SERVER FUNCTIONS AND HARDWARE

A. A central server shall be provided. The server shall support all Network Area Controllers (NAC) connected to the customer' s network whether local or remote.

B. Local connections shall be via an Ethernet LAN. Remote connections can be via ISDN, ADSL, T1 or dial-up connection.

C. It shall be possible to provide access to all Network Area Controllers via a single connection to the server. In this configuration, each Network Area Controller can be accessed from the Full User Interface (FUI) or from a standard Web browser (BUI) at the server.

D. The server shall provide the following functions, at a minimum:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.

2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any NAC in the network, local or remote.

3. The server shall include a master clock service for its subsystems and provide time synchronization for all Network Area Controllers (NAC).

4. The server shall accept time synchronization messages from trusted precision Atomic Clock Internet sites and update its master clock based on this data.

5. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.

6. The server shall provide demand limiting that operates across all Network Area Controllers. The server must be capable of multiple demand programs for sites with multiple meters and/or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.

7. The server shall implement the BACnet Command Prioritization scheme (16 levels) for safe and effective contention resolution of all commands issued to Network Area Controllers. Systems not employing this prioritization shall not be accepted.

8. Each Network Area Controller supported by the server shall have the ability to archive its log data, alarm data and database to the server, automatically. Archiving options shall be user-defined including archive time and archive frequency.

9. The server shall provide central alarm management for all Network Area Controllers supported by the server. Alarm management shall include:

a. Routing of alarms to display, printer, email and pagers

b. View and acknowledge of alarms

c. Query alarm logs based on user-defined parameters

10. The server shall provide central management of log data for all Network Area Controllers supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:

a. Viewing and printing log data

b. Exporting log data to other software applications

c. Query log data based on user-defined parameters

E. Server Hardware Requirements: The server hardware platform shall have the following requirements:

1. The computer basis of design shall be a Dell Optiplex 7010MT shall be an Intel Pentium 4 based computer with 8 GB memory and a 500-gigabyte minimum hard drive. It shall include a 16X CD-ROM/DVD ROM, 2-parallel ports, 2-asynchronous serial ports and 4-USB ports. Provide a minimum 19" flat screen color monitor.

2. The server operating system shall be the latest version of Microsoft. Include latest addition of Microsoft Internet Explorer, Microsoft Word and Excel.

3. Connection to the FMCS network shall be via an Ethernet network interface card, 10 or 100 Mbps.

4. A system printer shall be provided. Printer shall be ink jet type with a minimum 9600 x 2400 dpi resolution and rated for 9 PPM color print speed minimum.

2.15 SYSTEM PROGRAMMING

A. The Full User Interface software (FUI) shall provide the ability to perform system programming and graphic display engineering as part of a complete software package. Access to the programming functions and features of the FUI shall be through password access as assigned by the system administrator.

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

C. Programming Methods

1. Provide the capability to copy objects from the supplied libraries, or from a user-defined library to the user' s application. Objects shall be linked by a graphical linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-

to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; i.e., internal, external, hardware, etc.

2. Configuration of each object will be done through the object' s property sheet using fill-in the blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration will not be accepted.

3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.

4. All programming shall be done in real-time. Systems requiring the uploading, editing, and downloading of database objects shall not be allowed.

5. The system shall support object duplication within a customer' s database. An application, once configured, can be copied and pasted for easy re-use and duplication. All links, other than to the hardware, shall be maintained during duplication.

2.16 OBJECT LIBRARIES

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

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

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

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

E. The object library shall include objects to support the integration of devices connected to the Network Area Controller (NAC). At a minimum, provide the following as part of the standard library included with the programming software:

1. LonMark/LonWorks devices. These devices shall include, but not be limited to, devices for control of HVAC, lighting, access, and metering. Provide LonMark manufacturer-specific objects to facilitate simple integration of these devices. All network variables defined in the LonMark profile shall be supported. Information (type and function) regarding network variables not defined in the LonMark profile shall be provided by the device manufacturer.

2. For devices not conforming to the LonMark standard, provide a dynamic object that can be assigned to the device based on network variable information provided by the device manufacturer. Device manufacturer shall provide an XIF file and documentation for the device to facilitate device integration.

3. For BACnet devices, provide the following objects at a minimum:

a. BACnet AI

b. BACnet AO

c. BACnet BI

d. BACnet BO

e. BACnet Device

4. For each BACnet object, provide the ability to assign the object to a BACnet device and object' s instance number.

2.17 LONWORKS NETWORK MANAGEMENT

A. The Full User Interface software (FUI) shall provide a complete set of integrated LonWorks network management tools for working with LonWorks networks. These tools shall manage a database for all LonWorks devices by type and revision, and shall provide a software mechanism for identifying each device on the network. These tools shall also be capable of defining network data connections between

LonWorks devices, known as " binding" . Systems requiring the use of third party LonWorks network management tools shall not be accepted.

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

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

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

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

2.18 DDE DEVICE INTEGRATION

A. The Network Area Controller shall support the integration of device data via Dynamic Data Exchange (DDE), over the Ethernet Network. The Network Area Controller shall act as a DDE client to another software application that functions as a DDE server.

B. Provide the required objects in the library, included with the Full User Interface programming software, to support the integration of these devices into the FMCS. Objects provided shall include at a minimum:

1. DDE Generic AI Object
2. DDE Generic AO Object
3. DDE Generic BO Object
4. DDE Generic BI Object

2.19 OTHER CONTROL SYSTEM HARDWARE

A. Motorized Control Dampers: Dampers shall be constructed of galvanized steel, with nylon bearings. Blade edge and tip seals shall be included for all dampers. Blades shall be 16-gauge minimum and 6 inches wide maximum and frame shall be of welded channel iron. Dampers with both dimensions less than 18 inches may have strap iron frames. Ruskin CD-46 or Equal. Exterior Application: Provide dampers with thermally broken jambs and insulated blades if in communication with exterior.

1. The controls contractor shall supply all motorized dampers within the scope of this project, including but not limited to the Energy Recovery Unit (ERU) exhaust ducts, Exhaust Fans (EF) and Intake Hoods, refer to specification section ' 230993 Sequences of Operation' .

2. Control Damper & Valve Actuators: Two-position or proportional electric actuators shall be direct-mount type. All actuators shall be spring return type. Provide one actuator per damper minimum. Actuators shall be sized to provide a minimum of 5 in-lb torque per square foot of damper area and shall include positive positioning pneumatic relays when sequenced with other actuators or when control action is to be proportional.

3. The controls contractor shall coordinate provision of damper operators on all equipment provided with factory supplied dampers.

B. Control Valves: Control valves shall be 2-way or 3-way pattern as shown constructed for tight shutoff and shall operate satisfactorily against system pressures and differentials. 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). Valves with sizes up to and including 2 inches shall be " screwed" configuration and 2-1/2 inch and larger valves shall be " flanged" configuration. Electrically controlled valves shall include spring return type actuators sized for tight shut-off against system pressures and furnished with integral switches for indication of valve position (open-closed). Pneumatic actuators for valves, when utilized, shall be sized for tight shut-off against system pressures. Three-way butterfly valves, when utilized, shall include a separate actuator for each butterfly segment.

C. Wall Mount Room Thermostats: Each room thermostat shall provide temperature indication to the digital controller, provide the capability for a software-limited set point adjustment and operation override capability.

1. Corridors, toilet rooms and stairwells shall be provided with temperature sensors only, no temperature indication. Setpoints and room temperatures shall be accessible through the FMCS only.

2. Where indicated on the drawings provide a tamper resistant metal guard over the thermostat, removable with a key or tool.

D. Duct Mount, Pipe Mount and Outside Air Temperature Sensors: 10,000-ohm thermistor temperature sensors with an accuracy of ± 0.2°C. Outside air sensors shall include an integral sun shield.

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. Current switch to include an integral LED for indication of trip condition and a current level below trip set point.

F. Air Flow Meters:

1. Provide airflow measurement devices where indicated on the plans and as indicated by device manufacturer to maintain cataloged performance. Install flow measurement devices as deemed possible by construction as recommended by device manufacturer. Desired locations are in straight run of duct, in duct ahead of control damper, upstream of control damper.

2. Duct and plenum mounted sensors shall be fabricated of anodized aluminum alloy tube with 303/304 stainless steel mounting brackets.

3. Each measuring device shall consist of one or more multi-point measuring probes and a single microprocessor-based transmitter. Each transmitter shall have an LCD display capable of displaying airflow and temperature. Airflow shall be field configurable to be displayed as a velocity or volumetric rate. Each transmitter shall operate on 24 VAC.

4. Each sensing point shall independently determine the airflow rate and temperature, which shall be equally weighted and averaged by the transmitter prior to output.

5. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location. Probes and transmitters shall not require field matching for proper operation.

6. The operating temperature range for the measuring probes shall be -20° F to 140° F. The operating humidity range for the measuring probe shall be 0-99% RH (non-condensing).

7. The operating temperature range for the transmitter shall be -20° F to 120° F. The transmitter shall be protected from weather and water.

8. Each independent airflow sensor shall have a laboratory accuracy of +/-2% of reading over the entire operating airflow range and be wind

tunnel calibrated or verified against standards that are traceable to NIST.

9. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

10. The number of sensors for each location shall be as follows:

a. Ducts and plenums:

Area (sq.ft.)	Sensors
<= 1	2
>1 to <4	4
4 to <8	6
8 to <12	8
12 to <16	12
>=16	16

11. The airflow/temperature measuring device shall be capable of displaying the airflow and temperature readings of each sensor on the transmitter's LCD display.

12. The transmitter shall be capable of communicating with the host controls using the following interface options:

a. Linear analog output signal: Field selectable, fuse protected and isolated, 0-10VDC and 4-20mA (4-wire)

b. RS-485: Field selectable ModBus-RTU and Johnson Controls N2 Bus

c. 10 Base-T Ethernet: Field selectable ModBus TCP and TCP/IP

d. LonWorks Free Topology

e. Airflow/Temperature measuring devices shall be UL listed as an entire assembly.

f. The manufacturer' s authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer' s placement requirements.

g. As manufactured by Ebtron Inc., or approved equal.

G. 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.

PART 3 - EXECUTION

INSTALLATION

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

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

Drawings of temperature control systems are diagrammatic only and any apparatus not shown, such as relays, accessories, etc., but required to make the system operative to the complete satisfaction of the Architect shall be furnished and installed without additional cost.

Line and low voltage electrical connections to control equipment shown specified or shown on the control diagrams shall be furnished and installed by the Temperature Control sub-contractor in accordance with these specifications.

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 the Temperature Control sub-contractor.

All control devices mounted on the face of control panels shall be clearly identified as to function and system served with permanently engraved phenolic labels.

WIRING

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

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

All wiring shall be in accordance with the Project Electrical Specifications (Division 26), the National Electrical Code and any applicable local codes. All FMCS wiring shall be installed in the conduit types specified in the Project Electrical Specifications (Division 26) unless otherwise allowed by the National Electrical Code or applicable local codes. FMCS plenum rated cable wiring is allowed above accessible ceilings. It shall be run parallel to or at right angles to the structure, properly supported and installed in a neat and workmanlike manner. All FMCS wiring in Mechanical Equipment Rooms shall be installed in ¾" conduit or larger with compression fittings.

WARRANTY

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

Within this period, upon notice by the Owner, any defects in the FMCS due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by the Temperature Control sub-contractor at no expense to the Owner.

WARRANTY ACCESS

The Owner shall grant to the Temperature Control sub-contractor, reasonable access to the FMCS during the warranty period. The owner shall allow the contractor to access the FMCS from a remote location for the purpose of diagnostics and troubleshooting, via the Internet, during the warranty period.

ACCEPTANCE TESTING

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

The Temperature Control sub-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.

Upon completion of the performance tests described above, repeat these tests, point by point as described in the validation log above in presence of Owner's Representative, as required. Properly schedule these tests so testing is complete at a time directed by the Owner's Representative. Do not delay tests so as to prevent delay of occupancy permits or building occupancy.

System Acceptance: Satisfactory completion is when the Temperature Control sub-contractor has 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.

Coordinate efforts required for commissioning process with commissioning authority and owner' s representative.

OPERATOR INSTRUCTION, TRAINING

General

Owner training shall be executed in three phases. The first phase shall be provided off site at a Local Training Center and will be scheduled at a time immediately preceding owner acceptance. The purpose of this training is to provide an introduction and an overview of the FMCS. Completion of this training shall be a condition of system acceptance and the commencement of the Warrantee Period. The second phase of training shall take place at the actual customer job site and will at a minimum include a site-specific walk through and hands on site-specific instruction. The third phase of training shall be again provided off site at the Local Training Center as a follow-up and enrichment to the introductory and site specific training. A proposed training agenda will be submitted to the engineer in writing, and approved by the engineer before training takes place. All and materials shall be supplied for three trainees to be selected by the owner.

Coordinate efforts required for commissioning with commissioning authority and owner's representative.

Phase I – Training (This phase of training shall be a minimum of 16 hours for 8 people) This training will give the operator with little or no experience with the FMCS an introduction to:

Building automation fundamentals

System architecture and functions

System access using FUI software and BUI software

Basic concepts for OOT programming

Editing parameters such as set points and schedules

Day to day system monitoring techniques

Phase II - On-Site Training (This phase of training shall be a minimum of 8 hours for 8 people) Site personal and operators shall become familiar and proficient with:

Using As-Built documentation-Sequence of operation, control drawings, Input / Output summaries

Field sensor and actuator location and maintenance

Field controller location and maintenance

System architecture and functions as they pertain to the site

FUI and BUI hardware operation and maintenance

FUI and BUI software site specific capabilities

Phase III – Training (This phase of training shall be a minimum of 16 hours for 8 people) Building operators will become qualified using hands-on labs for:

Monitoring and making changes to a preprogrammed FMCS

Understanding the PC and windows environment

Using the Browser tools to navigate BUI functions

Using graphic floor plans and equipment screens

Changing point values such as set points, schedules, and overrides

Retrieving trend reports and graphs

Acknowledging exceptions and alarms.

The training room shall be clean, well lit, well ventilated and isolated from noise (including HVAC noise) and other distractions. The Contractor shall arrange, via delamping, covering fixtures or by light switches, for there to be adequate contrast lighting to take notes and fend off drowsiness.

Instructor shall employ an LCD panel, video projector or other suitable device to project large images of the EMS software and/or other training images.

Printed training materials shall be tailored to the task at hand and shall be well illustrated. Materials shall take students through the steps of learning the EMS and its software and shall provide sample exercises for the trainees to perform on the computers.

Training must steer clear of jargon and other confusing terminology and focus instead on learning how to use the system. Specific jargon may be addressed after the trainees have demonstrated a basic understanding of system operation.

Training shall involve actual field-type equipment using a training demonstration package that simulates real-time temperatures, settings, alarms, etc. Training shall also spend substantial time observing the site' s actual system, include point logs, graphics, and alarms. In addition, a brief field visit shall be included to familiarize trainees with the equipment installed at their site.

Training must include quizzes, tests, and exercises that compel trainees to demonstrate understanding of the system' s most important concepts. These concepts shall include, but not be limited to, the elements of a monitoring checklist developed by the site.

END OF SECTION 23 09 23

SECTION 23 21 13 - BASIC PIPING MATERIALS AND METHODS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

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

B. Related Sections:

1. Division 23 Basic Mechanical Requirements section applies to the work at this Section.

2. Piping materials and installation methods peculiar to individual systems are specified within their respective system specification sections of Divisions 2 and 23.

3. Valves are specified in a separate section and in individual piping system sections of Division .

4. Expansion Compensation is specified in a separate section of Division 23.

5. Supports and Anchors are specified in a separate section of Division 23.

6. Mechanical Identification is specified in a separate section of Division 23.

7. Fire Barrier Penetration Seals are specified in Division 7.

8. Vibration controls for HVAC, Electrical and Plumbing

1.02 SECTION INCLUDES

A. This Section specifies piping materials and installation methods common to more than one section of Division 23 and includes joining materials, piping specialties, and basic piping installation instructions.

1.03 SUBMITTALS

A. Refer to Division 1 and Basic Mechanical Requirements for administrative and procedural requirements for submittals.

B. Product Data: Submit product data on the following items:

Escutcheons

Dielectric Unions and Fittings

Mechanical Sleeve Seals

Strainers

C. Quality Control Submittals:

1. Submit welders' certificates specified in Quality Assurance below.

1.04 QUALITY ASSURANCE

A. Welder's Qualifications: All welders shall be qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.

B. Welding procedures and testing shall comply with ANSI Standard B31.1.0 - Standard Code for Pressure Piping, Power Piping, and the American Welding Handbook.

C. Soldering and brazing procedures shall conform to ANSI B9.1 Standard Safety Code for Mechanical Refrigeration.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube , except for concrete, corrugated metal, hub-and-spigot, clay pipe. Maintain end-caps through shipping, storage and handling to prevent pipe-end damage and prevent entrance of dirt, debris, and moisture.

B. Protect stored pipes and tubes. Elevate above grade and enclose with durable, waterproof wrapping. When stored inside, do not exceed structural capacity of the floor.

C. Protect flanges, fittings, and specialties from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproofing wrapping.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer uniformity: Conform with the requirements specified in Basic Mechanical Requirements, under "Product Options"

B. Available Manufacturers: Subject to compliance with requirements, manufacturers offering piping materials and specialties which may be incorporated in the work include, but are not limited to, the following:

C. Manufacturer: Subject to compliance with requirements, provide piping materials and specialties from one of the following:

1. Pipe Escutcheons:

   Chicago Specialty Mfg. Co.

   Sanitary-Dash Mfg. Co.

   Grinnell

2. Dielectric Waterway Fittings:

   Epco Sales, Inc.

   Victaulic Company of America

3. Dielectric Unions:

   Eclipse, Inc.

   Perfection Corp.

   Watts Regular Co.

4. Strainers:

   Armstrong Machine Works.

   Hoffman Specialty ITT: Fluid Handling Div.

   Metraflex Co.

   R-P&C Valve; Div. White Consolidated Industries, Inc.

   Spirax Sarco.

Trane Co.

Victaulic Co. of America. (Low-pressure applications only)

Watts regulator Co.

5. Mechanical Sleeve Seals:

Linkseal Co.

Thunderline Corp.

2.02 PIPE AND FITTINGS

A. Refer to the individual piping system specification sections in Division 23 for specifications on piping and fittings relative to that particular system.

2.03 JOINING MATERIALS

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

1. Brazing Materials: Comply with SFA-5.8, Section II, ASME Boiler and Pressure

B. Vessel Code for brazing filler metal materials appropriate for the materials being joined.

C. Soldering Materials: Refer to individual piping system specifications for solder appropriate for each respective system.

