SECTION 15010

GENERAL REQUIREMENTS

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. General requirements for mechanical contractor.

B. Identification systems for piping, ductwork, equipment, and controls including a complete valve chart.

1.2 GENERAL REQUIREMENTS

A. Provide all labor, materials, accessories and all other related items as required to complete all operations in connection with the complete installation of the fire protection, Plumbing, HVAC, and mechanical systems as shown on the drawings and as specified herein.

1.3 RELATED REQUIREMENTS

A. Conditions of the Contract and Division 1 General Requirements apply to all the work including the work of this division. Examine all contract documents for requirements affecting the work.

B. Section 01130, Construction Area Containment.

C. Section 01850, Commissioning.

D. Section 09900, Painting.

E. Section 15510, Hydronic Piping, Pumps, Valves, and Specialties.

F. Section 15855, Air Handling Units.

G. Section 15880, Air Energy Recovery Equipment.

H. Section 15890, Ductwork, Fans, and Accessories.

I. Section 15900, Automatic Temperature Controls.

J. Division 16, Electrical.

1.4 DRAWINGS & SPECIFICATIONS

A. The drawings and specifications are complementary. All work indicated on the drawings or described in the specifications shall be included in the scope of work. The work indicated on the drawings does not take

precedence over the work described in the specifications or vice versa. In the event that the work indicated on the drawings and work described in the specifications conflicts, the conflict shall be brought to the immediate attention of the architect for formal resolution.

B. The general location of the apparatus and the details of the work are shown on the drawings. Exact locations not indicated via dimensioning on the drawings shall be determined at the site as the work progresses and shall be subject to the Architect's approval.

C. It is not intended that the drawings shall show every pipe, fitting or appliance, but it shall be a requirement to furnish, without additional expense, all material and labor necessary to complete the systems in accordance with the plans, sections, details, and schedules, with the highest possible quality available.

1.5 SUBMITTALS

A. The Contractor shall, after award of contract and before installation, submit for approval copies of Shop Drawings, Bulletins, Product Data for equipment furnished under this contract, in accordance with requirements of Section 01330.

B. Submit shop drawings and product data as required in each section. Submittal shall include all physical data and performance data required to verify compliance with the contract documents. All equipment finishes shall be noted and a minimum of three color charts or samples shall be submitted with Shop Drawings. The Architect reserves the right to disapprove incomplete submissions.

C. After the Shop Drawings have been approved, one copy shall be retained by the engineer.

D. Begin no fabrication or work which requires submittals until return of submittals with engineer's stamp indicating acceptance.

E. Submittals shall be submitted to the engineer via the Architect through the contractor. Contractor shall stamp and initial submittals certifying verification of products, field measurements and field construction criteria, and coordination of the information within the submittal with requirements of the work and of the Contract Documents.

F. Make any corrections or changes in the submittals required by the engineer and resubmit until approved. Resubmit submittals to the architect within fifteen days after receipt.

G. Architect shall review submittals within ten business days after receipt of submittals and affix stamp and initials and indicate requirements for re-submittal, or acceptance of submittal.

H. Contractor shall distribute returned submittals to subcontractors, other affected contractors, supplier or fabricator.

1.6 SUBSTITUTIONS

A. Comply with all provisions of the Instructions to Bidders, General Conditions and Division 1.

B. The first item listed under "Acceptable Manufacturers" is the design basis. Other manufacturers listed may be used in the base bid, but dimensional and electrical data must be verified by the Contractor. Any modifications required shall be made at the Contractor's expense. For items that have no manufacturers listed, any item meeting all the specifications is acceptable.

1.7 ALTERATIONS

A. The Contractor shall execute all demolition, alterations, additions, removals, relocation or new work, and all other related items as indicated or required to provide a complete installation in accordance with the intent of the drawings and specifications, including changes required by building alterations described under other divisions of the specifications.

B. Any existing systems and equipment to remain which are disturbed or damaged by the demolition, alterations, or new work shall be repaired or replaced to the Architect's satisfaction at no extra cost to the owner.

1.8 TEMPORARY VENTILATION

A. Ventilation shall be provided to protect occupants from application and installation of odor causing materials. The area where material is being used shall be isolated from the existing ventilation system. No work creating fumes shall be done in the existing building while it is occupied by the owner. Adequate ventilation shall be maintained for a period of 24 hours or until release of fumes has subsided, whichever is longer.

B. Temporary ventilation and isolation systems shall be installed by the general contractor in accordance with section 01130 – Construction Area Containment.

1.9 ELECTRIC WORK

A. Furnish and install all motors, pilot lights, controllers, starters, overload protection, variable frequency drives, limit switches and all other related items for equipment provided under Division 15.

B. Except as noted, all required disconnects, line switches, fused switches, and all other related items and all necessary wiring to properly connect all equipment to motors and switches shall be furnished and installed under Section 16000, Electric.

C. Provide complete wiring system for oil or gas burner and associated operating and safety controls.

D. Provide complete wiring system for automatic temperature controls as specified under Section 15900, Automatic Temperature Controls.

E. All wiring shall conform to the requirements of Division 16, Electric, of these specifications.

1.10 EQUIPMENT INSTALLATION REQUIREMENTS

A. Installation Directions: Obtain manufacturer's printed installation directions to aid in properly executing work on all major pieces of equipment.

B. Objectionable Noise, Fumes and Vibration

1. Mechanical and electrical equipment shall operate without creating objectionable noise, fumes or vibration as determined by the Architect.

2. If such objectionable noise, fumes or vibration should be produced and transmitted to occupied portions of building by apparatus, piping, ducts or any other part of mechanical and electrical work, make necessary changes and additions as approved without extra cost to Owner.

C. Equipment Design and Installation

1. Uniformity: Unless otherwise specified, equipment or material of same type of classification used for same purposes shall be product of same manufacturer.

2. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog numbers shall be designed in conformity with ASME, IEEE or other applicable technical standards, suitable for maximum working pressure and shall have neat and finished appearance.

3. Installation: Erect equipment aligned level and adjusted for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily. Provide adequate clearance around equipment so that all parts, including filters, are easily accessible for inspection, operation, maintenance and repair. Minor deviation for indicating arrangements may be made as approved.

D. Protection of Equipment and Materials

1. Responsibility for care and protection of all materials and mechanical work rests with the Contractor at all times until the

entire project has been completed, tested and the project is accepted by the Owner.

E. Foundations

1. Ceiling Mounting: Where ceiling mounting is indicated or specified, use suspended platform or strap hangers, bracket or shelf, whichever is most suitable for equipment and its location. Construct of structural steel members, steel plates, and rods as required. Brace and fasten to building structure or to inserts as approved or as detailed and in conformance with seismic restraint requirements. Rotating equipment shall be mounted using rubber in shear or spring type isolation hangers.

2. Where floor mounting is indicated, locate equipment on 4" high reinforced concrete pad of adequate size to fully support equipment, with anchors and base plates as required, on redwood or pressure treated sleepers or on structural steel frame, as detailed. The corners of concrete pads shall be chamfered 1/2". Pad and steel sizes and location shall be coordinated with the approved equipment.

1.11 PAINTING

A. Refer to Specification Section 09900.

1.12 ACCESS PANELS

A. Access panels required for items furnished under Division 15 shall be provided for under this division and installed under Divisions 4 and 9.

B. Access panels shall be standard panels, 16"x24" unless indicated otherwise. Door shall be flush type of 14 gauge steel hinged to 16 gauge frame. Shall be "Inryco/Milcor" Style M as manufactured by Inryco, Inc., Miami-Carey "HM", or approved equal. Latch shall be operated by flush face screw. Doors and frames shall be factory primed.

C. Access panels in fire rated construction shall have the same UL rating as the wall, floor or ceiling in which they are installed.

D. Access panels shall be installed in building construction where required for access to duct access doors or other components such as valves, air vents, actuators, volume dampers, motorized dampers in ductwork and all other related items.

E. Provide name, address and telephone number of the manufacturer's representative and service company for each piece of equipment so that service or spare parts can be readily obtained.

1.13 COORDINATION

A. Coordinate scheduling, submittals and work of the various sections of specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting, and placing mechanical equipment into service.

C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on drawings. Follow routing shown for pipes, ducts and conduit as closely as practicable.

D. Field changes to placement of boiler vents, exhaust outlets, plumbing stacks, or discharges of other odiferous or hazardous materials shall not be moved farther than 3 feet from the location shown on the plans, without the express written approval of the engineer.

E. Place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations for maintenance and for repairs.

F. In finished areas conceal pipes, ducts and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

G. Coordinate completion and clean-up work of separate sections in preparation for substantial completion.

H. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with contract documents to minimize disruption of Owner's activities.

1.14 CLEANING

A. Remove all debris from site daily.

B. All material and pieces of equipment shall be turned over to the Owner free of any dust and dirt, both inside and out.

C. At the completion of the project, all equipment shall have a clean, neat appearance of factory finish by cleaning or repainting as required.

1.15 STARTING SYSTEMS

A. Coordinate schedule for startup of various equipment and systems.

B. Notify Owner seven days prior to startup of each item.

C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence or other conditions which may cause damage.

D. Verify that tests, meter readings and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. Verify wiring and support components for equipment are complete and tested.

F. Execute startup under supervision of responsible manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.

G. When specified in individual specification sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to startup, and to supervise placing equipment or system in operation.

H. Submit a written report in accordance with Section 01770, Closeout Procedures, that equipment or system has been properly installed and is functioning correctly.

1.16 ADJUSTMENTS AND OWNER'S INSTRUCTIONS

A. Adjustments: After completion of the installation work called for in this specification, the Contractor and his Subcontractors shall furnish necessary mechanics or engineers for the adjustment and operation of the plant to the end that the plant may be perfectly adjusted and turned over to the Owners in perfect working order.

B. Instruction: The Contractor shall instruct the Owner's Authorized Representative in the care and operation of the installation, providing all required framed instruction charts, directions and all other related items.