D. Gaskets for Flanged Joints: Gasket material shall be full-faced for cast-iron flanges and raised-face for steel flanges. Select materials to suit the service of the piping system in which installed and which conform to their respective ANSI Standard (A21.11, B16.20, or b16.21). Provide materials that will not be detrimentally affected by the chemical and thermal conditions of the fluid being carried.

2.04 PIPNG SPECIALTIES

A. Escutcheons: Chrome-plated, stamped steel, hinged, split-ring escutcheon, with setscrew. Inside diameter shall closely fit pipe outside diameter, or outside of pipe

insulation where pipe is insulated. Outside diameter shall completely cover the opening in floors, walls, or ceilings.

B. Unions: Malleable -iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and socket joints, metal to metal bronze seating surfaces; female threaded ends.

C. Dielectric Unions: Provide dielectric unions with appropriate end connections for the pipe materials in which installed (screwed, soldered, or flanged), which effectively isolate dissimilar metals, prevent galvanic action, and stop corrosion.

D. Dielectric Waterway Fittings: Electroplated steel or brass nipple, with an insert and non-corrosive, thermoplastic lining.

E. Y- Type Strainers: Provide strainers full line size of connecting matching piping system materials. Screens shall be Type 304 stainless steel, with 3/64" perforations at 233 per square inch.

1. Provide strainers with 125psi working pressure rating for low-pressure applications, and 250psi pressure rating for high-pressure application.

2. Threaded Ends, 2" and Smaller: Cast -iron body, screwed screen retainer with centered blow down fitted with pipe plug.

3. Threaded Ends, 2-1/2" and Larger: Cast -iron body, bolted screen retainer with off-center blow down fitted with pipe plug.

4. Flanged Ends, 2-1/2" and Larger: Cast-iron body, bolted screen retainer with off-center blow down fitted with pipe plug.

5. Butt Welded Ends, 2-1/2" and Larger For Low Pressure Application: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blow down fitted with pipe plug.

6. Butt Welded Ends, 2-1/2" and Larger For High Pressure Applications: Schedule 80 cast carbon steel body, bolted screen retainer with off-center blow down fitted with pipe plug.

7. Grooved Ends, 2-1/2" and Larger: Tee pattern, ductile-iron or malleable-iron body and access end cap, access coupling with EPDM gasket.

F. SLEEVES:

1. Sheet-Metal Sleeves: 10-gauge, galvanized sheet metal, round tube closed with welded longitudinal joint.

2. Steel Sleeves: Schedule 40 galvanized, welded steel pipe, ASTM A53 Grade-A.

G. Mechanical Sleeve Seals: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

PART 3 - EXECUTION

3.01 PREPARATION

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

B. Remove scale, slag, dirt, and debris for both inside and outside of piping and fittings before assembly.

3.02 INSTALLATIONS

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated. Refer to individual system specifications for requirements for coordination drawing submittals.

B. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated otherwise.

C. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

D. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.

E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other spaced to permit applying full insulation and servicing of valves.

G. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, 3/4"ball valve, and short 3/4" threaded nipple and cap.

H. Exterior Wall Penetrations: Seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. Pipe sleeves smaller than 6" shall be steel; pipe sleeves 6" and larger shall be sheet metal.

I. Fire Barrier Penetrations: Where pipes pass through fire rated walls, partitions, ceilings, or floors, the fire rated integrity shall be maintained. Refer to Division 7 for special sealers and materials.

3.03 FITTINGS AND SPECIALTIES

A. Use fittings for all changes in direction and all branch connections.

B. Remake leaking joints using new materials.

C. Install strainers on the supply side of each control valve, solenoid valve, and elsewhere as indicated.

D. Install unions adjacent to each valve, and at final connection to each piece of equipment and plumbing fixture having 2" and smaller connections, and elsewhere indicated.

E. Install Flanges in piping 2-1/2" and larger, where indicated, adjacent to each valve, and at the final connection to each piece of equipment.

F. Install dielectric unions to connect piping materials of dissimilar metals in dry piping systems (gas, compressed air, vacuum).

G. Install dielectric fittings to connect piping materials of dissimilar metals in wet piping systems (water, steam).

3.04 JOINTS

A. Steel Pipe Joints:

1. Pipe 2" and smaller: Thread pipe with tapered pipe threads in accordance with ANSI B2.1. Cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint lubricant or sealant suitable for the service for which the pipe is intended on the male threads at each joint and tighten joint to leave not more than 3 threads exposed.

2. Pipe Larger Than 2":

a. Weld pipe joints (except for exterior water service pipe) in accordance with ASME Code for Pressure Piping, B31.

b. Weld pipe joints of exterior water service pipe in accordance with AWWA C206.

c. Install flanges on all valves, apparatus, and equipment. Weld pipe flanges to pipe ends in accordance with ASME B31.1.0 Code for Pressure Piping. Clean flange faces and install gaskets. Tighten bolts to torque specified by manufacturer of flange and flange bolts, to provide uniform compression of gaskets.

3. Non-ferrous Pipe Joints:

a. Brazed And Soldered Joints: For copper tube and fitting joints, braze joints in accordance with ANSI B31.1.0 - Standard Code for Pressure Piping, Power Piping and ANSI B9.1- Standard Safety Code for Mechanical Refrigeration.

b. Thoroughly clean tube surface and inside surface of the cup of the fittings, using very fine emery cloth, prior to making soldered or brazed joints. Wipe tube and fittings clean and apply flux. Flux shall not be used as the sole means for cleaning tube and fitting surfaces.

c. Mechanical Joints: Flared fittings may be used for refrigerant lines 3/4" and smaller.

4. Joints for other piping materials are specified within the respective piping system sections.

3.05 FIELD QUALITY CONTROL

A. Upon completion of installation of piping (partial or complete) test piping to demonstrate compliance with requirements. Where possible, field correct malfunctioning piping, then retest to demonstrate compliance. Replace piping, which cannot be satisfactorily corrected.

END OF SECTION 23 21 13

SECTION 23 21 16 - HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 - Basic Mechanical Requirements

1.02 SECTION INCLUDES

1. Water Specialties

1.03 SUBMITTALS

A. Product Data, including rated capacities of selected models, Weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each specialty.

B. Maintenance Data for hydronic specialties for inclusion in operating and maintenance manual.

1.04 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of water specialties of types and sizes required, whose products have been in satisfactory use in similar service for not less than ten years.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Store and handle the products as per manufacturer's instructions prevent them from damaging.

PART 2 - PRODUCTS

2.01 BLADDER TYPE EXPANSION TANKS

A. Acceptable Manufacturers:

1. Bell & Gossett.
2. Amtrol.
3. Taco.

B. Construction: Welded steel, tested and stamped in accordance with Section 8D of ANSI/ASME Code; rated for working pressure of 125 psi and 240 degree F, with removable bladder, and steel legs or saddles.

C. Accessories: Pressure gauge and air-charging fitting, tank drain; in-line air purger, automatic fill valve, precharge to 12 psi.

2.02 AIR VENTS

A. Vents: Automatic types by Bell & Gossett, Amtrol or Taco.

B. Float type cast iron, brass or semi-steel body, copper float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; installed with an isolating valve at air separators, tanks and other equipment; B & G Model 87 or 107.

2.03 DRAINS

A. 3/4 inch ball valve with hose connection for use at piping system low points.

B. 1/2 inch ball valve with hose connection for use at coils, radiators and convertors.

2.04 AIR SEPARATORS

A. Acceptable Manufacturers:

1. Bell & Gossett
2. Amtrol

3. Spirax Sarco

4. Taco

B. Tangential Air Separators: Steel, tested and stamped in accordance with Section VIII Division I of ANSI/ASME Code, for 125 psi operating pressure, blow down nozzle, tangential inlet and outlet connections, and internal stainless steel air collector tube; removable galvanized steel strainer. Bell and Gossett Model R or approved equal.

C. Provide line size air separator inlet and outlet connections.

2.05 WATER STRAINERS ('Y' TYPE)

A. Acceptable Manufacturers:

1. Spirax/ Sarco (Models as specified).

2. Armstrong.

3. Mueller.

B. Size 2 Inch and Smaller: Bronze body, screwed, Y pattern with 1/32 inch stainless steel perforated screen, 250 psi; Model BT [Armstrong Model F4SC].

C. Size 2 1/2 Inch to 8 Inch: Cast iron body, flanged, Y pattern with 1/16 inch stainless steel perforated screen, 125 [250] psi; Model CI-125 [AF-250] [Armstrong Model A1FL].

2.06 PUMP SUCTION FITTINGS

A. Acceptable Manufacturers:

1. Bell & Gossett Suction Diffuser.

2. Taco.

B. Fitting: Angle pattern, cast iron body, flanged for 2/12 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable fine mesh strainer to fit over cylinder strainer to fit over cylinder strainer, and permanent magnet located in flow stream and removable for cleaning.

C. Accessories: Adjustable foot support, blow down and gauge tappings.

2.07 RELIEF VALVES

A. Acceptable Manufacturers:

1. Bell and Gossett
2. Watts
3. Kunkle

B. Bronze body, Teflon seat, stainless stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

2.08 BALANCING VALVES

A. 2 Inch and Smaller: Calibrated brass or bronze balance valve with provisions for connecting a portable differential pressure meter. Meter connections shall have built-in check valves. An integral pointer shall register degree of valve opening. Construct valves with internal seals to prevent leakage around rotation element. Furnish a calibrated curve to determine the flow rate by means of pressure drop and valve setting. Construct valves for 300 psi working pressures at 250 degrees F and provide insulation suitable for use on heating and cooling systems. Bell &Gossett Model CB Circuit Setter, Series 6000 by Illinois or Armstrong.

B. 2 ½ and larger: 150 psi, flanged plug valve, cast or ductile iron body, EPDM coated plug, lever actuated with memory stop. Keystone Ballcentric, Dezurik.

2.09 AUTOMATIC FLOW CONTROL BALANCING VALVES

A. Acceptable Manufacturer: Griswold Controls

B. Factory calibrate valves for the service intended. Valves shall automatically limit the rate of flow to the engineered capacity required, regardless of system fluctuations.

C. Valves shall regulate flow within plus or minus 5 percent of their tag rating over an operating pressure differential of at least 15 times the minimum required for control.

D. Valves shall be tamperproof with internal working parts constructed of passivated stainless steel; self-cleaning, spring loaded with variable orifice area and of the cartridge-piston type. Bodies shall have tappings suitable for connection of instruments for verification of flow rates and shall be rated for use at not less than 125 psi pressures.

E. Furnish each valve with a valve kit consisting of 1/4 inch x 2 inch minimum size nipples, disconnect valves (located outside of insulation), and fittings suitable for use with the measuring instruments specified herein.

F. Furnish flow measuring instrument to verify flow rates. Verify correct flow by establishing that the operating pressure differential across the valve tappings is within the range indicated on the identification tag. The pressure measuring apparatus shall be portable and consist of a carrying case, instructions, hoses, and connections; and a pushbutton 3-way valve which transmits either of two pressures to a pressure gauge. The pressure gauge shall have a 4 1/2 inch minimum diameter dial calibrated in increments of 1 psi or less, and shall have a range of -14.7 psi to +150 psi. Furnish a higher pressure range gauge where system pressure exceeds 125 psi.

G. Upon completion of the work and verification of the flow rates, deliver the instrument to the Owner.

PART 3 -EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where water specialties are to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install all specialties and accessories in accordance with manufacturer's instructions.

B. Support tanks inside building from building structure [in accordance with manufacturer's instructions].

C. Provide manual air vents at system high points and drain valves at system low points.

D. Use automatic vents in ceiling spaces and other concealed or non-accessible locations; provide vent tubing to nearest drain.

E. Provide air separator on suction side of system circulation pump and connect to expansion tank.

F. Provide strainers to protect automatic control valves.

G. Provide full size valved drain and hose connection on strainer blow down connection. Use valves specified for shut-off duty.

H. Provide pump suction fitting on suction side of base mounted and suction centrifugal pumps where indicated. Remove disposable strainer after system has been cleaned.

I. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.

J. Support pump fittings with floor mounted pipe and flange supports.

K. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat Exchangers and expansion tanks.

L. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.

M. Pipe relief valve outlet to nearest floor drain.

N. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

O. Locate flow indicators adjacent to balancing valves within manufacturer's guidelines.

P. Install flow indicators in existing water systems prior to interruption of those systems for any other purpose. See preliminary balance requirements in Section 230593.

Q. Provide specified equipment (meters, instruments and related devices) for system balancing. Turn over portable equipment to Balancing Agency in time for scheduled system balance.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of water specialties, test the Specialties to demonstrate compliance with requirements. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units which cannot be satisfactorily corrected.

END OF SECTION 23 21 16

SECTION 23 21 23 - HYDRONIC PUMPS

PART 1 - GENERAL

1.01 SUMMARY

A. The contractor shall furnish and install in line pumps as shown and as scheduled on the contract documents. The pumps shall be installed in accordance with this specification and perform at the conditions specified, scheduled or as shown on the contract drawings.

1.02 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 23 05 11: Basic Mechanical Requirements

Division 23 - Section 23 05 13: Electrical Requirements for Mechanical Equipment

Division 23 - Section 23 05 48: Vibration mountings and controls, Vibration isolation and seismic restraint specification for HVAC, Fire Protection, Electrical and Plumbing

1.03 SUBMITTALS

A. Product Data: Include certified pump curves showing performance characteristics with pump and system operating point plotted. Include hp, frame size, dimensions, electrical requirements and NPSH curve when applicable.

B. Operation and Maintenance Data: Include assembly views, lubrication instructions and replacement parts list.

C. Spare parts: Mechanical Seals: One set for each pump type. Tag spare seal with pump I.D.

1.04 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of pumps of types and sizes required, whose products have been in satisfactory use in similar service for not less than ten years.

1.05 WARRANTY

A. Provide a full parts warranty and labor for three (3) year from start-up or 42 months from shipment, whichever occurs first.

B. The equipment shall have staggered delivery schedule. However, the warranty for the equipment shall commence from the date of start-up. In any event, the total warranty on the project shall not exceed 3 years from the date of start-up or 42 months from the date of delivery of any unit.

1.06 DELIVERY

A. The intent of the project is to procure packaged pumps as per specifications and operating conditions mentioned in the schedule. However, the pumps shall be delivered as per the project schedule or as desired by the project coordinator.

B. If for any reason, the pumps are delivered before the scheduled delivery date, the contactor shall arrange for proper storage and warehousing. All costs associated with early delivery are excluded from this specification and shall be the responsibility of the contactor.

1.07 STORAGE AND HANDLING

A. Store pumps in a dry location.

B. Retain shipping flange protective covers and protective coatings during storage.

C. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

PART 2 - PRODUCTS

2.01 GENERAL CONSTRUCTION REQUIREMENTS

A. Balance: Rotating parts, statically and dynamically.

B. Construction: To permit servicing without breaking piping and motor connections.

C. Material: Where option is given, materials selected shall be compatible.

D. Pump Motors:

1. Operate at 1800 rpm unless specified otherwise.

2. Motor shall not be smaller than scheduled. Conform to Section 23 05 13.

E. Pump Connections: Flanged.

2.02 IN-LINE PUMPS

A. Acceptable Manufacturers:

1. Bell & Gossett.

2. Armstrong.

3. Worthington, Flowserve Corp.

B. Type: In-line, single stage, spacer coupled, bar installation in vertical position capable of being serviced without disturbing piping connections. Rated for 175 Psi working pressure.

C. Casing: Cast iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.

D. Impeller: Bronze, fully enclosed, keyed to shaft.

E. Bearings: Re-grease able lubricated self-aligning ball bearings.

F. Shaft: Stainless steel.

G. Seal: Carbon rotating against a stationary ceramic seat, Viton fitted when applicable, 275°F maximum continuous operating temperature.

H. Provide spring vibration isolators.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where pumps are to be installed and determine space conditions and notify Architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. All components shall be installed in accordance with manufacturer's installation instructions.

B. Reduction from line size to pump connection size shall be made with eccentric reducers attached to the pump with tops flat to allow continuity of flow.

C. Furnish and install triple duty valves on the discharge side of all pumps and furnish and install a line size shut-off valve on the suction side of all pumps. Anywhere that 5 straight pipe diameters of pipe cannot be provided on the inlet side of a pump a suction diffuser shall be used to provide appropriate flow distribution into the eye of the pump's impeller.

D. Provide temperature and pressure gauges where and as detailed or directed.

E. On systems where pump seals require flushing water or cooling water for a heat exchanger kit, provide cooling water supply piping and connections as well as the return piping, if required. Piping should be of adequate size to pass required flow rate.

F. Proper access space around a device should be left for servicing the component. No less than the minimum recommended by the manufacturer.

G. Provide an adequate number of isolation valves for service and maintenance of the system and its components.

H. Circulating pump shall have sufficient capacity to circulate the scheduled GPM against the scheduled external head (feet) with the horsepower and speed as scheduled and/or as denoted on the drawings. Motors shall be of electrical characteristics as scheduled, denoted and/or as indicated on the electrical plans and

specifications. Pump characteristics shall be such that the head of the pump under varying conditions shall not exceed the rated horsepower of the drive motor.

I. On systems where the final balancing procedure requires the triple duty valve to be throttled more than 25% to attain design flow (on a constant speed pumping system), and no future capacity has been built into the pump, the pump impeller must be trimmed to represent actual system head resistance. The pump provider and engineer of record, based on the balancing contractor' s reports, shall determine the final impeller trim diameter.

J. Install foot mounted and base mounted pumps on vibration isolator on housekeeping pad, via anchor bolts. Set and level and grout in place.

K. All piping shall be brought to equipment and pump connections in such a manner so as to prevent the possibility of any loads or stresses being applied to the connections or piping. All piping shall be fitted to the pumps even though piping adjustments may be required after the pipe is installed.

L. On components that require draining, contractor must provide piping to and discharging into appropriate drains.

M. Provide drains for bases and seals, piped to and discharging into floor drains.

N. Power wiring, as required, shall be the responsibility of the electrical contractor. All wiring shall be performed per manufacturer' s instruction and applicable state, federal, and local codes.

O. Control wiring for remote mounted switches and sensor / transmitters shall be the responsibility of the control' s contractor. All wiring shall be performed per manufacturer' s instructions and applicable state, federal, and local codes.

3.03 START UP AND TRAINING

A. Provide services of factory trained representative for a minimum of two days to inspect installation and supervise start-up.

B A factory-trained technical representative shall be available for two days of training on operation and maintenance at the customer job site.