C. Testing: After the entire installation is completed, ready for operation, the Contractor shall test prior to the acceptance testing process outlined below. These tests are supplementary to detailed tests specified herein or directed. The Owner will provide all water and electric current for the tests. The Contractor shall provide necessary labor, test pump, gauges, meters, other instruments and materials. The Architect and/or engineer or representative reserves the right to be present at any of these tests.

1.17 ACCEPTANCE TESTING (COMMISSIONING)

A. The Acceptance Testing agent shall performance test all systems in accordance with section 01850, Commissioning, after the contractor certifies that all HVAC systems in each phase of construction are completed:

1. Ductwork is complete and sealed

2. Piping is complete,

3. Mechanical equipment is functioning,

4. Automatic Temperature Controls are complete and tested by the controls contractor,

5. Balancing is complete.

B. The contractor shall provide a technician as required to correct any problems found during the performance testing processes.

C. The contractor shall coordinate on site work with the controls contractor to aid the Acceptance Testing agent in performance testing all equipment and control systems – up to one day for each air handling system.

D. Acceptance Testing shall consist of observing the function of all controlled devices due to changing input conditions (by overriding control input points as necessary) certify that all systems perform as specified and intended.

E. The contractor shall correct any problems discovered by the Acceptance Testing agent, and make technicians available to retest any systems which did not initially perform correctly, at no additional cost to the owner. This process shall continue until all systems are certified by the Acceptance Testing agent to be working properly.

1.18 WARRANTEES

A. The contractor shall provide a complete parts and labor warrantee for a period of at least one year on all equipment, materials, and workmanship. The warrantee period shall extend longer where specified elsewhere for individual equipment or systems.

B. The warrantee on each system and its related equipment shall start when the system is under fully automatic operation and is substantially complete. The warrantee on all components in each system shall be commence when the entire system is operational. The warrantee on cooling equipment shall commence only after the cooling equipment is fully installed, charged, and functional, which may not coincide with completion of the air handling system (due to winter time completion).

1.19 OPERATING AND MAINTENANCE MANUALS

A. Furnish bound Operating and Maintenance (O&M) Manuals in accordance with Section 01782, and forward to the Architect for review and transmittal to the Owner. The Architect reserves the right to disapprove incomplete submissions.

B. Operating instructions shall be specified for each system and shall include copies of posted specific instructions.

C. For maintenance purposes, provide shop drawings, parts lists, specifications and manufacturer's maintenance bulletins for each piece of equipment.

D. Provide calibration curves or calculator wheels for circuit setters.

E. Provide complete points list with addresses and programming for all DDC points.

F. Provide list of all filter and belt sizes required for each piece of equipment.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS - LABELS & IDENTIFICATION

A. Seton Nameplate Co.

B. Marking Services Incorporated (MSI)

C. Allstate

D. Or approved equal.

2.2 EQUIPMENT IDENTIFICATION

A. Nameplates for equipment shall be aluminum with a black enamel background and with etched or engraved natural aluminum lettering or laminated phenolic with white letters on black Background, of sizes easily readable from the floor.

B. Nameplates for controls, switches, starters, pilot devices, pushbuttons, relays and transformers shall be minimum 2-½" x 3/4".

C. Nameplates for major equipment shall be minimum 1-1/2" x 4" with the designated number engraved in lettering not less than 3/4" high.

2.3 IDENTIFICATION OF VALVES (BRASS VALVE TAGS)

A. Each valve identification tag to be minimum 19 gauge polished brass, 1-1/2" diameter. Each tag to designate appropriate service with 1/4" stamped black filled letters and appropriate valve number with 1/2" stamped black filled number. Tags shall be securely fastened to valves with approved brass "S" hooks or brass jack chain in a manner to permit easy reading.

2.4 IDENTIFICATION OF PIPING

A. All service piping which is accessible for maintenance operations (except piping in finished spaces) will be identified with semi-rigid plastic (not pressure sensitive) identification markers. Direction of flow arrows are to

be included on each marker. In conformance with "Scheme for the Identification of Piping Systems" (ANSI A13.1- 1975), each marker must show:

1. Approved color coded background.

2. Proper color of legend in relation to background color.

3. Approved legend letter size.

4. Approved marker lengths.

B. For pipes under ¾" O.D. (too small for color bands and legends), brass identification tags 1- ½" in diameter with depressed ¼" high black filled numbers will be fastened securely at specified locations.

2.5 IDENTIFICATION OF DUCTWORK & AIR SYSTEMS

A. Ductwork in air handling unit rooms entering and leaving each air handler, fan, heat recovery unit, etc. shall be labeled with pressure sensitive identification markers with permanent adhesive backing and water resistant face. Direction of air flow arrows are to be included on each marker.

PART 3 EXECUTION

3.1 EQUIPMENT IDENTIFICATION

A. All items of mechanical equipment such as condensing units, air handling units, fans, pumps, unit heaters, variable air volume boxes, DDC control panels, etc. shall be identified by approved nameplates to be provided by the Contractor furnishing the equipment. Nameplates shall be securely affixed, in a manner approved by the Architect/Engineer, to each individual piece of equipment, and shall also include but not be limited to each starter, switch, relay and transformer which controls this equipment. Nameplates shall bear notations corresponding to the same notations used on the plans and on the framed wiring diagrams and operating instructions.

B. Furnish on all equipment, controls, switches, starters, relays and transformers approved nameplates describing the function and use of the equipment in non-technical language.

C. Each piece of equipment shall be identified by a distinguishing number to be designated by the Architect. Furnish and securely affix to each unit an approved nameplate

3.2 VALVE IDENTIFICATION

A. All valves shall be designated by labels with numbers and letters and noted on as-built plans. The Contractor shall install approved brass tags

for all designated items, with numbers and letters on the tags corresponding to those on the chart(s) and diagram(s).

B. Each valve shall have an identifying letter designating the system and an identifying number designating the unit. Identifying letters for various systems shall be, for example: HTG, PLBG. Abbreviations shall be approved by the Engineer. A chart of all valves shall be furnished and include the following items:

1. Valve identification number.

2. Location.

3. Purpose.

4. Chart to be mounted in a frame (aluminum frame with Plexiglas cover) and secured on a wall in the Mechanical Room or in a location as otherwise directed by the Architect.

3.3 PIPE MARKER LOCATIONS

A. Mark each pipe in the following locations:

1. Adjacent to each valve and fitting.

2. At each branch and riser takeoff.

3. At each pipe passage through-wall, floor and ceiling construction.

4. At each pipe passage to underground.

5. On all horizontal pipe runs - marked every 25 feet.

3.4 IDENTIFICATION OF DUCTWORK & AIR SYSTEMS

A. Ductwork in air handling unit rooms entering and leaving each air handler, fan, heat recovery unit, etc. shall be labeled on the outside of insulation jackets or casing.

B. Labels on ductwork shall include:

1. Outside air

2. Exhaust air

3. Supply air

4. Return air

5. Flow direction arrows

6. Heating Coils

7. Dampers

C. Labels on air handling units shall include:

1. Filter Access

2. Heating Coil

3. Cooling Coil

4. Supply Fan

5. Exhaust Fans

6. Dampers

END OF SECTION

# SECTION 15170

# MOTORS, DRIVES, AND ACCESSORIES

# (FILED SUB-BID)

## PART 1 GENERAL

### 1.1 SECTION INCLUDES

A. Motors

B. Thermal Overload Devices

C. Belt drives

### 1.2 SUBMITTALS

A. Submit shop drawings in accordance with Section 15010.

B. Submit complete manufacturer's data and installation instructions for the following:

C. Motors

D. Thermal Overload Devices

### 1.3 OPERATION AND MAINTANENCE MANUALS

A. Submit manuals and data in accordance with Section 15010.

## PART 2 PRODUCTS

### 2.1 MOTORS

A. ACCEPTABLE MANUFACTURERS

1. MagneTek Century
2. Baldor
3. Marathon
4. General Electric
5. Westinghouse

B. Motors furnished shall meet NEMA requirements and shall have an operating temperature not to exceed 70°F (40°C.) above ambient temperature and be so marked, except as noted.

C. Motors shall operate at a maximum of 1800 rpm unless specifically noted or scheduled on the drawings.

D. All three phase motors shall have a service factor of at least 1.15 and be rated for continuous duty. No motor shall have a power factor of less than 0.85. All single phase motors shall have a service factor of at least 1.25.

E. Motors shall be premium efficiency rated with the highest efficiency rating offered by the motor manufacturer. Motor efficiencies shall exceed the requirements of the National Energy Policy Act of 1992 (EPACT). Motors shall be MagneTek Century E-plus 3, Marathon XRI, Baldor Super-E, or equal by General Electric or Westinghouse. Motor efficiencies shall meet or exceed the following minimum efficiencies:

| SIZE | MINIMUM % EFFICIENCY AT FULL LOAD (1800 RPM) |
|---|---|
| LESS THAN 1 HP | MANUFACTURER'S STANDARD |
| 1 HP | 85.5% |
| 1.5 HP | 85.5% |
| 2 HP | 86.5% |
| 3 HP | 88.5% |
| 5 HP | 90.0% |
| 7.5 - 10 HP | 91.0% |
| 15 HP | 92.9 % |
| 20-30 HP | 93.6% |

F. Motors for inside service shall be open drip proof (ODP) unless noted otherwise on the drawings or totally enclosed fan cooled is standard equipment of the equipment manufacturer.

G. Motors for outside service shall be totally enclosed fan cooled (TEFC) unless enclosed in a weatherproof cabinet or housing or otherwise noted.

H. Single phase motors shall have prelubricated ball bearings and built in automatic reset overload protection.

I. Three phase motors shall have grease lubricated anti-friction ball bearings with provisions for relubrication. Bearings shall be rated for minimum AFBMA 9, 1-10 life of 20,000 hours.