C. Provide training to school maintenance staff for the operation and maintenance of the packaged pump system.

3.04 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment and after motor has been energized with normal power source, test equipment to demonstrate compliance with requirement. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units, which cannot be satisfactory corrected. Refer to Section Test and Balancing.

B. All pump casings shall be hydrostatically tested at 1-1/2" times design working pressure. The pump manufacturer shall be responsible for his service department aligning in the field prior to start-up of all flexibly coupled units. Alignment shall be with dial indicator with accuracy of plus or minus .002 inches. The pump manufacturer must submit a written report certifying that his personnel had performed the alignment work and that the pumps are ready for operation.

END OF SECTION 23 21 23

SECTION 23 31 00 - AIR DUCT AND ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 - Basic Mechanical Requirements

Division 23 - Section 230548 - Vibration mountings and controls, Vibration isolation and seismic restraint specification for HVAC, Fire Protection, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. Rectangular and round ductwork

B. Double wall insulated flat oval aluminum ductwork

C. Ductwork accessories

1.03 SUBMITTALS

A. Product Data: Submit product data for the products specified.

B. Shop Standards

1. Submit standards for all ductwork prior to the first shop fabrication drawing.

2. Indicate duct fittings, gauges, sizes, welds and configurations. Submit assembly and installation instructions for proprietary mechanical duct connection system.

C. Shop Drawings

1. Prepare plans and sections at scale of 3/8 inch to a foot.

2. Show air outlets, inlets, light fixtures, structural elements, lintels, partitions and other elements affecting routing of ductwork. Coordinate air device locations with ceiling installer. Show room numbers, names and column lines.

3. Locate roof mounted equipment and penetrations. Detail duct supports.

4. Coordinate proposed installation to provide access for components requiring maintenance.

5. Show details of louver connections.

6. Show details of typical duct to O.A. plenum connection and detail plenum to structure interface.

7. To avoid delay in review of submittals, do not submit more than 4 drawings within the same review period.

D. Samples: Submit samples of typical shop fabricated duct fittings and volume dampers.

1.04 QUALITY ASSURANCE

A. Fabrication and installation shall be by a single firm specializing and experience in metal ductwork for not less than 10 years.

B. Unless otherwise noted, fabricate and install ductwork systems in conformance to the following standards:

1. SMACNA HVAC Duct Construction Standards - 1985.

2. SMACNA Accepted Industry Practice for Industrial Duct Construction - 1975.

3. SMACNA Round Industrial Duct Construction Standard - 1977.

4. SMACNA Rectangular Industrial Duct Construction Standard - 1980.

5. SMACNA Fire Damper and Heat Stop Guide for Air Handling Systems, Second Edition - 1981.

6. NFPA 90A - Air Conditioning and Ventilation Systems.

1.05 GENERAL REQUIREMENTS FOR DUCTWORK

A. Drawings indicate the general arrangement of the work. Carefully examine the Drawings, gather all details from site visits, and be responsible for proper fitting of the work without substantial alteration of the indicated layout. Verify dimensions and routing shown with relation to existing work and the work of other trades. Verify locations and interferences prior to fabrication and erection.

B. While the Drawings shall be adhered to as closely as possible, the Engineer's right is reserved to vary the run and size of ducts during the progress of the work if required to meet structural conditions.

C. The sheet metal ductwork shall, whether indicated or not, rise and/or drop and/or change in shape to clear any and all conduits, lighting fixtures, plumbing and heating mains to maintain the desired ceiling heights and to provide adequate maintenance room and headroom in mechanical equipment rooms.

D. The ductwork shall be continuous, with airtight joints and seams presenting a smooth surface on the inside and neatly finished on the outside. Ducts shall be constructed with curves and bends so as to effect an easy flow of air. Unless otherwise shown on the Drawings, the inside radius of all curves and bends shall be not less than width of ducts in plane of bend.

1.06 INTERPRETATIONS/DEFINITIONS

A. Duct Sizes: Clear inside dimensions. Adjust sheet metal duct sizes for lined ductwork to maintain clear inside sizes indicated on drawings.

B. Ductwork Pressure Classification

Class	Pressure	Velocity

Low Pressure	1/2" WG (Positive or Negative)	Less than 2,000 FPM
Low Pressure	1" or 2" WG (Positive or Negative)	Less than 2,500 FPM
Medium Pressure	3" WG (Positive or Negative)	Less than 4,000 FPM
Medium Pressure	4" or 6" WG (Positive or Negative)	Less than 2,000 FPM
High Pressure	10" WG (Positive or Negative)	Less than 2,000 FPM

1.07 DELIVERY, STORAGE, AND HANDLING

A. Protect open ends of the work from weather, dirt and obstructing materials by means of temporary covers.

B. Deliver sealant and fire-stopping materials to site in original unopened containers or bundles with labels informing about manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.

C. Store and handle sealant fire-stopping materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

D. Deliver and store stainless steel sheets with mill-applied adhesive protective paper, maintained through fabrication and installation.

1.08 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Install duct mounted equipment, components and accessories furnished by other Sections of Division 23. Manufacturer shall supervise airflow sensor installation.

B. Install smoke detectors furnished under Division 26.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Steel: Galvanized sheet, lock-forming quality, G90 finish, ASTM A527.

B. Aluminum: ASTM B209, sheet or plate alloy 3003-H14. Aluminum connectors and bar stock; alloy 6061-T5 or of equivalent strength.

C. Stainless Steel: ASTM A167, Type 304L. Provide NAAMM No. 4 finish, including ground and polished welds, on surfaces exposed to view in finished areas. Provide stainless steel screws and fasteners.

D. Hanger Rod: Steel, galvanized, threaded both ends, threaded one end or continuously threaded.

E. Joint Sealant: United McGill, United Duct Sealer.

F. Flexible Sleeves: Vent glass by Ventfabrics, Inc., or acceptable substitution. Eight (8) inch wide, 30 oz. glass fabric, double coated with neoprene, flame spread rating of 25, sewn together at edges and seams. Provide with one inch wide, 12 gauge galvanized steel securing bands and 1/8 inch stove bolts for fastening on 5-inch centers.

2.02 SHEET METAL GAUGES

A. Rectangular Ductwork (Galvanized)

Largest Side Dimension	Gauge (all four sides)	
	Low Pressure	Medium Pressure
Up thru 12"	24	24
13" thru 18"	24	24
19" thru 30"	24	22
31" thru 48"	22	22
49" thru 54"	22	20
55" thru 72"	20	20
73" thru 84"	20	18
85" and over	18	18

B. Round Ductwork (Galvanized)

Duct Diameter	Low Pressure	Medium Pressure
Up thru 8"	24	24
9" thru 13"	24	24
14 thru 22"	24	24
23" thru 36"	22	22
37" thru 50"	20	20
51" thru 84"	20	18

Notes:

1. Provide medium pressure ductwork except as noted on drawings.

2. Provide double wall insulated oval aluminum ductwork for classrooms and in areas as indicated on drawings. See Paragraph 2.05 for specifications for double wall insulated oval aluminum ductwork.

2.03 FABRICATION - GENERAL REQUIREMENTS

A. Fabrication requirements specified requirements under individual ductwork system description.

B. Conform accurately to dimensions shown with ducts straight and to joints neatly finished.

C. Rigidly brace and reinforce ducts with angles or other structural members. Make Internal ends of slip joints lay with the flow.

D. Elbows in Rectangular Ductwork:

1. Square throat elbows larger than 8 inches; double thickness turning vanes.

2. Securely fasten vanes to runners for quiet, vibration free operation.

3. Square throat elbows 8 inches and smaller; radius elbows.

4. Radius elbows; minimum center line radius of 1 1/2 times duct width.

5. In parallel flow branches with 8-inch neck and smaller; make 90-degree turns out of nested fittings with radius elbows.

E. Provide inside collars where registers or grilles are mounted flush to the ductwork. Use minimum size collars required to install a controller, which will produce uniform airflow over the face of the register or grille.

F. Holes in Ductwork:

1. Plugs: Low density polyethylene, snap-in type, Niagara Plastics Company Model 659 for 3/8-inch hole.

2. Test Holes: Instrument test holes, sized to suit insulation thickness with flat gasket, screw cap and connection hardware in material to suit ductwork; Ventfabrics Ventlock Model 699 or approved equal. Use concave gaskets for round duct.

3. Where it is necessary for pipes, hangers, conduits or other devices to penetrate ductwork, obtain A/E acceptance of the locations. Provide an airfoil of the proper design and increase duct size as required to satisfy each individual condition. Provide gaskets, flanges and apply sealant to make opening airtight.

G. Where ducts are located outdoors, locate longitudinal seams on the bottom of the duct and cross break top surfaces to shed water.

H. Dissimilar Metals: Make connections using fully casketed flanges.

2.04 GENERAL CONSTRUCTION

A. Rectangular; Sealed Joints, Seams and Connections:

1. Low, Medium and High Pressure:

i. Seams: Pittsburgh Lock.

ii. Joints: Proprietary Mechanical Duct Connection System for ducts 8 inches and larger. Pocket lock type for ducts smaller than 8 inches.

iii. Seal Class: A.

B. Round; Sealed Joints, Seams and Connections:

1. All pressure classifications; 10 inch positive to 2 inch negative:

i. Seams: Lock type, RL-1 (Spiral), RL-4 (Butt Weld or Lapped and Seam Welded) or RL-5 (Grooved Seam, Pipe or Flat Lock).

ii. Joints: RT-1 (Beaded Sleeve), RT-6 (Swedge), or RT-5 (Beaded Crimp) up to 2 inch maximum.

iii. Fittings: Slip type; pleated or continuously welded stamped or segmented. Continuously welded fittings such as conical tees, 45 degree laterals or wyes may be used.

iv. Seal Class: A.

C. Rectangular, Round [and Flat Oval]; continuously welded joints, seams and connections as specified:

1. Round Seams: RL-4 (Butt Welded).

2. Rectangular Joints: T-21 Welded Flange.

3. Round Joints: RT-4 (Outside Sleeve)

2.05 DOUBLE WALL INSULATED FLATOVAL ALUMINUM DUCTWORK

A. General

1. All duct and fittings shall be manufactured by a company for whom the manufacture of spiral duct and welded fittings has been a principal business for at least 15 years.

2. All duct and fittings covered by this specification shall be manufactured by a single company.

3. All companies being considered as potential suppliers of duct and fitting components shall have the following laboratory test data on file with or available to the project engineer, contractor, and other interested parties.

   i. Laboratory test data covering the performance of the manufacturer's spiral duct is required. Generic performance data is unacceptable. Test data must include leakage rate, bursting strength, collapse strength, seam strength, and pressure loss. Duct pressure loss data must be consistent with that used in the system design.

   ii. Laboratory test data covering the performance of the manufacturer's fittings is required. Generic performance data is unacceptable. Test data must include zero-length dynamic losses of die-stamped, gored, mitered, and flat back elbows; straight, conical, 45-degree entry, capped, and bullhead tees; laterals, Y-branches, capped crosses, reducers, straight-through, and combinations of fittings. Fittings must have data for converging and/or diverging airflow, as appropriate to the system.

4. Contractor shall provide, at his expense, a mock up of flat oval sheet metal ductwork in one classroom as per design drawings for approval by the Engineer, Architect and Owner. Contractor shall proceed with procurement of flat oval sheet metal ductwork only after he receives written approval for the installed mock up and follow the recommendations in the written approval.

B. Materials

1. Oval duct shall be fabricated out of type 3003-H14 aluminum (in accordance with ASTM B209). Aluminum thickness shall be substituted for the gauges indicated as follows:

Galvanized/Gauge	Aluminum Thickness (inches)
28	0.025
26	0.032
24	0.040
22	0.050
20	0.063
18	0.080

C. Construction

1. Provide Double-wall (insulated) duct. Unless otherwise indicated, all insulated duct dimensions shown on drawings are nominal inner liner dimensions.

2. Insulated duct shall be constructed of a perforated inner liner, a 1-inch (unless otherwise specified) layer of fiberglass insulation, and an outer pressure shell. For 1-inch insulation, the outer pressure shell must be 2 inches larger than the (nominal) inner liner dimension. Outer shell gauge shall always be based on actual outer shell dimensions.

3. Perforations in the liner walls shall be 3/32 inch in diameter with an overall open area of 23 percent.

4. All insulated duct shall have a maximum thermal conductivity (k) of 0.27 Btu/hr/sq ft/°F/inch thickness at 75 °F mean temperature.

5. Insulation ends shall be provided at all locations where internally insulated duct connects to single-wall duct or to any non0insulated component. The insulation end shall terminate the insulation and reduce the outer shell diameter to the nominal single-wall size.

6. Double-wall (insulated) fittings shall be provided.

7. Insulated fittings shall be constructed of a perforated inner liner, a 1-inch (unless otherwise specified) layer of fiberglass insulation, and an outer pressure shell. For 1-inch insulation, the outer pressure shell will be 2 inches

larger than the (nominal) inner liner dimension. Outer shell gauge and construction shall always be based on actual outer shell dimensions.

8. Access doors shall be provided immediately downstream of all fire or smoke dampers and elsewhere as indicated on drawings.

9. A relief-type access door shall be provided immediately downstream of all smoke and fire dampers (or other dampers subject to sudden closure) when there is no branch takeoff near that location or when the branch takeoff is not sufficient to relieve the negative pressure if a damper closes suddenly. Relief-type doors shall be fastened by spring clips that release if sudden negative pressure occurs.

10. Double-wall, flat oval control dampers shall be constructed with a 1-inch layer of insulation and a solid inner liner. Duct system temperatures shall not exceed 250 °F. Stainless steel bearing sleeves shall be pressed into the outer shell to support the damper axle. The axle shall extend 6 inches from the outer shell body. A center mullion shall be provided for dampers with outer shell nominal major axes exceeding 36 inches.

D. Installation

1. Assembly joints to be installed indoors and outdoors shall be sealed with a solvent-based duct sealant that is a neoprene-phenolic mastic formulated to withstand temperatures from – 20 to +300 °F. Sealant shall be formulated such that surface preparation or solvent cleaning is not necessary. Sealant shall have a UL Classification marking with a flame spread of 5 and smoke developed of 5 when applied to inorganic reinforced cement board, both at coverage of 53 square feet per gallon. Sealant shall exceed 1,000 hours under ASTM D572 test conditions (oxygen bomb) without becoming brittle and 500 hours in QUV accelerated-exterior-aging apparatus without degradation (under ASTM C732 test conditions).

2. Where duct fittings are constructed with standing seam all construction joints shall be sealed with a metal cement that is composed of neoprene rubber, resins, and inert reinforcing material dispersed in a petroleum distillate. Sealant shall be formulated to withstand temperatures from – 20 to +225 °F. Sealant shall be formulated such that surface preparation or solvent cleaning

is not necessary. Sealant shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to 18-gauge galvanized steel and a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, tested as applied in two 1/8-inch beads 8 inches on center. Sealant shall exceed 500 hours without becoming brittle under ASTM D572 test conditions.

3. Where duct liner adhesive is used to secure insulation to metal surfaces, it shall be a water-based vinyl acrylic copolymer formulated to withstand temperatures from – 20 to 160 °F. Adhesive shall have a UL Classification marking with a flame spread of 0 and smoke developed of 0 when applied to inorganic reinforced cement board, both at coverage of 267 square feet per gallon. Adhesive shall exceed 500 hours without becoming brittle under ASTM D572 test conditions (oxygen bomb).

2.06 OUT DOOR AIR PLENUM ENCLOSURES

A. General

1. Provide double-wall (insulated) plenum enclosures. All panels and components shall be prefabricated and supplied by a nationally recognized manufacturer with published standards of construction, assembly, and technical performance. The manufacturer shall have produced a standardized prefabricated panel system for at least 10 years.

2. The entire plenum installation shall be designed by the plenum manufacturer to be self supporting. Provide all structural members as recommended by the panel manufacturer.

3. The finished plenum installation shall be able to with stand a positive internal static pressure of 2 inches wg and a negative internal static pressure of 2 inches wg.

4. The assembled structure shall not exhibit any panel joint deflections in excess of L/200, where L is the unsupported span length of any panel section within the completed plenum.

B. Construction

1. Panels shall be of " snap-lock: construction, such that adjacent panels are held together rigidly with an integral, continuous self-locking joint on both inside and outside panel surfaces. These joints should not require screws, H-connectors, tape, or any other type of additional fasteners or connectors.

2. All panels shall be 2 inches thick with a solid galvanized steel outer shell and a solid galvanized steel inner shell.

3. The outer and inner shells shall be tack or spot welded to perimeter and internal longitudinal steel channels and box-end internal closures, in such a manner and spacing that the panel assembly shall not fail at the maximum operating Loads.

4. The outer shell shall be constructed of galvanized steel with a minimum 20-gauge thickness.

5. The inner shell shall be constructed of galvanized steel with a minimum 22-gauge thickness.

6. All perimeter and internal longitudinal steel channel members shall be constructed of ASTM A446 structural quality galvanized steel with a minimum 18-gauge thickness or ASTM A526 commercial-quality galvanized steel with a minimum 16-gauge thickness.

7. All steel panel surfaces, internal channels, and trim items shall be fabricated from zinc-coated steel with a hot-dipped galvanized coating (minimum G-90 coating class as determined by ASTM A525) and shall meet all requirements of ASTM A526 for commercial-quality galvanized carbon steel.

8. Each panel assembly shall be completely filled with acoustical/thermal insulating material that is noncombustible, inert, mildew resistant, and vermin-proof. Insulation shall not settle within the panel assembly. No insulating materials shall be used that have a flame spread greater than 25 or a smoke developed greater than 50.

9. Where indicated on drawings, septum panels shall consist of a solid galvanized steel sheet (minimum 20-gauge thickness). The solid steel inner sheet shall be framed and sealed so that air does not leak through the assembly when a pressure differential exists.

C. Components and Installation

1. All assembly trim items shall be constructed of hot-dipped galvanized steel (minimum 18-gauge thickness) and furnished in standard lengths to be field cut to the required dimensions. Spacing of sheet metal screws, application of duct sealant, and positioning of trim shall be in accordance with the plenum manufacturer' s published erection and installation details.

2. All mechanical joints and external trim items shall be sealed with a UL-Classified duct sealant (for indoor and outdoor installations). In order to show that joints have been sealed properly, enough sealant shall be used so that excess sealant is extruded from all completed external joints.

3. Personnel access doors shall be provided where indicated on drawings and shall be 24 inches wide by 60 inches high unless otherwise indicated. All doors shall be the same nominal thickness as the prefabricated standard door panel in which they are mounted. Al access door panels and doors shall be constructed with a solid inner and outer shell (minimum 20-gauge thickness). Each door shall be installed in the door panel at the factory and shall have a minimum of two ball-bearing hinges and two wedge-lever door latches. All levers shall be operable from the interior and exterior sides of the door panels. All doors shall be installed to open against the air pressure differential. Doors shall seat against neoprene gasket materials, installed around the entire perimeter of the door frame in such a manner that door operation will provide direct compression with no sliding action between the door and gasket.