J. Motors for use with variable frequency drives shall be rated for "inverter duty" and shall meet NEMA MG1 Part 31.40.4.2 requirements and shall be capable of withstanding a 1600 volt peak limit, with a rise time of 0.1 microseconds or longer. Motors for use with variable frequency drives be rated for continuous service over a 6:1 speed ratio, and be recommended by the motor manufacturer for variable speed service driven by a VFD.

2.2 V-BELT DRIVES

A. Provide self-aligning roller or ball bearings mounted in sealed housings with grease fittings and grease overflow valves. Provide extension tubes to grease fittings to allow easy access for greasing bearings. Fan wheels and shafts shall be designed for critical speed at least 20% higher than maximum fan speed. The assembled fan shall be statically and dynamically balanced at the factory. Bearings shall be certified to have an average life per AFBMA of not less than 200,000 hours.

B. Provide adjustable belt drives for all motors. Belts and pulleys shall be designed for a minimum safety factor of 1.5. The motor mounting base shall be constructed to allow adjustment of belt tension without having to loosen motor hold-down bolts.

PART 3 EXECUTION

3.1 INSTALLATION

A. Coordinate motors, drives, and accessories with equipment served.

B. Verify electrical characteristics of equipment with utilities available on site.

C. Install all equipment in accordance with manufacturer's recommendations.

D. Verify proper rotation of 3 phase motors.

END OF SECTION

SECTION 15260

DUCTWORK, PIPING, AND EQUIPMENT INSULATION

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Ductwork Insulation

B. Equipment Insulation

C. Pipe insulation

D. Insulation finishes.

1.2 RELATED WORK

A. Section 15410 - Plumbing Piping and Specialties

B. Section 15510 - Hydronic Piping, Pumps, Valves, and Specialties.

C. Section 15535 - Refrigerant Piping and Specialties.

D. Section 15855 - Air Handling Units

E. Section 15880 - Air Energy Recovery Equipment

F. Section 15890 - Ductwork and Accessories

1.3 SUBMITTALS

A. Submit shop drawings and samples in accordance with Section 15010.

B. Submit shop drawings which indicate complete material data, a list of materials proposed for each application on this project, and indicate thickness of material to be used for individual services.

C. Submit Product Data on the following:

1. Insulation materials.

2. Jackets and Vapor Barrier materials.

3. Finishes and jacket sealing tapes.

4. Accessories.

5. Installation methods.

1.4 JOB CONDITIONS

A. Deliver material to job site in original non-broken factory packaging, labeled with manufacturer's density and thickness.

B. Perform work at ambient and equivalent temperatures as recommended by the adhesive manufacturers.

C. Application shall be by experienced insulation mechanics. Insulation shall be installed with smooth surfaces and square corners and edges ready to receive finish paint in accordance with the best practice of the trade, using methods recommended by the manufacturer and approved by the architect.

1.5 ALTERNATIVES

A. Alternative insulation materials are subject to approval. Alternatives shall provide same thermal resistance within 10% at normal conditions as materials specified.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Schuller/Johns Manville

B. Owens-Corning.

C. Certainteed.

D. Armstrong.

E. Knauf.

2.2 GENERAL

A. FLAME SPREAD AND SMOKE DEVELOPED RATINGS:

1. Insulation materials shall have a flame-spread rating of not more than 25 and a smoke-developed rating of not more than 50 in accordance with NFPA 255, ASTM E 84, or UL 723.

2. Adhesives and Insulation Materials: Composite fire and smoke hazard ratings maximum 25 for flame spread and 50 for smoke developed. Adhesives to be waterproof.

B. All insulation and materials shall be asbestos free. All materials used shall not release any fibers with dimensions similar to asbestos fibers.

## 2.3 PIPE INSULATION MATERIALS

A. Fiberglass Pipe Insulation:

1. Fiberglass insulation preformed for piping of bonded glass fiber with an integral factory applied All Service Jacket (ASJ). Jacket shall provide a vapor barrier and have self-sealing adhesive strips. Schuller "Microloc" or approved equal.

2. Maximum thermal conductivity shall be 0.26 (BTU-in)/(hr-sqft-°F) rated at 75°F. Minimum insulation density shall not be less than 3 lb./cubic foot.

3. Minimum rated service temperature shall be 600°F, or no less than 100°F above the highest temperature expected for the intended service.

4. Jackets shall have a maximum water vapor permeability of 0.05 perm per ASTM E 96, a puncture resistance of not less than 50 Beach units, and a minimum tensile strength of 35 pounds-force per inch of width. Provide vapor barrier for cold water service as listed in Table 1. In exposed locations, jackets shall have a white surface suitable for field painting.

5. For fittings and elbows, provide preformed PVC covers (Zeston) stuffed with flexible fiberglass batt insulation.

B. Flexible Unicellular Insulation:

1. Insulation of closed cell extrusions of polyethylene or other approved elastomeric material, preformed for piping. Armstrong Armaflex AP or AP SS, or approved equal.

2. Maximum thermal conductivity shall be 0.27 (BTU-in)/(sqft-hr-°F) at a mean temperature of 90°F. Polyethylene insulation materials shall be used with copper piping.

3. Maximum rated service temperature shall be at least 210°F.

4. Provide insulation with self-sealing strips, and/or provide manufacturer's recommended adhesives. Armstrong 520 adhesive, or approved equal.

5. For outdoor service, apply a minimum of two coats of UV resistant water base insulation finish approved for use by the insulation manufacturer on all exterior exposed unicellular insulation. Armstrong WB finish, or approved equal. Paint surface shall be suitable for accepting top coat of latex paint by the painting contractor.

C. Polyisocyanurate Foam

1. Rigid polyisocyanurate foam insulation preformed for piping with an integral factory applied PVC jacket.

2. Maximum thermal conductivity shall be 0.20 (BTU-in)/(hr-sqft-°F) rated at 75°F. Minimum insulation density shall not be less than 2 lb./cubic foot.

3. Minimum rated service temperature shall be 300°F.

2.4 ADHESIVES, SEALANTS, AND COATING COMPOUNDS:

A. Adhesives for securing insulation to metal surfaces and vapor barrier lap adhesive for use in building interior only. ASTM C 916, Type 1 (adhesive vehicle nonflammable in liquid state and passes edge-burning test) or Type 2 (adhesives vehicle nonflammable in liquid state and will not pass edge-burning test)

B. Mineral Fiber Insulation Cement: ASTM C 195, thermal conductivity 0.85 BTU-in/sqft-hr-°F. maximum at 200°F mean when tested per ASTM C 177.

2.5 PIPE INSULATION ACCESSORIES:

A. Insulation Bands: 3/4-inch wide 0.018-inch thick stainless steel.

B. Anchor Pins: Provide anchor pins and speed washers as recommended by the insulation manufacturer.

C. Staples: ASTM A 167, type 304 stainless steel outside-clinch type.

D. Wire: Soft annealed stainless steel. 0.047-inch diameter.

E. Glass Cloth and Tape: 4-inch wide rolls. Tape shall be 4.5 ounces per square yard. In lieu of tape open weave glass membrane may be used.

2.6 DUCTWORK INSULATION MATERIALS

A. Rigid fiberglass board

1. Rigid fiberglass board insulation with maximum thermal conductivity of 0.24 Btu-in/hr-sqft-°F at 75°F.

2. Provide factory laminated foil reinforced kraft vapor retarder facing (FRK).

B. Flexible fiberglass "ductwrap"

1. Flexible fiberglass "ductwrap" insulation "K" value at 75°F, maximum 0.26 Btu/hour/square foot/°F/hour. For round ducts and concealed rectangular ducts in HVAC applications.

2. Provide factory laminated foil reinforced kraft vapor retarder facing (FRK).

C. Elastomeric insulation sheets

1. Provide Insulation of flexible closed cell sheets of polyethylene or other approved elastomeric material, Armstrong Armaflex AP, or approved equal. Self adhering sheets, Armstrong AP Armaflex SA or approved equal, are also acceptable.

2. Maximum thermal conductivity shall be 0.27 (BTU-in)/(sqft-hr-°F) at a mean temperature of 90°F.

3. Maximum rated service temperature shall be at least 180°F.

4. Provide insulation manufacturer's recommended adhesives, Armstrong 520 adhesive, or approved equal.

5. For outdoor service, apply a minimum of two coats of UV resistant water base insulation finish approved for use by the insulation manufacturer on all exterior exposed unicellular insulation. Armstrong WB finish, or approved equal. Paint surface shall be suitable for accepting top coat of latex paint by the painting contractor.

D. Acoustic Duct Lining

1. Refer to requirements specified in section 15890.

E. Jacket Seam Sealant Tape

1. Provide 4" wide permanent adhesive tape which matches the insulation jacket as recommended by the insulation manufacturer. Use to seal joints between fiberglass insulation blankets or boards applied to the exterior of ducts. Duct tape is not acceptable.

2. On elastomeric insulation, provide self adhesive elastomeric insulation tape to seal seams - Armstrong AP Armaflex insulation tape or approved equal.

PART 3 EXECUTION

3.1 PIPING SYSTEMS APPLICATIONS

A. GENERAL

1. Provide and install insulation for all new piping, equipment, specialties, and as indicated.

2. Insulation thickness shall be in accordance with ASHRAE 90.1, 1999, or State of Maine Energy Codes, whichever is more stringent, as indicated in table 2, for the type of insulation used.

B. EXPOSED PIPE

1. All heating and domestic hot water piping exposed in occupied areas of the building (excluding the boiler room) shall be insulated using fiberglass pipe insulation with welded PVC jacket, installed so that the weld is hidden at the top or back, as applicable.

2. At the contractors option, flexible unicellular (elastomeric) foam preformed pipe insulation suitable for painting with Latex paint may be used. Seams shall be neatly cemented or self seal, with seam hidden at the top or back, as applicable.

3. At the contractors option, Polyisocyanurate or urethane foam preformed pipe insulation, with PVC jacket, may be used instead of flexible unicellular insulation. Insulation jacket shall be paintable.