4. Openings for pipe and conduit shall be field cut to ensure proper positioning. All framing members, collars, and bellmouth fittings shall be insulated, welded, and sealed according to the plenum manufacturer' s published installation details.

2.07 PROPRIETARY MECHANICAL DUCT CONNECTION SYSTEM

A. Acceptable Manufacturers:

1. Ductmate Industries, Inc. "Ductmate".

2. Lockformer "T.D.C."

3. Engle "T.D.F."

4. Ward Duct Connector Industries.

B. General: Do not use mechanical connections on ducts heavier than 16 guage or lighter than 26-gauge.

C. Products and Materials:

1. Construction Materials: Same as specified for ductwork.

2. Angle: 20 gauge with or without integral polymer type seal.

3. Corner Piece: Minimum 16 gauge.

4. Cleat: 20 gauge. Use of PVC at fire dampers and connections to dissimilar metals is permitted.

5. Corner Clips, Bolts and Nuts: 16 gauge clips or 3/8-inch diameter bolts with nuts. Use stainless steel nuts and bolts on dissimilar metals.

6. Gasket: Tremco #440, Ductmate #440 or Hardcast #1902FR.

7. Mastic: Service Adhesives Inc. No. 5511M.

2.08 SEALANT MATERIALS

A. Joint and Seam Sealants, General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes tapes and combinations of open weave fabric strips and mastics.

B. Joint and Seam Tape: 2 inches wide, glass-fiber-fabric reinforced.

C. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with the tape to form a hard, durable, airtight seal.

D. Joint and Seam Sealant: One-part, non-sag, solvent-release-curing, polymerized butyl sealant complying with FS TT-S-001657, Type I; formulated with a minimum of 75 percent solids.

E. Flanged Joint Mastics: One-part, acid-curing, silicone elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

2.09 ACCESS DOORS

A. Factory fabricated access doors of 22-gauge minimum made of same material as specified for duct.

B. Sizing

DUCT WIDTH	DOOR LENGTH X WIDTH	NO. REQUIRED
18 inch and smaller	12 inch x Duct Width Less 2"	1
20 inch to 48 inch	18 inch x 18 inch	1
50 inch and larger	18 inch x 18 inch	2

C. Hardware:

1. Acceptable Manufacturers:

   i. Duro Dyne.

   ii. Ventfabric Inc.

   iii. Buffalo Forge.

2. Hinges: Wrought steel, zinc plated, brass pins; sized to suit door; minimum two per door.

3. Fasteners: Brass, window sash type; minimum two per door.

4. Pull: Brass; minimum one per door on suction side of fan.

5. Latch: Heavy-duty, non-corrosive aluminum and zinc alloy or zinc plated steel, 7 inch lever with self-locking latch nut; 5 3/4 inch door pull; shims, stud, stud barrel when appropriate and stainless steel screws; minimum two per walk-through type door.

D. Reinforce doors with flat or angle iron stiffening frame to avoid twisting or distortion. Make doors on insulated ductwork of double panel construction with an acceptable type insulated filler not less than 1 inch thick. Frame out duct openings with a continuous reinforcing bar or angle against which the door shall close. At insulated ducts, provide an extended metal collar flush with the butt face of insulation. Attach gaskets to the bar or angle with flameproof adhesive for airtight construction. Attach doors with a minimum of two hinges.

2.10 VOLUME DAMPERS

A. Acceptable Manufacturer
   1. Ruskin (Series CD or CDR).
   2. Carnes
   3. Greenheck.

B. Rigidly construct to eliminate flutter or vibration at any volume setting; exterior quadrant adjustment with locking nut, elevated platform for insulated ducts and sealed end bearings screwed or riveted to the duct. Include open-end bearings on ducts beneath elevated platforms to reduce duct leakage.

C. Splitter dampers are not acceptable as volume dampers.

D. Dampers larger than 12 inches in any dimension: Multi-blade opposed type.

E. Dampers for duct velocity over 1100 fpm and dampers for laboratory exhaust system Multi-blade airfoil type.

F. Material: Same as specified for ductwork unless otherwise noted.

2.11 FIRE DAMPERS

A. Acceptable Manufacturers:
   1. Ruskin.
   2. Air Balance.
   3. Carnes

B. Galvanized steel, curtain type with blades stored out of air stream, gravity operated for vertical use and spring operated for horizontal use, 165 degree F fusible link, 1 1/2 hour rated, UL label per UL 555.

C. Use Model IBD2, Style B for low pressure rectangular, Style C for medium or high pressure rectangular and Style CR for round.

2.12 SMOKE DAMPERS

A. Acceptable Manufacturers:

1. Ruskin.

2. Air Balance.

3. Carnes

B. GENERAL

1. Frame shall be a minimum of 16-gage (1.6) galvanized steel formed into a structural hat channel reinforced at corners for added strength. The blades shall be airfoil shaped single-piece hollow construction with 14-gage (2.0) equivalent thickness. Blade action shall be parallel. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame for long life. (Galvanized bearings shall not be acceptable.) Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge (adhesive or clip fastened seals shall not be acceptable) and shall withstand a minimum of 450°F (232°C). Jamb seals shall be non-corrosive stainless steel flexible metal compression type to further ensure smoke management.

2. Each smoke damper shall be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems in accordance with the latest version of UL555S and bear the UL label attesting to same. Damper manufacturer shall have tested and qualified with UL, a complete range of damper sizes covering all dampers required by this specification.

3. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be leakage Class I (4 cfm/sq. ft. at 1.0" w.g.).

4. As part of the UL qualification, damper shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures up to 4" w.g. in the velocity in the open position.

5. In addition to the leakage ratings already specified herein, the smoke dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250°F, 350°F, or 450°F (121°C, 177°C, or 232°C0 depending on the actuator. Appropriate electric actuators shall be installed by the

damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity, which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Damper and actuator assembly shall be factory cycled 10 times to assure operation.

2.13 COMBINATION FIRE / SMOKE DAMPERS

A. Acceptable Manufacturers:

1. Ruskin.
2. Air Balance.
3. Carnes

B. GENERAL

1. Frame shall be a minimum of 16-gage (1.6) galvanized steel formed into a structural hat channel reinforced at corners for added strength. The blades shall be airfoil shaped single-piece hollow construction with 14-gage (2.0) equivalent thickness. Blade action shall be parallel. Bearings shall be stainless steel sleeve turning in an extruded hole in the frame for long life. (Galvanized bearings shall not be acceptable.) Blade edge seals shall be silicone rubber and galvanized steel mechanically locked into blade edge (adhesive or clip fastened seals shall not be acceptable) and shall withstand a minimum of 450°F (232°C). Jamb seals shall be non-corrosive stainless steel flexible metal compression type to further ensure smoke management.

2. Each combination fire smoke damper shall be classified for use for fire resistance ratings of less than 3 hours, in accordance with UL Standard 555, and shall further be classified by Underwriters Laboratories as a Leakage Rated Damper for use in smoke control systems in accordance with the latest attesting to same. Damper manufacturer shall have tested, and qualified with UL, a complete range of damper sizes covering all dampers, required by this specification. Testing and UL qualifying a single damper size is not acceptable. The leakage rating under UL555S shall be leakage Class I (4 cfm/sq. ft. at 1.0" w.g. and 8cfm/ft. at 4" w.g.).

3. As part of the UL qualification, damper shall have demonstrated a capacity to operate (to open and close) under HVAC system operating conditions, with pressures up to 4" w.g. in the velocity in the open position.

4. In addition to the leakage ratings already specified herein, the smoke dampers and their actuators shall be qualified under UL555S to an elevated temperature of 250 °F, 350 °F, or 450 °F (121 °C, 177 °C, or 232 °C0 depending on the actuator. Appropriate electric actuators shall be installed by the damper manufacturer at time of damper fabrication. Damper and actuator shall be supplied as a single entity, which meets all applicable UL555 and UL555S qualifications for both dampers and actuators. Damper and actuator assembly shall be factory cycled 10 times to assure operation.

5. Manufacturer shall provide factory-assembled sleeve of 17" (432) minimum length (contractor to verify requirement). Factory supplied caulked sleeve shall be 20 gage (1.0) for dampers through 84" (2134) wide and 18 gage (1.3) above 84" (2134) wide.

6. Each combination fire/smoke damper shall be equipped with a controlled 7 to 15 second heat actuated release device. The electric EFL shall close and lock the fire/smoke damper during test, smoke detection, power failure or fire conditions through actuator closure springs. To prevent duct and HVAC component damage, the damper shall at all times be connected to the actuator for controlled closure in not less than 7 seconds and no more than 15 seconds. Instantaneous damper closure is unacceptable. Damper shall be automatic remote resettable after test, smoke detection or power failure conditions. After exposure to high temperature or fire, the damper must be inspected prior to reset to ensure proper operation. Release temperature shall be 165 °F.

2.14 Not Used.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where ductwork is to be installed and determine space conditions and notify Engineer in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Coordinate with other work as necessary to interface installation or ductwork with other components of systems.

B. Duct sizes shown on the drawings at connection to fans or other equipment may vary in actual installation. Contractor shall provide transition pieces as required.

C. Ducts, casings and hangers shall be installed straight and level the ductwork installation shall be free of vibration and noise when fans are operating.

D. Ducts at ceilings shall be suspended from supplemental steel as required. Ducts at floor shall be supported by steel angles suitably anchored to floor construction. Each duct shall be independently supported and shall not be hung from or supported by another duct, pipe, conduit or equipment of any trade.

E. Supports shall be placed at each joint and change in direction up to a maximum spacing of 8 feet on centers. Prevent buckling of ductwork.

F. All fastenings to building structure shall be adequate to insure permanent stability of sheet metal work and shall be capable of resisting all applied forces.

G. Vertical ducts in shafts or passing through floors shall be supported by steel angles or channels, welded, riveted, screwed or bolted to ducts and fastened to building structural members at each floor level. Provide safing to close all floor openings around ductwork - pack annular space with rock wool and 18 gauge sheet metal safing Floor openings in plenums shall have 1/2 inch diameter steel bars.

H. Rigid connections between ductwork and non-rotating equipment shall be made with flanged joints, sealed with fireproof material (Fiber or Neoprene gaskets).

I. For leakage test for medium and high-pressure ductwork refer to Section "Testing and Balancing".

J. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems.

K. Holes in Ductwork:

1. Where ducts are insulated, neatly cut a 3-inch wide strip of insulation away from hole site.

2. Drill holes in ducts, casings and plenums not exceeding 12 inches o.c. in locations as directed by Balancing Agency,

3. Use snap-in plugs for low and medium pressure systems with material gauges of 14 through 26.

4. Reinstall cut away insulation and cover with 4-inch wide duct tape. Identify plug and instrument hole locations on insulated ducts as "test holes" for future reference and use.

L. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

M. Set plenum doors 6 to 12 inches above floor. Arrange door swing so that static pressure holds door in closed position.

N. Connect ducts to fans with flexible sleeves.

O. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.

P. Install duct and plenum mounted equipment in accordance with manufacturer's recommendations.

Q. Provide angle iron enclosures where ductwork passes through floors, roofs and walls.

R. Install mechanical duct connection systems in strict conformance with manufacturer's instructions. Over tightening of corner piece nuts and bolts may cause leakage in excess of allowable levels.

S. Install fire dampers in duct extension sleeves and with perimeter angles and breakaway fittings in accordance with the manufacturer's instructions and SMACNA details.

T. Install access doors at plenum, humidifiers, fire and smoke dampers, and other locations where duct access is required. Install access doors both before and after duct mounted in-line fans [, coils and airflow sensors]. Locate doors on duct sidewalls where water or condensation may be present in the airstreams.

U. Cut, fit and install blank out panels at portions of louvers not used. Seal seams, perimeter, cut-outs and duct connection. Provide angle closure collars where ducts meet blank out panels.

V. All square elbows shall have factory-designed and built single thick turning vanes. Shop fabrication vanes will not be approved. Where turning vanes are in conflict with the access doors to fire dampers. They shall be made movable, so that fire dampers, shall be accessible.

W. Dissimilar metals shall be connected with flanged joints made up with fiber or neoprene gaskets to prevent contact between dissimilar metals. Flanges shall be fastened with bolts protected by ferrules and washers made of the same materials as the gaskets. Where an aluminum duct is to be connected to a galvanized steel duct, the end of the galvanized steel duct shall be coated with heavy black asphaltum paint before connecting it to the aluminum duct.

X. Changes in shape and dimension shall conform to the following: Except where otherwise noted, for increases in cross-sectional area, the shape of the transformation shall not exceed 1" in 7". Except where otherwise noted, for reductions in area, the slope shall not be less than 1" in 4" but 1" in 7" preferred.

Y. Wherever it may be necessary to make provisions for vertical hangers of the ceiling construction passing through ducts, provide streamlined shaped sleeves around such

ceiling construction hangers as to fully protect the duct from being punched with holes for the passage of such hangers. Any such streamlined sleeves shall be made air tight at top and bottom of ducts. In no case shall there be more than two rods in any 9 sq. ft. area. No rods shall pierce ducts smaller than 12" in horizontal area.

3.03 EXISTING CONSTRUCTION

A. Existing duct openings shown to be closed, shall be sealed with gasketed sheet metal panels and sheet metal screws. Panels shall be same gauge and material as existing duct. Submit gasketing material and method of installation prior to installation.

3.04 DUCT HANGERS

A. Low pressure ducts up to 24" on a side or up to 20" diameter shall be suspended with 16-gauge, galvanized strap hangers, 1" wide.

B. Low pressure ducts 25" to 40" on a side or 21" to 40" diameter shall be suspended with galvanized strap hangers 1" wide by 1/8" thick.

C. Strap hangers shall be bent 90^0, extended down sides of ducts and turned under bottom of ducts a minimum of 2". Strap hangers shall be fastened at ceiling with nuts, bolts and lock washers and to sides and bottom of ducts with sheet metal screws.

D. All medium and high-pressure ductwork and low pressure. Ducts 41" and larger on a side or diameter shall be suspended with eighter rod or angle type hangers. No screws shall penetrate medium and high-pressure ductwork.

E. Rod type hangers shall be 3/8" diameter black steel rods threaded at both ends and bottom bracing angles on ducts, with nuts and lock washers.

F. Angle type hangers shall be extensions of side bracing angles on ducts, bent 90^0 at ceiling and fastened with nuts, bolts and lock washers.

G. Hangers for vertical ducts shall be as per SMACNA standards.

H. Stainless steel ductwork shall be supported with rod or angle type hangers, so that there will be no penetration of the stainless steel ducts.

3.05 CLEANING AND PROTECTION

A. Clean ductwork internally, unit by unit as it is installed, to remove of dust and debris. Clean external surfaces of foreign substances, which might cause corrosion, deterioration of metal or interfere with painting.

B. At end of ducts, which are not connected to equipment or air distribution devices at the time of ductwork installation, provide temporary closure of polyethylene film or other covering.

C. Cleaning of new supply ductwork in existing buildings. After completion of ductwork installation clean ductwork as follows:

1. Cover all supply registers and diffusers with oil cheesecloth.

2. Use supply fan or install temporary fan to provide air to the system for four (4) hours.

3. Remove oil cheesecloth.

END OF SECTION 23 31 00

SECTION 23 34 16 - HVAC FANS

PART 1 - GENERAL

1.01 SUMMARY

A. This specification section includes the following:

i. Roof Fans

ii. Ceiling Mounted Fans

1.02 RELATED SECTIONS

A. Related sections of Division 23 applicable to this section are:

Division 23 - Section 23 05 11 - Basic Mechanical Requirements
Section 23 05 13 - Electrical Requirements for Mechanical Equipment
Section 23 05 48 - Vibration controls for HVAC, Electrical and Plumbing
Section 23 31 00 - Ductwork and Accessories
Section 23 33 13 - Dampers
Section 23 09 23 - Building Management Controls System
Section 23 05 93 - Testing, Adjusting and Balancing

1.03 SUBMITTALS

A. Product data for selected models, including specialties, accessories, and the following:

1. Certified fan performance curves with system operating conditions indicated.

2. Certified fan sound power ratings.

3. Motor ratings and electrical characteristics plus motor and fan accessories.

4. Materials gages and finishes, including color charts.

5. Dampers, including housings, linkages, and operators.

B. Shop drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights required clearances, components, and location and size of field connections.

C. Wiring diagrams that detail power, signal, and control wiring. Differentiate between manufacturer-installed wiring and field-installed wiring.

D. Maintenance data for air-handling units, for inclusion in Operating and Maintenance Manual.

E. Maintenance Materials: Furnish one additional complete set of belts for each belt driven fan. Tag spare belts with Fan I.D.

1.04 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of fans of types and sizes required, whose products have been in satisfactory use in similar service for not less than 10 years.

1.05 WARRANTY

A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

1.06 DELIVERY

A. The intent of the project is to procure fans as per specifications and operating conditions mentioned in the schedule. However, the fans shall be delivered as per the project schedule, or as desired by the project coordinator.

B. If for any reason the fans are delivered before the scheduled delivery date, the contactor shall arrange for proper storage and warehousing of the equipment. All costs associated with early delivery are excluded from this specification and shall be the responsibility of the contractor.

C. Comply with manufacturer's installation instructions for rigging, unloading, and

transporting units.

D. Fans not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging, lifting and final placement of fan section(s).

E. Fans shall be shipped in a clear shrink-wrap or stretch-wrap to protect fan sections from in-transit rain and debris per ASHRAE 62.1 recommendations.

1.07 STORAGE AND HANDLING

A. Installing contractor shall be responsible for storing exhaust fans in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 - PRODUCTS

2.01 CENTRIFUGAL ROOF EXHAUST FANS

A. Acceptable Manufacturers

1. Acme
2. Loren Cook Co.
3. Greenheck

B. Furnish and install the roof fans where indicated on the Drawings.

C. General

1. Roof exhauster fans shall be centrifugal belt drive type.
2. Fan impeller shall have centrifugal backwardly curved blades constructed of aluminum, which are die-formed. Steel impeller hub shall be securely fastened to the impeller backplate. The impeller shall be optimally matched with the

inlet orifice, and statically and dynamically balanced.

3. The fan housing shall be constructed of heavy gauge aluminum and include a full perimeter stormband to aid in protection of the orifice from blowing rain and snow.

4. The structural steel frame shall transmit the weight of the motor and impeller directly to the curb cap to prevent orifice distortion.

5. Permanently lubricated ball bearings shall be used in a duplex split pillow block housing for accurate alignment and rated at an L-50 life of 200,000 hours. Bearings shall be resilient mounted in neoprene rings providing protection and vibration isolation.

6. Pulleys shall be cast iron. Motor pulleys shall be variable pitch.

7. V belts shall be oil and heat resistant and non-static conducting and designed for 1.5 service factor.

8. Fan shaft shall have a protective coating for resistance against corrosion.

9. Fan shall be provided with a stainless steel data tag, NEMA 3R disconnect mounted and internally wired, 12" high roof self flashing curb with treated wood nailer, damper tray, motor operated aluminum back draft damper and treated wood nailer.

10. Fans shall be covered by a 2 year limited warranty with 5 year limited warranty on duplex split pillow block bearing and shaft. Sealed ball bearing motors shall be mounted out of the airstream.

11. The motor compartment shall be ventilated with outside air by a " forced air" cooling system.

12. A birdscreen shall be provided and attached on all sides.

13. A conduit post shall be provided through the fan base to the motor compartment for ease of electrical wiring.

14. A disconnect device/switch shall be factory installed to the junction box on the internal wiring posts (except fans with explosion resistant motors).

15. Standard wiring shall comply with National Electric Code and materials used shall be U.L. Listed. Fans shall bear the AMCA Certified Ratings Seal for sound and air performance.

16. Each fan shall have a permanently affixed manufacturer' s nameplate containing the model number and serial number.

17. Thermal overload protection shall be standard for explosion resistant motors.

18. Fan housing shall be weatherproof, utilize heavy-gauge aluminum construction with a large rolled bead for strength with aluminum base, rigid galvanized steel internal support structures. Housing shall not provide any of the internal structural support. Large diameter cooling tube shall provide ambient air to flow over motor.

19. The fans shall have the capacities indicated on the drawings.

2.02 INLINE RETURN FANS

A. Acceptable Manufacturers:

1. Acme

2. Loren Cook Co.

3. Greenheck

B. Description:

1. Fan shall be duct mounted, belt driven centrifugal square inline.

C. Certifications: Fan shall be manufactured at an ISO 9001 certified facility. Fan shall be listed by Underwriters Laboratories (UL 705) and UL listed for Canada (cUL 705). Fan shall bear the AMCA certified ratings seal for sound and air performance.

D. Construction: The fan shall be of bolted construction utilizing corrosion resistant fasteners. Housing shall be minimum 18 gauge galvanized steel with integral duct

collars. Bolted access doors shall be provided on three sides, sealed with closed cell neoprene gasketing. Pivoting motor plate shall utilize threaded L-bolt design for positive belt tensioning. Housing shall be pre-drilled to accommodate universal mounting feet for vertical or horizontal installation. Unit shall bear an engraved aluminum nameplate. Nameplate shall indicate design CFM, static pressure, and maximum fan RPM. Unit shall be shipped in ISTA certified transit tested packaging.

E. Wheel: Wheel shall be centrifugal backward inclined, constructed of 100% aluminum, including a precision machined cast aluminum hub. Wheel inlet shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.

F. Motor: Motor shall be NEMA design B with class B insulation rated for continuous duty and furnished at the specified voltage, phase and enclosure.

G. Bearings: Bearings shall be designed and individually tested specifically for use in air handling applications. Construction shall be heavy duty re-greasable ball type in a pillow block cast iron housing selected for a minimumL50 life in excess of 200,000 hours at maximum cataloged operating speed.

H. Belts and Drives: Belts shall be oil and heat resistant, static conducting. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts. Drives shall be sized for 150% of the installed motor horsepower. The variable pitch motor drive must be factory set to the specified fan RPM.

I. Minimum Motor Efficiency Per Ashrae 90.1-2007

TABLE 10.8 Minimum Nominal Efficiency for General Purpose Design A and Design B Motors[a]

	Minimum Nominal Full Load Efficiency (%)					
	Open Motors			Enclosed Motors		
No. of Poles	2	4	6	2	4	6
Synchronous Speed (RPM)	3600	1800	1200	3600	1800	1200
Motor Horse						

Power						
1	-	82.5	80.0	75.5	82.5	80.0
1.5	82.5	84.0	84.0	82.5	84.0	85.5
2	84.0	84.0	85.5	84.0	94.0	86.5
3	84.0	86.5	86.5	85.5	87.5	87.5
5	85.5	87.5	87.5	87.5	87.5	87.5
7.5	87.5	88.5	88.5	88.5	89.5	89.5
10	88.5	89.5	90.2	89.5	89.5	89.5
15	89.5	91.0	90.2	90.2	91.0	90.2
20	90.2	91.0	91.0	90.2	91.0	90.2
25	91.0	91.7	91.7	91.0	92.4	91.7
30	91.0	92.4	92.4	91.0	92.4	91.7
40	91.7	93.0	93.0	91.7	93.0	93.0
50	92.4	93.0	93.0	92.4	93.0	93.0
60	93.0	93.6	93.6	93.0	93.6	93.6
75	93.0	94.1	93.6	93.0	94.1	93.6
100	93.0	94.1	94.1	93.6	94.5	94.1
125	93.6	94.5	94.1	94.5	94.5	94.1
150	93.6	95.0	94.5	94.5	95.0	95.0
200	94.5	95.0	94.5	95.0	95.0	95.0

[a] Nominal Efficiencies Shall Be Established In Accordance With NEMA Standard MG1. Design A And Design B Are National Electric Manufacturer Association (NEMA)Design Class Designation For Fixed Frequency Small And Medium AC Squirrel – Cage Induction Motors.

PART 3 - EXECUTION

3.01 INSPECTION

A. Contractor shall examine location where this equipment is to be installed and determine space conditions and notify architect in writing of conditions detrimental to proper and timely completion of the work.

B. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install equipment where shown, in accordance with manufacturer's written

instructions, and with recognized industry practices, to ensure that equipment comply with requirements and serve intended purposes.

B. Coordinate with other work as necessary to interface installation of equipment with other components of systems.

C. Check alignment and, where necessary (and possible), realign shafts or motors and equipment within tolerances recommended by manufacturer.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation of equipment, test equipment to demonstrate compliance with requirement. When possible, field correct malfunctioning units, then retest to demonstrate compliance. Replace units, which cannot be satisfactorily corrected. Refer to Section - Testing and Balancing.

END OF SECTION 23 34 16

SECTION 23 37 13 - HVAC AIR OUTLETS AND INLETS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Related sections of Division 23 applicable to this section are:

Division 23 - Section 230511 - Basic Mechanical Requirements

Division 23 - Section 230511 - Vibration mountings and controls, Vibration isolation and seismic restraint specification for HVAC, Fire Protection, Electrical and Plumbing.

1.02 SECTION INCLUDES

A. Diffusers

B. Supply Grille

C. Return Grille

1.03 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for air outlets and inlets including the following:

1. Schedule of air outlets and inlets indicating drawing designation, room location, number furnished, model number, size, and accessories furnished.

2. Data sheet for each type of air outlet and inlet, and accessory furnished; indicating construction, finish, and mounting details.

3. Performance data for each type of air outlet and inlet furnished, including aspiration ability, temperature and velocity traverses, throw and drop, and noise criteria ratings. Indicate selections on data.

B. Samples: Submit 3 samples of each type of finish furnished.

C. Shop Drawings: Submit manufacturer's assembly-type shop drawing for each type of air outlet and inlet, indicating materials and methods assembly of components.

D. Maintenance Data: Submit maintenance data, including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manuals.

E. Spare Parts: Furnish to Owner, with receipt, 3 operating keys for each type of air outlet and inlet that require them.

1.04 QUALITY ASSURANCE

A. Firms regularly engaged in manufacture of air outlets and inlets of types and sizes required, whose products have been in satisfactory use in similar service for not less than ten years.

1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver air outlets and inlets wrapped in factory-fabricated fiberboard type containers. Identify on outside of container type of outlet or inlet and location to be installed. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

B. Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors; when necessary to store outdoors, store above grade and enclose with waterproof wrapping.

PART 2 – PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS:

A. Carnes

B. Price

C. Titus

2.02 GENERAL REQUIREMENTS

A. Finish exposed surfaces with baked off-white epoxy enamel unless specified otherwise.

B. Unless specified otherwise, furnish units with a volume control damper in the face without removal. Provide tools required to change deflections.

C. Construction Material: Steel, unless noted otherwise.

D. Provide blank off baffles where shown.

2.03 SQUARE CEILING DIFFUSERS

A. Refer to mechanical diffuser/register schedule.

2.04 PERFORATED CEILING DIFFUSERS FOR RETURN AIR

A. Refer to mechanical diffuser/register schedule.

2.05 FLOOR AND CEILING GRILLE

A. Refer to mechanical diffuser/register schedule.

PART 3 - EXECUTION

3.01 INSPECTION:

A. Examine areas and conditions under which air outlets and inlets are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

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

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

C. Install diffusers to ductwork with airtight connections. Attach round neck diffusers to duct work using draw bands.

D. Support Type 11 diffusers from concrete floor slabs independent of T-bar suspension system.

E. Provide balancing dampers on duct take-off to diffusers, grilles and registers, Regardless of whether dampers are specified as part of the diffuser, grille or register assembly and regardless of whether shown on the drawings.

END OF SECTION 23 37 13

SECTION 23 52 16 - CONDENSING BOILERS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide hot water condensing boilers suitable for burning natural gas, as specified herein, as shown on the Drawings, and as needed for a complete and proper installation. The burners shall be part of the packaged boiler-burner units. Product specific requirements are contained herein; Section 23 05 11, Basic Mechanical Requirements, shall be referred to for general requirements.

1.02 RELATED SECTIONS

Division 1 Sections (General Requirements)

Division 23 Sections

1.03 SUBMITTALS

A. Shop Drawings:

1. Submit wiring diagrams for power and control wiring required for final connections to boiler/burner units and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

2. Submit details of the boiler fabrication and combustion chamber.

3. Submit gas burner piping diagrams.

B. Maintenance Data: Submit maintenance data and spare parts list for boilers/burners, controls, and accessories; including "trouble-shooting" maintenance guide, and preventative maintenance schedule and procedures.

C. Piping and Wiring Diagram: Provide " As Built" wiring diagram and piping layout of the gas for the boiler/burner system. The diagram and layout shall be framed and mounted where directed in the Boiler Room. Frame shall be of aluminum, plywood backing, safety glass in front and one side removable. All parts shall be indicated exactly as installed and shall be properly identified. HVAC Identification and all piping shall be clearly shown and labeled.

D. Provide a set of manufacturer' s guarantees for each boiler/burner.

E. Certificate: Contractor' s start-up and demonstration affidavit.

1.04 QUALITY ASSURANCE

A. Listing and Labeling: Provide electrically operated components specified in this section that are listed and labeled.

1. The Terms " Listed" and " Labeled" : As defined in NFPA 70, Article 100.

2. Listing and Labeling Agency Qualifications: A " Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

B. ASME Compliance: Boilers shall bear ASME " H" stamp and be National-Board Listed. Boilers shall be built and tested in accordance with ASME Section IV.

C. UL/FM Compliance: Control devices and control sequences according to requirements of UL and FM.

D. Comply with NFPA 70 for electrical components and installation.

E. Comply with ASME CSD-1.

F. SCAQMD Rule 1146.2 for low NOx equipment.

G. Controls: The hot water condensing boiler' s control system shall include all required temperature sensors, input/output boards, transformers, main microprocessor and operator interface, and shall perform all unit control functions and safety functions. The basis of design shall be a native LonWorks controller for the control functions of the boiler package. If this is unavailable, a Lon-compliant LonTalk Communications Interface gateway/card shall be provided by the equipment manufacturer as described above to allow the unit to communicate directly with generic LonTalk Network Building Management System Controls.

1.05 SUPPLEMENTAL QUALITY ASSURANCE

A. Codes and Standards

1. Gas-fired condensing boilers shall have minimum combustion efficiency of 94% as required by National Energy Conservation Act or ASHRAE 90.1.

2. Low pressure boiler construction: in accordance with American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code, Section IV and any other public authorities having jurisdiction.

3. Provide platforms/ladders in order to grant access to safety valves in accordance with IMC. Clearances shall be maintained around boilers, heaters and tanks and related equipment and appliances so as to permit inspection, servicing, repair, replacement and visibility of all gauges. When boilers are installed or replaced, clearance shall be provided to allow access for inspection, maintenance and repair. Passageways around all sides of boilers shall have an unobstructed width as required by the manufacturer.

4. NFPA Compliance: Install gas-fired burners in accordance with NFPA Code 54: National Fuel Gas Code.

B. Fuel burning equipment shall be designed to operate satisfactorily and efficiently without objectionable smoke, odor, or noise.

1.06 WARRANTY

A. General Warranty: The special warranty specified in this article shall not deprive Owner of other rights that they may have under other provisions of the contract documents and shall be in addition to, and run concurrent with other warranties made

by the Contractor under requirements of the contract documents. Installing Contractor shall provide one (1) year warranty of parts and labor from acceptance of the system.

B. A warranty certificate must be issued from the boiler manufacturing company.

C. The heat exchanger shall have a twelve (12) year limited warranty from the manufacturer which shall run concurrent with the other warranty described below.

D. All parts shall have two (2) year limited warranty from the manufacturer.

1.07 DELIVERY

A. The intent of the project is to procure the boilers as per specifications and operating conditions mentioned in the schedule. However, boilers shall be delivered as per the project schedule, or as desired by the project coordinator.

B. If for any reason the boilers are delivered before the scheduled delivery date, the contactor shall arrange for proper storage and warehousing of the equipment. All costs associated with early delivery are excluded from this specification and shall be the responsibility of the contractor.

C. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

D. Boiler shall ship fully assembled up to practical shipping and rigging limitations. Boiler not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. Each section shall have lifting lugs for field rigging, lifting and final placement of Unit section(s).

E. Deliver boiler units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

F. Boiler shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

1.07 STORAGE AND HANDLING

A. Installing contractor shall be responsible for storing boilers in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

PART 2 - PRODUCTS

2.01 General Requirements

A. Furnish and install packaged, modulating, sealed combustion, power-vented, high efficiency gas-fired boiler(s) with cast aluminum heat exchangers that use outside air for combustion.

B. Install packaged boiler unit(s) according to manufacturer's installation instructions. All work to be done in a neat and workmanlike manner.

C. Weil-McLain Ultra-series 3CT, packaged boiler capable of burning natural gas.

D. Boiler shall be capable of full modulation firing with a turn down of up to 5 to 1.

E. Boiler(s) shall be manufactured by ISO 9001 registered company to conform to Section IV of the ASME Boiler and Pressure Vessel Code.

1. Individual cast aluminum mono block to be fire tested and hydrostatically pressure tested at factory in accordance with ASME requirements.

2. Maximum allowable working pressure 30 PSIG water as listed on the rating label.

F. Regulatory Requirements

1. Boiler(s) shall meet or exceed the SCAQD (South Coast Air Quality District of California) Low Nox emission requirement of 40NG/J.

2. Boiler(s) and controls to comply with applicable regulations.

3. Boiler(s) shall meet U.S. Environmental Protection Agency and Department of Energy guidelines for "Energy Star" energy efficiency.

2.02 Boilers

A. Acceptable boiler manufacturer(s) include(s):

1. Weil-McLain

2. Aerco International

3. Viessmann Manufacturing Company

Boilers must comply with requirements, including:

(a) Full intent of these specifications, and

(b) Provide complete submittal including literature, manuals, wiring diagrams, fuel piping diagrams, and list of similar installations. Any alternate must be of similar size and footprint, piping configuration, clearance requirements and heating surface.

(c) Submittal presented to engineer at least seven working days before bid opening for approval. Substitutions are not permitted after contract is awarded.

B. Boiler Construction

1. Boiler(s) heat exchanger:

   (a) Cast aluminum mono block.

2. Boiler main components:

   (a) The combustion chamber will be sealed and located at the top of the mono block casting which will be of counterflow design, to assure that sediment and any lime that might form will fall to the bottom, away from the crown sheet area.

   (b) Boiler(s) shall be supplied with a gas valve designed with negative pressure regulation (fan suction " pulls" gas through valve rather than gas pressure " pushing" gas through valve). This enables the boiler to operate in a safe condition at a derated output, even if the inlet gas pressure should drop to as low as 4 inches W.C. The inlet (natural) (propane) gas pressure to the boiler gas valve should be a minimum of 4" W.C. and a maximum of 13" W.C. If inlet gas pressure exceeds 13" W.C., a 100% lock-up type gas pressure regulator of adequate size must be installed in gas supply piping and adjusted to prevent pressure in excess of 13" W.C.

   (c) The burner shall be premix combustion type, made with stainless steel and a woven metal fiber outer covering providing a wide range of modulating firing rates.

   (d) The boiler shall be equipped with a variable speed blower system, capable of modulating the boiler-firing rate.

   (e) The boiler shall be equipped with a device capable of controlling the air/fuel ratio through a 5 to 1 turndown ratio.

   (f) The control system shall have an electronic display for boiler set-up, boiler status, and boiler diagnostics.

C. Venting and Combustion Air

1. Boiler(s) must be capable of using outside air piped directly to boiler for combustion. Inlet and termination of these pipes must be connected to either, through the roof or sidewall terminations as recommended by the manufacturer.

2. The boiler shall be direct vent using Schedule 40 PVC, ABS or CPVC.

D. Boiler Trim

1. All electrical components to be high quality manufacture and bear UL label.

2. Water boiler(s) controls furnished:

   (a) High limit temperature control (190 degrees F maximum allowable boiler water temperature).

   (b) Combination pressure-temperature gauge. Gauge dial clearly marked and easy to read.

(c) ASME certified pressure relief valve, set to relieve at 30 PSIG.

(d) Flue gas, outlet water temperature, and return water temperature sensors.

(e) Low water protection.

(f) Built-in freeze protection.

(g) 007, 0013 or 0014 Taco circulator.

E. Boiler Manuals

1. The boiler(s) shall be provided with complete instruction manuals, including:

(a) Boiler Installation Manual.

(b) User' s Manual.

PART 3 - EXECUTION

3.01 SUPPLEMENTAL INSTALLATION

A. General

1. Comply with State Code, local authority and regulations concerning the installation of the boilers/burners and file with that department all required information before starting the boilers/burners installation.

2. Boilers/burners shall be set level on a 6" concrete base.

3. Boilers/burners shall not be installed until the boiler room floor finish (whether waterproof type or not) has been completed. The grounding electrode shall be installed by the Division 16 Contractor prior to the pouring of the concrete base for the boilers/burners. Each boiler/burner unit shall be electrically grounded as specified and recommended by the manufacturer and regulatory agencies.