4. Preinsulated piping systems, such as Perma-Pipe, Ricwil, or approved equal, may be used.

C. HOT WATER, STEAM, STEAM CONDENSATE PIPE CONCEALED OR IN BOILER ROOM:

1. All heating and domestic water piping and equipment, not exposed in occupied areas, shall be insulated with fiberglass Preformed Pipe Insulation with All Service Jacket (ASJ). Provide PVC "Zeston" type jackets over pipe fittings.

2. At the contractor's option, one of the following insulation types may also be used:

a. Flexible Unicellular Foam.

b. Urethane Foam with plastic jacket.

D. CHILLED WATER PIPES:

1. All chilled water pipes shall be insulated with water resistant foam insulation as follows. Fiberglass insulation is not acceptable for chilled water pipes.

   a. Flexible Unicellular Foam.

   b. Urethane Foam with plastic jacket.

E. EQUIPMENT

1. Insulate all equipment and accessories carrying water below 60°F and above 80°F. Increase thickness of insulation if required to meet height of angles and other structural members to make exterior surface of insulation smooth. Additional insulation need not be applied to factory insulated equipment.

F. EXTERIOR APPLICATIONS

1. All piping exposed outdoors shall be insulated with water resistant insulation materials, such as flexible unicellular or isocyanurate foam.

2. Insulation exposed outdoors shall be protected by UV resistant welded PVC jacket.

G. EXISTING INSULATION REPAIR

1. Existing piping with fiberglass insulation, damaged insulation, or no insulation shall be reinsulated with new fiberglass pipe insulation similar to new piping, under the terms of this contract. Where existing insulation is still in place, it shall be removed before reinsulating.

3.2 DUCTWORK AND EQUIPMENT APPLICATIONS

A. Rectangular and Round Supply and Return air ducts exposed in the occupied spaces shall be left uninsulated.

B. Rectangular or Round ducts which supply air conditioned air shall be insulated with 1.5 inch thick fiberglass blankets ("ductwrap") with vapor barrier foil faced jacket (FRK), with all seams taped vapor tight.

C. Return and exhaust air ducts shall be left uninsulated.

D. Exhaust discharge from energy recovery units (ERU) and air to air heat exchangers shall be insulated with 2" thick ductwrap insulation with FRK vapor barrier jacket.

E. Rectangular outdoor air intake ductwork in mechanical rooms shall be insulated with 2 layers of 1" thick rigid fiberglass board insulation with FRK vapor barrier facing. The seams shall be staggered.

3.3 PREPARATION

A. Insulate piping, ductwork, and equipment after all system tests have been completed.

B. All surfaces to be insulated shall be cleaned of dirt, rust, and scale and dried. Ensure surfaces are clean and dry prior to installation. Ensure insulation is dry before and during application.

C. Ensure full range of motion of equipment actuators.

3.4 PIPING INSULATION INSTALLATION

A. General

1. All insulation shall be applied in accordance with the manufacturers recommendations.

2. Provide insulation shields where pipe is supported from the bottom.

3. Where pipes penetrate fire walls, provide mineral-fiber insulation inserts and sleeves of sheet metal or steel pipe.

4. Provide vapor barrier cover or use Elastomeric insulation as specified for pipes conveying fluids at less than 60°F. Jackets shall provide a vapor barrier for cold water piping, or as required by service as listed in Table 1.

5. All fittings shall be insulated unless otherwise noted. In cold water or refrigerant systems, flanges and valves shall also be insulated. Do not insulate valve stems, hand wheels and operators. Use factory molded, precut or field fabricated insulation of the same thickness and thermal conductivity as the material on the adjacent pipe.

B. Fiberglass Pipe Insulation:

1. Sections of insulation shall be sized to fit snugly and shall be tightly butted into place. The jacket laps shall be drawn tight and smooth. Secure jacket with factory applied self sealing lap. Cover circumferential joints with butt strips, not less than 3 inches wide, of material identical to the jacket material.

2. When a vapor barrier is required or on ends of insulation that butt against unions, flanges, valves, fittings or joints, cover exposed fiberglass insulation with a water resistant vapor barrier coating

(mastic) that meets recommendations of manufacturer. DO NOT USE STAPLES to secure jacket laps on pipes transporting fluid medium at temperatures below 55°F.

3. Patch any damaged jacket material by wrapping a strip of jacket material with self adhesive around the pipe and cementing and coating as specified for butt strips. Extend the patch not less than l-l/2 inches past the break in both directions.

4. Where penetrating roofs, insulate piping to a point flush with the top of the flashing and seal with vapor barrier coating. Butt tightly the exterior insulation to the top of the flashing and interior insulation. Extend the metal jacket 2 inches down beyond the end of the insulation. Seal the flashing and counter flashing underneath with vapor barrier coating. In chilled and cold water piping in high humidity areas, use polyisocyanurate foam or flexible unicellular insulation.