4. Boilers/burners shall be not less than the rating shown on the Drawings, and the height shall fit the space available, leaving ample allowance for replacing tubes (if tubes are used), vent connections, piping, and all other items and accessories along with manufacturer's recommended clearances around and over boilers/burners.

5. Approved piping and wiring diagrams and installation instruction shall be obtained from the manufacturer and followed in the installation of the boilers/burners.

6. Install boilers/burners in accordance with State Code and Local Utility Company Requirements.

7. Contractor shall provide liquid tight flexible metal conduit (Sealtite) for final conduit connections to all the motors.

B. Connections

1. Install one (1") inch drain valves on the outlet piping prior to first shutoff valve.

2. Connect gas piping full size to boiler gas train inlet with union.

3. Connect hot water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.

4. Install piping from safety relief valves to nearest floor drain.

5. Connect breeching to boiler outlet, full size of outlet. The boiler shall operate under positive (Category IV) stack pressure. Vent material shall be listed stainless steel double wall type for condensing appliances (AL-29-4C).

6. Ground Equipment: Tighten electrical connectors and terminals according to manufacturer' s published torque-tightening valves. If manufacturer' s torque values are not indicated, use those specified in UL486A and UL486B.

C. Gas Piping: refer to Section 22 34 50: Gas Piping System. Connect gas piping to boiler/burner, full size of boiler/burner gas train inlet as a minimum or as shown on Drawings. Provide union with sufficient clearance for burner removal and service.

1. Install gas piping as per approved Shop Drawings and as shown on the Drawing Details. Submit for approval prior to fabrication and installation. Provide required boiler clearances.

2. Gas vent piping of the gas trains shall be as specified under Specification Section 23 11 23 " Gas Piping System" .

D. Hot Water Piping: Refer to Section 23 05 23: HVAC Piping. Connect supply and return boiler tappings as indicated, with shutoff valve and union or flange at each connection, and as shown on the Drawings.

E. A balanced-flow piping system shall be used.

F. Each boiler shall be individually valved on supply and return from the system for maintenance and standby. Each boiler shall be individually protected by safety controls. Boilers shall be properly spaced to allow for installation of valving and service between units. Piping shall be located to allow free access between boilers. Each unit shall have an individual factory installed drain in the boiler.

G. Each boiler shall have separate, indirect condensate drains that shall be permanently piped as part of the installation. There shall be separate drains leading from each of the following; condensate drain pan, the stack condensate drain connection, and the stack y-connection as required. Alternately, have a separate, single flue from each boiler arranged so that any condensate forming in the flue drains back into the boiler.

H. Neutralization Kit: The contractor shall furnish and install an neutralization kit as specified on schedule and drawings. Condensate shall be drained by gravity into neutralization kit and then drained to a floor drain.

I. Boiler Exhaust Flue: The contractor shall furnish and install manufacturer recommended PVC pipe and terminate per recommendations.

3.02 SEQUENCE OF OPERATION FOR MULTIPLE BOILER MODULES

A. See Section 23 09 00 Sequence of Operation.

B. TCC shall provide the BMS I/O points as shown on control schematics of the contract drawings and as required accomplishing the described sequence of control. Mechanical Contractor (MC) shall coordinate with the Temperature Controls Contractor (TCC).

3.03 PAINTING

A. Painting: Boiler/burner units shall be primed painted at the factory with one coat of heat resistant primer. The factory coat shall provide a complete protective covering. All damaged spots shall be touched up before insulation is applied.

3.05 DEMONSTRATION

A. Preliminary Requirements: Provide the services of the field service representative of the boiler-burner unit manufacturer for the following:

1. Inspect each boiler/burner unit installations prior to start-up.

2. Supervise initial firing of boilers/burners.

3. Instruct Designated Personnel.

B. Instruction of Maintenance Personnel: The manufacturers' representative shall instruct custodial maintenance personnel in the operation and maintenance of the boilers/burners and all items and accessories. Provide a minimum of 40 hours of instruction, exclusive of all pre-start-up, start-up and service call time. This instruction shall be given in multiple sessions.

C. Startup

1. A water treatment system shall be operational before any attempt is made to start the boiler/burner units.

2. Replace damaged or malfunctioning controls and equipment.

3. Perform services in accordance with manufacturer's written start-up instructions. Signed field interdisciplinary pre-start up and start up reports shall be provided by the authorized start up representative upon completion.

D. Maintenance and Operation Training

1. Boiler shall be maintained as per manufacturer's recommendations.

2. As a part of the maintenance and operating instructions, review data in operating and maintenance manual, preventative maintenance schedule and procedures, and procedures for obtaining repair parts and technical assistance. Manufacturer's representative shall provide training on all phases of operation including startup and shutdown.

E. Schedule training with the Owner. Provide at least four days notice to Owner or Building Manager.

3.06 BOILER CLEANING AND WATER TREATMENT

A. The Contractor shall retain the services of Owner' s approved water treatment service company. This company shall test boiler water and provide a written report with recommendation for chemical treatment. This same company shall provide water treatment service and inspection for a period of one (1) year after project completion.

B. Prior to start-up the Contractor shall flush and clean the boiler and the entire hot water piping distribution system to remove all rust and deposits. Cleaning agents to be used shall be as recommended and approved by the Chemical Treatment Firm and by the Boiler Manufacturer. Contractor shall provide certification that the system has had been thoroughly cleaned and flushed.

END OF SECTION 23 52 16

SECTION 23 62 13 - AIR COOLED CONDENSING UNIT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Condensing unit package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Refrigerant piping connections.

E. Motor starters.

F. Electrical power connections.

1.02 RELATED SECTIONS

A. Section 23 05 11 – Basic Mechanical Requirements

B. Section 23 05 12 – Basic Mechanical Materials and Methods

C. Section 23 05 13 – Electrical Requirements for Mechanical Equipment

D. Section 23 09 23 - Building Management and Controls Systems

E. Section 23 73 13 – Air Handling Unit

1.03 REFERENCES

A. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

B. ANSI/ASHRAE 90A - Energy Conservation in new Building Design.

C. AHRI 370 - Sound Rating of Large Refrigeration and Air-conditioning Equipment.

D. AHRI 360 - Unitary Air-Conditioning Equipment.

1.04 SUBMITTALS

A. Submit shop drawings indicating components, dimensions, weights and loadings, required clearances, and location and size of field connections. Include schematic

layouts showing condensing units, cooling coils, refrigerant piping, and accessories required for complete system.

B. Submit product data indicating rated capacities, weights, specialties and accessories, electrical nameplate data, and wiring diagrams.

C. Submit design data indicating refrigeration and chilled water pipe sizing.

D. Submit manufacturer's installation instructions.

1.05 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, start-up instructions, installation instructions, and maintenance procedures.

1.06 HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage.

1.07 WARRANTY

A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

1.08 MAINTENANCE

A. Furnish complete service and maintenance of air cooled condensing unit.

B. Provide maintenance service with a two month maximum time interval between calls. Provide 24-hour emergency service on breakdowns and malfunctions.

1.09 ACOUSTICS

A. Manufacturer of condensing unit shall provide outdoor sound power level data across all major octave band center frequencies for cataloged operating range of unit at gross cooling capacity range. Data shall be obtained in conformance with ANSI S1.32-1980, American National Standard Methods for the Determination of Sound Power Levels of Discrete Frequency and Narrow Band Noise Sources in Reverberation Rooms and per AMCA Standard 300-85 test code "Sound Rating Air Moving Devices".

1.10 REGULATORY REQUIREMENTS

A. Unit shall conform to UL 1995 , CAN/CSA C22.2 NO. 236-95 for construction of condensing units and shall have cULus label affixed to unit.

1. In the event the unit is not UL/CSA approved, the manufacturer shall, at his expense, provide for a field inspection by a UL representative to verify conformance to cULus standards. If necessary, contractor shall perform required modifications to the unit to comply with UL, as directed by the UL representative, at no additional expense to the Owner.

1.11 SUMMARY

A. The contractor shall furnish and install air-cooled condensing unit(s) as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The contractor shall furnish and install air-cooled condensing units as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. Manufacturers:

Condensing unit shall be manufactured by the same manufacturer as the indoor Air Handling Unit

1. Trane
2. Carrier
3. York.

2.02 GENERAL UNIT DESCRIPTION

A. Provide self-contained, packaged, factory-assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, subcooling circuits, and controls.

2.03 CASING

A. Cabinet: Galvanized steel, phosphatized, and finished with an air-dry paint coating durable enough to withstand 672 consecutive-hour salt spray application in

accordance with standard ASTM B 117. Structural members shall be 14 gauge with access doors and removable panels of minimum 18 gauge steel.

B. Control Panel: The unit control panel section shall be compartmented to separate high and low voltage components. The control panels shall also be fully gasketed, hinged and provided with quick release latches for easy access.

1. The high voltage control panel shall be provided with a door handle disconnect switch to facilitate convenient, safe disconnection of main three phase power.

2.04 CONDENSER SECTION

A. Condenser coils shall have all Aluminum Microchannel coils. All coils shall be leak tested at the factory to ensure pressure integrity. The condenser coil is pressure tested to 650 psig.

2.05 REFRIGERANT CIRCUIT(S)

A. Provide single circuit on 20 through 30 tons units and two circuits on 40 through 120 ton units.

B. Provide pressure gauges for suction and discharge for each circuit. Mount gauges adjacent to compressors.

2.06 FANS AND MOTORS

A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Fans shall be statically and dynamically balanced.

B. Provide motors suitable for outdoor use, three phase with permanently lubricated ball bearings and built in current and thermal overload protection.

2.07 COMPRESSORS

A. Compressors shall be industrial grade, energy-efficient direct-drive 3600 RPM maximum speed reciprocating, scroll type. The motor shall be of a suction gas cooled hermetic design. Compressor shall have centrifugal oil pump with dirt separator, oil sight glass, and oil charging valve. A solid state temperature sensor shall be embedded in the motor windings to protect against excessive winding temperatures.

1. If semi-hermetic reciprocating industrial grade compressors are utilized provide single piece crankshafts, connecting rods, aluminum pistons, rings to prevent gas leakage, high strength non-flexing ring type suction and discharge valves, spring loaded heads, replaceable cylinder liners, and

sealing surface immersed in oil. Provide removable discharge heads and hand hole covers, and discharge service valves.

2. Provide compressor with automatic capacity reduction equipment consisting of suction valve unloaders. Use electric solenoid actuated lifting mechanism. Provide for unloaded compressor start.

B. Motor shall be designed for across-the-line starting and suitable for a voltage utilization range of +/- 10 percent from nameplate voltage.

2.08 SYSTEM CONTROLS

A. Unit Control: Provide 115 volt control circuit with fusing and control power transformer. Unit wired with contactors for compressor and condenser motors, compressor overload protection, high/low cutouts, differential oil pressure control, reset relay,and anti-cycle compressor timer.

2.09 LOW AMBIENT CONTROLS

A. Provide low ambient electronic damper assemblies to allow the unit to start and operate down to 0 degrees F (10 degrees F with hot gas bypass) outdoor ambient conditions. Low ambient damper operation shall be modulated based upon refrigerant head pressure.

2.10 MISCELLANEOUS FEATURES

A. Unit Disconnect: Provide door handle disconnect switch for disconnection of main power. Lugs shall be suitable for copper wiring only.

B. Spring Isolators: Provide field installed vibration isolators.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide for connection to electrical service.

C. Install units on vibration isolation.

D. Install units on concrete base as indicated.

E. Provide connection to refrigeration piping system and evaporators.

3.02 MANUFACTURER'S FIELD SERVICES

A. Supply initial charge of refrigerant and oil for each refrigerant circuit.

END OF SECTION 23 62 13

SECTION 23 64 23 - AIR COOLED WATER CHILLERS

PART 1 GENERAL

1.01 SCOPE

A. Section includes design, performance criteria, controls and control connections, chilled water connections, electrical power connections and refrigerants of the chiller package.

1.02 RELATED SECTIONS

A. Section 23 05 11 – Basic Mechanical Requirements

B. Section 23 05 12 – Basic Mechanical Materials and Methods

C. Section 23 05 13 – Electrical Requirements for Mechanical Equipment

D. Section 23 09 23 - Building Management and Controls Systems

1.03 REFERENCES

A. Products shall be designed, rated and certified in accordance with applicable sections of the following Standards and Codes:

1. To comply with the most recent versions of applicable Standards and Codes of AHRI 550 / 590.

2. AHRI 370 - Standard for Sound Rating of Large outdoor Refrigerating and Air-conditioning Equipment.

3. To comply with the most recent versions of applicable Standards and Codes of ASHRAE 15.

4. Units shall meet the efficiency standards of the latest ASHRAE 90.1 Standard.

5. To comply with seismic application in accordance with the most recent versions of the International Building Code (IBC).

1.04 QUALITY ASSURANCE

A. UL 1995 -- Standard for Heating and Cooling Equipment.

B. Manufactured facility to be ISO 9001.

C. Factory Functional Test: The chiller shall be pressure tested, evacuated and fully charged with HFC-410A refrigerant and oil. In addition, a factory functional test to verify correct operation by cycling condenser fans, closing compressor contacts and reading data points from temperature and pressure sensors.

1. The test conditions shall be at AHRI standard rating conditions, 44F leaving evaporator, 2.4 gpm/ton and 95F ambient.

2. The owner or his representative shall be notified 14 days in advance to witness the factory performance test. If the owner or his representative desires to witness the performance test, all travel expenses will be the owner's responsibility.

D. Chiller manufacturer shall have a factory trained and supported service organization that is within a 75 mile radius of the site.

E. Warranty: The manufacturer shall warrant all equipment and material of its manufacture against defects in workmanship and material for a period of one year from date of initial start-up or eighteen months from date of shipment; whichever occurs first.

1.05 SUBMITTALS

A. Submit shop drawings and product data in accordance with the specifications.

B. Submittals shall include the following:

1. Dimensioned plan and elevation view drawings, required clearances, and location of all field connections.

2. Product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

1.06 OPERATION AND MAINTENANCE DATA

A. Include manufacturer's descriptive literature, installation checklist, start-up instructions and maintenance procedure.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Units shall be delivered to job site fully assembled and charged with refrigerant (unless selected with nitrogen charge) and oil by the manufacturer.

B. Unit shall be stored and handled per manufacturer's instructions.

C. During shipment, provide protective covering over vulnerable components. Fit

nozzles and open pipe ends with enclosures.

1.08 ENVIRONMENTAL REQUIREMENTS

1.09 WARRANTY

A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

B. OEM To provide Extended Warranty to include:

1. Compressor Parts (5 year)

2. Whole Unit Labor Warranty (1 year)

3. Compressor Warranty (5 year)

4. Refrigerant Warranty (1 year)

1.10 MAINTENANCE SERVICES

A. All inspections and service of units shall be accomplished by factory trained and authorized servicing technicians.

B. In conjunction with and supporting Factory warranty OEM shall furnish complete factory authorized service and maintenance of Applied Chillers.

C. OEM shall provide and report quarterly, annual, and bi-annual maintenance in compliance with or better than ASHRAE Standard 180-2008.

D. Include maintenance items as recommended in manufacturer's operating and maintenance data.

E. Submit copy of service call work orders and summary report to the Owner, including description of work performed, operating performance status and noted exceptions.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The contractor shall furnish and install unit(s) as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. Manufacturers:

1. Trane

2. Carrier

3. York.

Alternates must still comply with the performance and features as specified with these specifications and as indicated on the design documents. Job will be awarded on basis of specified product. Substitutions must be selected and approved within 14 calendar days after award of contract.

2.02 GENERAL UNIT DESCRIPTION

A. Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the package shall be all factory wiring, piping, controls, and refrigerant charge (HFC-410A).

2.03 CABINET

A. Frame shall be heavy-gage, with a powder-coated paint finish for both aesthetic appeal and to offer more resistance to corrosion.

B. Units shall be constructed of a galvanized steel frame with galvanized steel panels and access doors. Component surfaces shall be finished with a powder-coated paint. The coating or paint system shall withstand a 1000-consecutive-hour salt spray application in accordance with standard ASTMB117.

2.04 COMPRESSORS

A. Fully hermetic scroll type compressors with R410A optimized and dedicated scroll profile.

B. Direct drive motor cooled by suction gas with only three major moving parts and a completely enclosed compression chamber which leads to increased efficiency.

C. Each compressor will have crankcase heaters installed and properly sized to minimize the amount of liquid refrigerant present in the oil sump during off cycles.

2.05 EVAPORATOR

A. The evaporator shall be a high efficiency, brazed plate-to-plate type heat exchanger consisting of parallel plates. Braze plates shall be stainless steel with copper braze material.

B. The evaporator shall be protected with an etched foil heater and insulated with 3/4 inch insulation. This combination shall provide freeze protection down to -20F ambient temperatures while the heater is powered. Contractor shall provide separate power to energize heater and protect evaporator while chiller is disconnected.

C. The water side working pressure shall be rated at 150 psig and tested at 1.5 times maximum allowable water side working pressure.

D. The refrigerant side working pressure shall be rated at 460 psig (29.6 bars) and tested at 1.1 maximum allowable refrigerant side working pressure.

2.06 CONDENSER

A. The condenser coils shall consist of copper tubes mechanically bonded into plate-type aluminum fins. A subcooling coil shall be an integral part of the main condenser coil.

B. The maximum allowable working pressure of the condenser shall be 650 psig (44.8 bars). The condensers shall be factory proof and leak tested at 715 psig (49.3 bars).

C. Low Sound Fans shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise fan blade.

D. Low speed fan motors shall be three-phase with permanently lubricated ball bearings and individually protected by circuit breakers.

E. Unit shall be capable of starting and running at outdoor ambient temperatures from 32F to 125F (0C - 52C) for all sizes.

F. Provide coil protection for shipping. Entire condenser coil shall be covered with heavy plastic to prevent inadvertent damage to coil during shipment or rigging.

2.07 ENCLOSURES

A. Mount starters in a UL1995 rated panel for outdoor use.

B. The starter shall be across-the-line configuration, factory-mounted and fully pre-wired to the compressor motor(s) and control panel.

C. Unit shall have a single point power connection.

D. A control power transformer shall be factory-installed and factory-wired to provide unit control power.

E. Control panel shall be dead front construction for enhanced service technician safety.

F. Power line connection type shall be standard with a terminal block.

2.08 REFRIGERATION COMPONENTS

A. Each refrigerant circuit shall include a filter drier, electronic expansion valve with site glass, liquid line service valves and a complete operating charge of both refrigerant HFC-410A and compressor oil.

B. Each refrigerant circuit shall include a discharge line service valve to allow the refrigerant to be isolated in the condenser.

2.09 CONTROLS, SAFETIES AND DIAGNOSTICS

A. The microprocessor-based unit controller shall be factory-installed and factory-tested.

B. The unit display shall provide the following data:

1. Water and air temperatures
2. Refrigerant levels and temperatures
3. Flow switch status
4. Compressor starts and run times

C. The unit controller shall provide chilled water reset based on return water as an energy saving option.

D. Chilled water temperature control shall be microprocessor-based, proportional and integral controller to show water and refrigerant temperature, refrigerant pressure, and diagnostics. This microprocessor-based controller is to be supplied with each chiller by the chiller manufacturer. Controls shall include the following readouts and diagnostics:

1. Low evaporator refrigerant temperature and/or pressure
2. High condenser refrigerant pressure
3. Motor current overload
4. High compressor discharge temperature

5. Electronic distribution faults: phase loss, phase imbalance, or phase reversal

E. Unit shall be shipped with factory control and power wiring installed.

F. On chiller, mount weatherproof control panel, containing starters, power and control wiring, factory wired with terminal block power connection. Provide primary and secondary fused control power transformer and a single 115 volt 60 Hz single phase connection for evaporator freeze protection heaters.

G. The unit controller shall utilize a microprocessor that will automatically take action to prevent unit shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

1. Motor surge protector that is set at 95% of compressor RLA that will automatically shut off a compressor to help prevent an over current trip. One protector is required for each compressor and indicating light shall also be provided.

H. Provide the following safety controls with indicating lights or diagnostic readouts.

1. Low chilled water temperature protection.

2. High refrigerant pressure.

3. Low oil flow protection.

4. Loss of chilled water flow.

5. Contact for remote emergency shutdown.

6. Motor current overload.

7. Phase reversal/unbalance/single phasing.

8. Over/under voltage.

9. Failure of water temperature sensor used by controller.

10. Compressor status (on or off).

I. Provide the following operating controls:

1. Chilled water pump output relay that closes when the chiller is given a signal to start.

2. High ambient pressure controller that shuts off a compressor to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.

3. Compressor current sensing limit that shuts off a compressor to help prevent current overload nuisance trips.

4. Auto lead-lag functions that constantly even out run hours and compressor starts automatically. If contractor cannot provide this function then cycle counter and hour meter shall be provided for each compressor so owner can be instructed by the contractor on how to manually change lead-lag on compressors and even out compressor starts and running hours.

5. Low ambient lockout control with adjustable setpoint.

J. Provide user interface that displays chilled water temperature setpoint and actual leaving chilled water temperature. Display should be on the front of panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels.

1. Leaving chilled water setpoint adjustment from LCD input

2. Entering and leaving chilled water temperature output

3. Percent RLA output for each compressor

4. Pressure output of condenser for circuits one and two

5. Pressure output of evaporator for circuits one and two

6. Ambient temperature output

7. Voltage output

8. Current limit setpoint adjustment from LCD input.

9. Remote leaving water temperature setpoint.

10. Alarm indicating light and relay

K. Digital Communications to BAS system shall consist of a BACnet MS/TP interface via a single twisted pair wiring.

L. The chiller shall have Time of Day Scheduling capabilities for scheduling single chiller applications through the chiller control panel without the need for a building automation system. This feature allows the user to set up to 10 events in a 7 day

time period.

M. The chiller control panel shall provide leaving chilled water temperature reset based upon return water temperature.

N. The chiller control panel shall provide an alarm relay output that shall energize whenever a fault requiring manual reset is detected by the panel.

O. The chiller control panel shall provide input for leaving chilled water temperature setpoint based upon a 2-10VDC or 4-20mA signal from a building automation system.

P. The chiller control panel shall provide input for chiller current limit setpoint based upon a 2-10VDC or 4-20mA signal from a building automation system.

Q. The chiller control panel shall provide an output for chiller Percent Capacity via a 2-10VDC or 4-20mA signal to a building automation system.

2.10 Chilled Fluid Circuit

A. Chilled fluid circuit shall be rated for 150 psig (1034 kPa) working pressure.

B. Proof of flow switch shall be provided by the equipment manufacturer and installed the correct number of pipe diameters from any elbow and in the correct orientation.

C. Flow switch shall be IFM flow monitor type.

D. Units with brazed plate evaporators shall have a water strainer that is factory provided. It shall be installed with a blowdown valve to facilitate periodic cleaning of the strainer to prevent it from becoming clogged.

E. The pump motor shall be installed with an inverter or the pump impeller shall be trimmed to be within 10% of jobsite flow and total dynamic head to prevent excessive wasted pump energy. Pump shall include two high head pumps, with VFD, expansion vessels, drainage valves, shut-off vales at entering and leaving connections.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Align chiller package on steel or concrete foundations.

C. Install units on isolators.

D. Connect to electrical service.

E. Connect to chilled water piping.

3.02 SCHEDULE

3.03 MANUFACTURER'S FIELD SERVICES

A. OEM Startup is performed by factory trained and authorized servicing technicians confirming equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty.

1. Included OEM Factory Startup:

    a. Centrifugal, Rotary Screw, and Scroll Chillers

B. Applied Chiller manufacturers shall maintain service capabilities no more than 50 miles from the job site.

C. The manufacturer shall furnish an alternative price for:

1. Extended compressor warranty for 5 years.

D. The manufacturer shall furnish complete submittal wiring diagrams of the package unit as applicable for field maintenance and service.

END OF SECTION 23 64 23

SECTION 23 73 13 - AIR HANDLING UNIT

PART 1 GENERAL

1.01 WORK INCLUDED

A. Applied Air Handling Units.

1.02 RELATED SECTIONS

A. Section 23 05 11 – Basic Mechanical Requirements

B. Section 23 05 12 – Basic Mechanical Materials and Methods

C. Section 23 05 13 – Electrical Requirements for Mechanical Equipment

D. Section 23 09 23 - Building Management and Controls Systems

E. Section 23 31 00 – Air Duct and Accessories

F. Section 23 62 13 – Air Cooled Condensing Unit

1.03 REFERENCES

A. AMCA Publication 99 - Standards Handbook.

B. AMCA Standard 500-D - Laboratory Methods of Testing Dampers for Rating.

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

D. ANSI/AMCA Standard 204 - Balance Quality and Vibration Levels for Fans.

E. ANSI/AHRI Standard 410 - Forced Circulation Air-Cooling and Air-Heating Coils.

F. ANSI/AHRI Standard 430 - Central Station Air Handling Units.

G. ANSI/ASHRAE Standard 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.

H. ANSI/ASHARE Standard 62.1 - Ventilation for Acceptable Indoor Air Quality.

I. ANSI/ASHARE Standard 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.

J. ANSI/NEMA MG 1 - Motors and Generators.

K. ANSI/UL 900 - Standard for Safety Air Filter Units.

L. ASHRAE Standard 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems.

M. ASTM B117 - Standard Practice for Operation Salt Spray Apparatus.

N. NFPA 70 - National Electrical Code

O. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilation Systems.

P. UL 1995 - Standard for Safety Heating and Cooling Equipment

1.04 QUALITY ASSURANCE

A. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with current AHRI Standard 410.

B. Air handling units shall be rated and/or rated and certified in accordance with AHRI Standard.

C. ISO 9001 Certification.

1.05 SUBMITTALS

A. No equipment shall be fabricated or delivered until the receipt of approved shop drawings from the Owner or Owner's approved representative.

B. AHU manufacturer shall provide the following information with each shop drawing/product data submission:

1. Dimensioned arrangement drawings for each AHU including a plan and elevation view of the assembled unit with overall dimensions, lift points, unit shipping split locations and dimensions, installation and operating weights, and installation, operation and service clearances.

2. All electrical, piping, and ductwork requirements, including sizes, connection locations, and connection method recommendations.

3. Each component of the unit shall be identified and mechanical specifications shall be provided for unit and accessories describing construction, components, and options.

4. All performance data, including capacities and airside and waterside pressure drops, for components.

5. Fan curves shall be provided for fans with the design operating points indicated.

Data shall be corrected to actual operating conditions, temperatures, and altitudes.

C. The AHU manufacturer shall provide appropriate sets of submittals as referenced in the General Conditions and shall submit to the Owner electronic copies of the IOM.

D. The AHU manufacturer shall list any exceptions to the specification.

1.06 REGULATORY REQUIREMENTS

A. Agency Listings/Certifications

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

2. Air handling units shall be certified in accordance with AHRI Standard 430. Units meeting AHRI Standard 430 certification shall have a label affixed to the unit. If the unit is not AHRI 430 certified, or tested in accordance with AHRI 430 then the contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

3. Certify air handling coils in accordance with AHRI Standard 410. Units shall be provided with certification label affixed to the unit. If air handling coils are not certified in accordance with AHRI Standard 410, contractor shall be responsible for expenses associated with testing of coils after installation to verify performance of coil(s). Any costs incurred to adjust coils to meet scheduled capacities shall be the sole responsibility of the contractor.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Units shall ship fully assembled up to practical shipping and rigging limitations. Shipping splits shall be clearly defined on submittal drawings. Cost associated with non-conformance to shop drawings shall be the responsibility of the manufacturer. AHU's less than 100-inches wide shall allow for forklift transport and

maneuverability on the jobsite.

C. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

D. Unit shall be shipped in a clear shrink-wrap or stretch-wrap to protect unit from in-transit rain and debris per ASHRAE 62.1 recommendations.

E. Installing contractor shall be responsible for storing AHU in a clean, dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.08 START-UP AND OPERATING REQUIREMENTS

A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters in place, bearings lubricated (if applicable), condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

1.09 WARRANTY

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

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The contractor shall furnish and install unit(s) as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. Manufacturers:

1. Trane
2. Carrier
3. York.

Alternates must still comply with the performance and features as specified with these specifications and as indicated on the design documents. Job will be awarded on basis of specified product. Substitutions must be selected and approved within 14 calendar days after award of contract.

2.02 GENERAL

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

2.03 UNIT CASING

A. The entire air handler shall be constructed of galvanized steel. Casing finished to meet ASTM B117 250-hour salt-spray test. The removal of access panels or access doors shall not affect the structural integrity of the unit. All removable panels shall be gasketed. All doors shall have gasketing around full perimeter to prevent air leakage. Contractor shall be responsible to provide connection flanges and all other framework that is needed to properly support the unit.

B. All panels shall be 2-inch double wall construction to facilitate cleaning of unit interior. Casing deflection shall not exceed .005-inch deflection per linear foot under negative or positive pressure, up to unit casings maximum design limit of pressure.

C. Unit floor shall be of sufficient strength to support 300-lb load during maintenance activities, and shall deflect no more than .005-inches when sitting on a support structure.

D. Panel insulation shall provide a minimum thermal resistance (R) value of 13 ft^2*h*F/Btu throughout the entire unit. Insulation shall completely fill the panel cavities in all directions so that no voids exist and settling of insulation is prevented. Panel assembly shall comply with NFPA 90A.

E. Access panels and/or access doors shall be provided in all sections to allow easy access to drain pan, coil(s), motor, drive components and bearings for cleaning, inspection, and maintenance.

F. Access panels and doors shall be fully removable without the use of specialized tools to allow complete access of interior surfaces.

2.04 ACCESS DOORS

A. Access doors shall be 2-inch double-wall construction. Interior and exterior shall be of the same construction as the interior and exterior wall panels.

B. Gasketing shall be provided around the full perimeter of the doors to prevent air leakage.

C. Door hardware shall be surface-mounted to prevent through-cabinet penetrations that could likely weaken the casing leakage and thermal performance.

D. Handle hardware shall be designed to prevent unintended closure.

E. Access doors shall be hinged and removable without the use of specialized tools to allow.

F. All doors shall be a 60-inch high when sufficient unit height is available, or the maximum height allowed by the unit height.

2.05 PRIMARY DRAIN PANS

A. The drain pan shall be designed in accordance with ASHRAE 62.1 being of sufficient size to collect all condensation produced from the coil and sloped in two planes, pitched toward drain connections, promoting positive drainage to eliminate stagnant water conditions when unit is installed level and trapped per manufacturer's requirements. The outlet shall be located at the lowest point of the pan and shall be sufficient diameter to preclude drain pan overflow under any normally expected operating condition. Drainpan shall be constructed of 16 gauge, 304 Stainless Steel material.

B. All drain pan threaded connections shall be visible external to the unit. Threaded connections under the unit floor shall not be accepted.

C. Drain connections shall be of the same material as the primary drain pan and shall extend a minimum 2-1/2-inch beyond the base to ensure adequate room for field piping of condensate traps.

D. The installing contractor is responsible to ensure the unit is installed level, trapped in accordance with the manufacturer's requirements, and visually inspected to ensure proper drainage of condensate

2.06 FANS

A. Fan sections shall have a minimum of one hinged and latched access door located on the drive side of the unit to allow inspection and maintenance of the fan, motor, and drive components. Construct door(s) per Section 2.04.

B. Provide fans of type and class as specified on the schedule. Fan shafts shall be solid steel, coated with a rust-inhibiting coating, and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM.

C. All fans, including direct drive plenum fans shall be internally isolated to inhibit noise and vibration through the ductwork and building structure. A flexible connection shall be installed between the fan and unit casing to ensure complete

isolation. If fans and motors are not internally isolated, then the entire unit shall be externally isolated from the building, including supply and return duct work, piping, and electrical connections. External isolation shall be furnished by the installing contractor in order to avoid transmission of noise and vibration through the ductwork and building structure.

D. Belt-driven fans shall be provided with self-aligning, anti-friction bearings selected for L-50 200,000-hour average life per ANSI/AFBMA Standard 9

E. MOTORS AND DRIVES

1. All motors and drives shall be factory-installed and run tested. All motors shall be installed on a slide base to permit adjustment of belt tension. Slide base shall be designed to accept all motor sizes offered by the air-handler manufacturer for that fan size to allow a motor change in the future, should airflow requirements change. Fan sections without factory-installed motors shall have motors field installed by the contractor. The contractor shall be responsible for all costs associated with installation of motor and drive, alignment of sheaves and belts, run testing of the motor, and balancing of the assembly.

2. Motors shall meet or exceed all NEMA Standards Publication MG 1 - 2006 requirements and comply with NEMA Premium efficiency levels when applicable. Motors shall comply with applicable requirements of NEC and shall be UL Listed.

3. Fan Motors shall be heavy duty, open drip-proof operable at electrical characteristics as scheduled. If applicable, motor efficiency shall meet or exceed NEMA Premium efficiencies.

4. All fan types shall use 4-pole, 1800 rpm, motors, NEMA B design, with Class B insulation, capable to operate continuously at 104 deg F (40 deg C) without tripping overloads.

5. Motors shall have a +/- 10 percent voltage utilization range to protect against voltage variation.

6. V-Belt drives for housed fans shall be fixed pitch rated at 1.5 times the motor nameplate. Drives 20 hp and larger or any drives on units equipped with VFDs and housed fans shall be fixed pitch.

7. All housed fans with motors 15 hp and larger shall be equipped with multiple belt drives.

8. Manufacturer shall provide for each unit with a housed fan a nameplate to assist air balance contractor in start up and service personnel in

maintenance

2.07 COILS

A. Coils section header end panel shall be removable to allow for removal and replacement of coils without impacting the structural integrity of the unit.

B. Install coils such that headers and return bends are enclosed by unit casing to ensure that if condensate forms on the header or return bends, it is captured by the drain pan under the coil.

C. Coils shall be manufactured with plate fins to minimize water carryover and maximize airside thermal efficiency. Fin tube holes shall have drawn and belled collars to maintain consistent fin spacing to ensure performance and air pressure drop across the coil as scheduled. Tubes shall be mechanically expanded and bonded to fin collars for maximum thermal conductivity. Use of soldering or tinning during the fin-to-tube bonding process is not acceptable due to the inherent thermal stress and possible loss of bonding at that joint.

D. Construct coil casings of galvanized steel [stainless steel]. End supports and tube sheets shall have belled tube holes to minimize wear of the tube wall during thermal expansion and contraction of the tube.

E. All coils shall be completely cleaned prior to installation into the air handling unit. Complete fin bundle in direction of airflow shall be degreased and steam cleaned to remove any lubricants used in the manufacturing of the fins, or dirt that may have accumulated, in order to minimize the chance for water carryover.

F. On units with two coils in the airstream, space shall be provided by the unit manufacturer to facilitate cleaning and inspection of the fin surfaces. Access door(s) shall be located in the unit casing between the two coils. Construct door(s) in accordance with Section 2.04.

F. Hydronic Coils

1. Supply and return header connections shall be such that direction of coil water-flow is counter to direction of unit air-flow.

2. Coils shall be proof-tested to 300 psig and leak-tested to 200 psig air pressure under water.

3. Headers shall be constructed of round copper pipe.

4. Tubes shall be 1/2-inch .016 copper, with aluminum fins.

G. Refrigerant Cooling Coils

1. Refrigerant suction and liquid connections shall penetrate through unit casing to facilitate refrigerant piping in the field.

2. Coils shall be proof tested to 450 psig and leak tested to 300 psig air pressure under water. After testing, insides of tubes shall be air dried, charged with dry nitrogen or dry air, and sealed to prevent contamination.

3. Refrigerant suction and liquid headers shall be constructed of copper tubing. Suction and liquid connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.

4. Tubes shall be 1/2 inch O.D., minimum .016 inch thick copper. Fins shall be aluminum.

5. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

2.08 FILTERS

A. Provide factory-fabricated filter section of the same construction and finish as unit casings. Filter section shall have side access filter guides and access door(s) extending the full height of the casing to facilitate filter removal. Construct doors in accordance with Section 2.04. Provide fixed filter blockoffs as required to prevent air bypass around filters. Blockoffs shall not need to be removed during filter replacement. Filters to be of size, and quantity needed to maximize filter face area of each particular unit size.

B. Filters shall be provided as defined in project plans and schedule

C. One set of start-up filters shall be supplied with the unit.

2.09 DAMPERS

A. All dampers shall be internally mounted. Dampers shall be premium ultra low leak and located as indicated on the schedule and plans. Parallel blade arrangement shall be provided as indicated on the schedule and drawings. Dampers shall be Ruskin CD60 double-skin airfoil design or equivalent for minimal air leakage and pressure drop. Leakage rate shall not exceed 3 CFM/square foot at one inch water gauge complying with ASHRAE 90.1 maximum damper leakage and shall be AMCA licensed for Class 1A. All leakage testing and pressure ratings shall be based on AMCA Standard 500-D. Manufacturer shall submit brand and model of damper(s) being furnished, if not Ruskin CD60.

2.10 COIL/ACCESS SECTION

A. Unit(s) shall include a separate section housing a coil section and access section

as one assembly. Refer to drawings to determine which unit(s) includes the additional section.

B. Section shall include a stainless steel drainpan and an access door of sufficient size to allow for visual inspection of the leaving face of the first coil in the airstream and entering face of the second coil in the airstream shall be included as standard in this section.

C. Access door shall be of the same construction as all other doors on the unit. Refer to door specification for location of door(s).

2.11 VARIABLE FREQUENCY DRIVE

A. Service Conditions

1. VFDs shall provide full output in an ambient temperature from -10 to 50° C (14 to 104° F).

2. VFDs shall provide full output in a relative humidity from 0 to 95%, non-condensing.

3. VFDs shall provide full output up to 3300 feet elevation without derating.

4. VFDs shall provide full output with an AC line voltage variation from -10 to +10% of nominal voltage.

5. No side clearance shall be required for cooling of any units. All power and control wiring shall be done from the bottom.

B. Warranty

1. The VFD shall be warranted by the manufacturer for a period of 42 months from date of shipment, or 36 months from start-up, which ever occurs first. The warranty shall include parts, labor, travel costs and living expenses incurred by the manufacturer to provide factory-authorized on-site service.

2.12 FACTORY-INSTALLED MOTOR WIRE TERMINATION, VFD, AND STARTER ENCLOSURES

A. VFDs or starter shall be factory mounted on the drive side of the fan section.

B. Any welds shall be properly finished with no rough edges. Enclosures shall house, Drive-OFF switches, manual speed controls, and control transformers.

2.13 FACTORY WIRING OF VFD'S AND STARTERS

A. VFDs shall be wired per NEC, UL, and NFPA 90A requirements. Units with factory-mounted controls shall also include power wiring from the VFD or starter control transformer to the control system transformers. After mounting and wiring of VFDs, on the AHUs, trained factory personnel shall ensure proper operation of each VFD, through a thorough factory test. Testing shall include a Hypot test of unit wiring to ensure that no weaknesses exist in wiring or motor. Each VFD shall be energized and the fan run to ensure the VFD will operate throughout the usable range of the drive and that the fan rotation is correct.

B. On units provided with factory mounted and wired supply fan starter or VFD and DDC controls, the manufacturer shall provide a single point of power. Line-to-24v transformers shall be provided with sufficient vA to power the factory installed control points.

2.14 FACTORY-ENGINEERED AUTOMATIC TEMPERATURE CONTROLS

A. Unit control points only shall be factory installed for a field supplied controller and wiring. Control points shall be manufactures standard points.

B. Unit shall be provided with a factory wired, installed and tested unit controller, capable of standalone unit control, or tied into a building automation system through Bacnet communication. All control points in unit shall be tested at the unit manufacturer' s facility prior to shipment.

A. Damper actuators shall be selected, provided, and mounted by the AHU manufacturer on each damper. Actuators shall be of sufficient size and quantity to ensure complete damper operation. Actuators shall be direct coupled to minimize linkage.

B. Differential pressure switch shall be provided by the AHU manufacturer. Pressure switches shall be factory installed across the filter bank to monitor clean/dirty filter status.

C. Low limits shall be factory engineered to maximize coil coverage. Capillary radius clips shall be used at low limit bends to ensure no crimping or wear of low limits. Low limits shall be wired to shut down the fan to protect the unit.

D. Fan status switches shall be provided and mounted by the AHU manufacturer.

E. On variable volume units, a discharge temperature sensors shall be provided and mounted on the fans by the AHU manufacturer.

F. Outside air temperature sensors shall be provided at the jobsite.

G. Averaging temperature sensors shall be provided by the AHU manufacturer. Sensors shall be factory engineered to accurately measure mixed air temperatures.

Capillary radius clips shall be used at capillary bends to ensure no crimping or wear of the tube.

H. For variable-air-volume units, duct static pressure switches shall be provided by the AHU manufacturer in the unit. Switches shall be piped in the field.

2.15 Unit DDC Controller

A. One programmable DDC controller shall be provided by the AHU manufacturer for each AHU as indicated on the schedule and drawings. Control of multiple units from a single controller is not acceptable. Each programmable DDC controller shall use the LonTalk protocol and shall be LonMark certified to ensure open communication with other open BASs. Complete communications and diagnostics including all AI, BI, AO, BO, set points and alarms shall only require a twisted pair of wires between the unit controller and the BAS. Each unit controller shall be factory wired to the unit end devices.

B. The programmable DDC controller and the control components shall be selected, mounted, wired and tested by the AHU manufacturer to ensure delivery of specified performance and to minimize job site startup time. Testing shall be performed to ensure wiring continuity between the controller and all devices, and to ensure proper operation of the end devices. DDC controllers shall be located on unit as indicated on the drawings.

PART 3 EXECUTION

3.01 SHIPPING

A. Paper copies of the IOM shall also be shipped with each AHU.

B. The AHU manufacturer shall identify all shipments with the order number. Enough information shall be provided with each shipment to enable the Mechanical Contractor to confirm the receipt of units when they are received. For parts too small to mark individually, the AHU manufacturer shall place them in containers.

C. To protect equipment during shipment and delivery, all indoor units shall be stretch or shrink wrapped. Wrap shall be a minimum of 7 mil plastic. Pipe ends and pipe connection holes in the casing shall be capped or plugged prior to shipment

D. After loading the equipment for shipment, the AHU manufacturer shall contact the shipping contact on the order and provide the name of the carrier, description of equipment, order number, shipping point, and date of shipment.

3.02 ON-SITE STORAGE

A. If equipment is to be stored for a period of time prior to installation, the

Mechanical Contractor shall remove all stretch or shrink wrap from units upon receipt to prevent unit corrosion and shall either place the units in a controlled indoor environment or shall cover the units with canvas tarps and place them in a well-drained area. Covering units with plastic tarps shall not be acceptable.

3.03 FIELD EXAMINATION

A. The Mechanical Contractor shall verify that the mechanical room is ready to receive work and the opening dimensions are as indicated on the shop drawings and contract documents.

B. The Mechanical Contractor shall verify that the proper power supply is available prior to starting of the fans.

3.04 INSTALLATION

A. The Mechanical Contractor shall be responsible to coordinate ALL of his installation requirements with the Owner and the Owner's selected Mechanical Contractor to ensure that a complete installation for each unit is being provided. Coordination efforts shall include such items as unloading and hoisting requirements, field wiring requirements, field piping requirements, field ductwork requirements, requirements for assembly of field-bolted or welded joints, and all other installation and assembly requirements.

B. The AHU manufacturer shall provide all screws and gaskets for joining of sections in the field.

C. The Mechanical Contractor shall verify that the following items have been completed prior to scheduling the AHU manufacturer's final inspection and start up:

1. All isolated components have had their shipping restraints removed and the components have been leveled.

2. On all field-joined units, that all interconnections have been completed, i.e., electrical and control wiring, piping, casing joints, bolting, welding, etc.

3. All water and steam piping connections have been completed and hydrostatically tested and all water flow rates have been set in accordance with the capacities scheduled on the Drawings.

4. All ductwork connections have been completed and all ductwork has been pressure tested for its intended service.

5. All power wiring, including motor starters and disconnects, serving the unit has been completed.

6. All automatic temperature and safety controls have been completed.

7. All dampers are fully operational.

8. All shipping materials have been removed.

9. Clean filter media has been installed in the units.

3.05 LEVELING

A. The Mechanical Contractor shall level all unit sections in accordance with the unit manufacturer's instructions. The Mechanical Contractor shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level.

3.06 FINAL INSPECTION AND START UP SERVICE

A. After the Mechanical Contractor has provided all water and steam piping connections, ductwork connections, and field control wiring, and Electrical Contractor has provided all the field power wiring, the Mechanical Contractor shall inspect the installation. The Mechanical Contractor shall then perform startup of the equipment.

B. The Automatic Temperature Control (Building Direct Digital Control) Contractor shall be scheduled to be at the job site at the time of the equipment start up.

C. The Mechanical Contractor shall perform the following tests and services and submit a report outlining the results:

1. Record date, time, and person(s) performing service.

2. Check all motor and starter power lugs and tighten as required.

3. Verify all electrical power connections.

4. Conduct a start up inspection per the AHU manufacturer's recommendations.

5. Record fan motor voltage and amperage readings.

6. Check fan rotation and spin wheel to verify that rotation is free and does not rub or bind.

7. Check fan for excessive vibration.

8. If so equipped, check V belt drive for proper tension and alignment. Tighten

the belts in accordance with the AHU manufacturer's directions. Check belt tension during the second and seventh day's operation and re-adjust belts, as may be required, to maintain proper tension as directed by the AHU manufacturer.

9. Remove all foreign loose material in ductwork leading to and from the fan and in the fan itself.

10. Disengage all shipping fasteners on vibration isolation equipment.

11. Secure all access doors to the fan, the unit and the ductwork.

12. Switch electrical supply "on" and allow fan to reach full speed.

13. Physically check each fan at start up and shut down to insure no abnormal or problem conditions exist.

14. Check entering and leaving air temperatures (dry bulb and wet bulb) and simultaneously record entering and leaving chilled water temperatures and flow, steam pressures and flow, and outside air temperature.

END OF SECTION 23 73 13

SECTION 23 82 16 - AIR COILS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Water coils.

B. Glycol coils.

C. Steam coils.

D. Refrigerant coils.

1.02 RELATED SECTIONS

A. Section 23 05 11 – Basic Mechanical Requirements

B. Section 23 05 12 – Basic Mechanical Materials and Methods

C. Section 23 05 13 – Electrical Requirements for Mechanical Equipment

D. Section 23 09 23 - Building Management and Controls Systems

E. Section 23 05 19 – Meters and Gauges

F. Section 23 05 23 – HVAC Piping and Valves

G. Section 23 21 16 – Hydronic Specialties

H. Section 23 07 00 – Mechanical Insulation

1.03 REFERENCES

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

B. ANSI/NFPA 70 - National Electrical Code.

C. ANSI/UL 1096 - Electric Central Air Heating Equipment.

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

1.04 QUALITY ASSURANCE

A. Heating and Cooling Coils: Product of manufacturer regularly engaged in

production of coils who issues complete catalog data on product offering.

B. Heating and Cooling Coils: Certify capacities, pressure drops and selection procedures in accordance with AHRI 410-91.

C. ISO 9001 Certification. The coil manufacturer shall be ISO 9001 Certified by a third party registrar, such as HSB Registration Services, that is accredited by an accreditation body such as ANSI-RAB and / or RvC Dutch Council for Accrediation.

1.05 SUBMITTALS

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

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

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

1.06 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 10 years documented experience.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section.

B. Store and protect products under provisions of Section

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

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

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. The contractor shall furnish and install unit(s) as shown as scheduled on the contract documents. The unit(s) shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

B. Manufacturers:

1. Trane
2. Carrier
3. Heatcraft
4. USA Coil & Air.

C. Alternates must still comply with the performance and features as specified with these specifications and as indicated on the design documents. Job will be awarded on basis of specified product. Substitutions must be selected and approved within 14 calendar days after award of contract.

2.02 Fabrication - All coils

A. Fins: Shall be configurated aluminum fin plate type. Fins shall be die formed in multiple stages with full fin collars for maximum fin-tube contact and accurate spacing. Fin positioning must be continuous across entire coil face.

B. Coil pressure testing: All coils are to be proof and leak tested. The proof test must be performed at 1.5 times the maximum operating pressure and the leak test at the maximum operating pressure.

C. AHRI certification: Coils, computer selection programs, and catalogs must be certified to AHRI STANDARD 410-87 (where applicable).

2.03 Drain Pans

A. Install 16 gauge stainless steel drain pan under each cooling coil.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1.
2. Construct drain pans to extend beyond coil length and width and to connect to condensate trap and drainage.
3. Extend drain pan upstream and downstream from coil face.
4. Extend drain pan under coil headers and exposed supply piping.
5. Provide intermediate drain pan below top coil section, extend the drain from this drain pan to the drain pan at bottom cooling coils section.

2.04 1/2-Inch OD tubed water coils

A. Tubes: Shall be seamless 1/2-inch OD copper tubes arranged in a parallel or staggered pattern. Tubes to be mechanically expanded into full fin collars for permanent fin-tube bond. Tube wall thickness must be .016" Copper for refrigerant coils.

B. Casing: A minimum of 16-gauge galvanized steel casing with center and end supports shall be provided. To ensure structural integrity and allow for easy stacking of coils, casing channels must be constructed with a minimum of four (4) forms each or channels must be constructed from 14-gauge galvanized steel.

C. Water coil headers: Round copper pipe headers are to be provided on all coils. Coils shall have same end connection for supply and return piping. Drain and vent connections shall be provided.

D. Straighten bent fins on air coils.

E. Clean coils using materials and methods recommended in writing by manufacturers, and clean inside of casings and enclosures to remove dust and debris.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

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

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

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

E. Install coils level. [Install cleanable tube coils with 1:50 pitch.]

F. Make connections to coils with unions and flanges.

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

water coils are drainable and provide drain connection at low points.

H. On water coils, and chilled water cooling coils, connect water supply to leaving air side of coil.

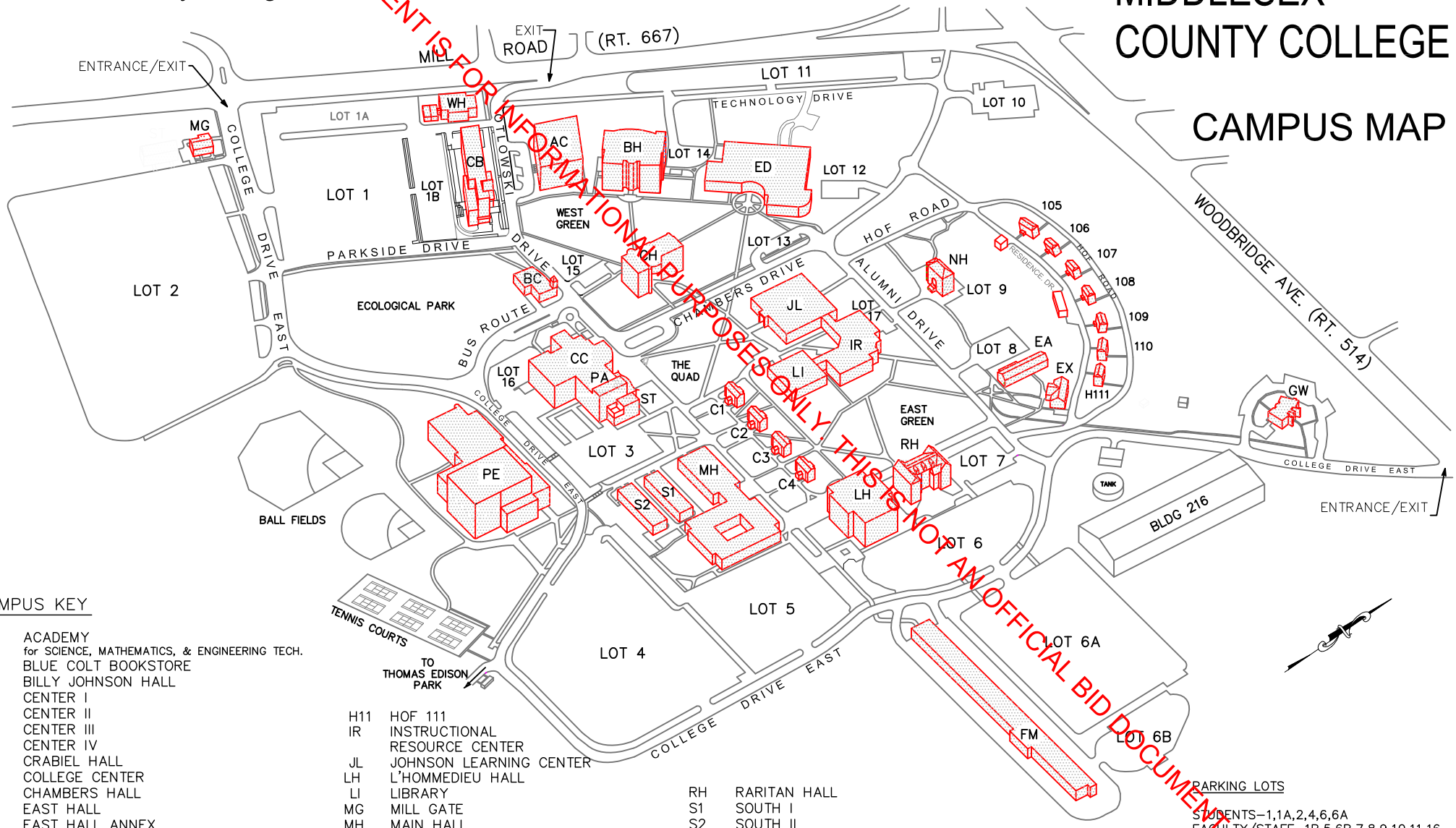
I. Insulate headers located outside air flow as specified for piping. Refer to Section 23 07 00.

END OF SECTION 23 82 16

Middlesex County College is a Smoke-Free Environment

MIDDLESEX COUNTY COLLEGE

CAMPUS MAP



CAMPUS KEY

AC	ACADEMY for SCIENCE, MATHEMATICS, & ENGINEERING TECH.
BC	BLUE COLT BOOKSTORE
BH	BILLY JOHNSON HALL
C1	CENTER I
C2	CENTER II
C3	CENTER III
C4	CENTER IV
CB	CRABIEL HALL
CC	COLLEGE CENTER
CH	CHAMBERS HALL
EA	EAST HALL
EX	EAST HALL ANNEX
ED	EDISON HALL
FM	FACILITIES MANAGEMENT
GW	GATEWAY–POLICE INFORMATION
H11	HOF 111
IR	INSTRUCTIONAL RESOURCE CENTER
JL	JOHNSON LEARNING CENTER
LH	L'HOMMEDIEU HALL
LI	LIBRARY
MG	MILL GATE
MH	MAIN HALL
NH	NORTH HALL
PA	PERFORMING ARTS CENTER
PE	PHYSICAL EDUCATION CENTER
RH	RARITAN HALL
S1	SOUTH I
S2	SOUTH II
SR	STAFF RESIDENCE (#106–110)
ST	STUDIO THEATER
WH	WEST HALL

PARKING LOTS

STUDENTS–1,1A,2,4,6,6A
FACULTY/STAFF–1B,5,6B,7,8,9,10,11,16
VISITORS–3,15
DISABLED–ALL LOTS
CHILDREN'S DAY CARE CENTER–12