C. Flexible Unicellular Insulation:

1. All insulation seams shall be neatly and tightly glued together using manufacturer's recommended adhesive. Bond cuts, butt joints, end and longitudinal joints with manufacturer's recommended adhesive. Insulation shall be mitered to cover elbows, tees, fittings, and valves.

2. Insulate flanges, unions, valves, and fittings in accordance with manufacturer's published instructions.

3. Apply minimum two coats of UV resistant insulation finish to outdoor locations of insulation.

D. Hangers and Anchors:

1. Pipe insulation shall be continuous through pipe hangers. Where pipe is supported by the insulation, provide MSS SP-58, Type 40 galvanized steel shields or MSS SP-58, Type 39 protection saddles conforming to MSS SP-69. Where shields are used on pipes 2 inches and larger, provide insulation inserts at points of hangers and supports.

2. Insulation inserts shall be of calcium silicate, cellular glass (minimum 8 pcf), molded glass fiber (minimum 8 pcf), or other approved material of the same thickness as adjacent insulation. Inserts shall have sufficient compressive strength to adequately support the pipe without compressing the inserts to a thickness less than the adjacent insulation. Insulation inserts shall cover the bottom half of the pipe circumference 180 degrees and be not less in length than the protection shield. Vapor barrier facing on the insert shall be the same material as the facing on the adjacent insulation. Seal inserts into insulation with vapor barrier coating, or

for outdoor work with manufacturer's recommended weatherproof coating, as applicable.

3. Where protection saddles are used, fill all voids with the same insulation material as used on the adjacent pipe. Where anchors are secured to chilled or cold piping that is to be insulated, insulate the anchors the same as the piping for a distance not less than four times the insulation thickness to prevent condensation. Vapor seal insulation at anchors.

E. Sleeves and Wall Chases:

1. Where penetrating interior walls, extend a metal jacket 2 inches out on either side of the wall and secure on each end with a band.

2. Where penetrating floors, extend a metal jacket from a point below the back-up material to a point 10" above the finish floor with one band at the floor and a band not more than 1 inch from the end of the metal jacket.

3. Where penetrating exterior walls, extend the metal jacket through the sleeve to a point 2 inches beyond interior surface of the wall.

F. Flanges, Unions, Valves and Fittings Insulation for Hot Piping:

1. Factory fabricated removable and reusable insulation covers may be used.

2. For inside dual temperature, domestic hot water, heating hot water, air conditioning coil condensate drains, high temperature hot water, steam, and exposed hot water piping and drains in handicapped areas, place factory pre-molded, precut or field fabricated segmented insulation of the same thickness and conductivity as the adjoining pipe insulation around the flange, valve, union, or fitting abutting the adjoining pipe insulation.

3. If nesting size insulation is used, overlap either a minimum of 2" or one pipe diameter which ever is the greater. Use insulating cement to fill voids. Place and join the segments with manufacturer's recommended water vapor resistant, fire retardant adhesive appropriate for temperature limit of service. Blanket insert insulation may also be used.

4. Factory pre-molded one-piece PVC fitting covers shall be used. Install factory pre-molded one-piece PVC fitting covers over the insulation and secure by stapling, taping with vapor barrier tape, or with metal or plastic tacks made for securing PVC fitting covers. Limit the use of PVC fitting covers to ambient temperatures below 150°F.

## 3.5 EQUIPMENT INSULATION

A. Modify insulation to avoid obstructions with valve handles, safety relief valves, etc. Allow adequate space for pipe expansion. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit.

B. Insulation shall be continuous through sleeves, wall and ceiling openings. Extend all surface finishes to protect all surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at the manufacturer's recommended coverage per gallon. Individually insulate piping, equipment, and ductwork. Keep insulation dry during the application of any finish. Bevel and seal the edges of exposed insulation. Provide a moisture and vapor seal where insulation terminates against metal hangers. Unless otherwise indicated, do not insulate the following:

1. Valve hand wheels.
2. Vibration isolating connections.
3. Adjacent insulation.
4. ASME stamps.
5. Piping inside radiation enclosures, cabinet unit heaters, or unit ventilators.

## 3.6 DUCTWORK INSULATION INSTALLATION

A. Install covering after ductwork and equipment have been sealed, tested, and approved.

B. Ensure insulation is continuous through inside walls. Pack around ducts with fireproof self- supporting insulation material properly sealed.

C. Finish insulation neatly at hangers, supports and other protrusions.

D. Locate insulation or cover seams in least visible locations.

E. Insulation exposed to outdoors shall be waterproof closed cell elastomeric type with UV resistant insulation finish.

F. Secure rigid insulation with 90% coverage of adhesive and 12 gauge galvanized impale anchor tabs on 16 inch centers in accordance with the manufacturers printed instructions. Seal joints and breaks with vapor barrier tape.

G. Repair separation of joints or cracking of insulation due to thermal movement, damage, or poor workmanship.

H. Standing seams, supporting angles and flanges on all insulated ductwork shall be insulated with thickness equal to the duct and all edges shall be finished and vapor sealed.

I. Mechanical fasteners shall not be riveted or screwed to the duct and shall not penetrate the metalwork.

3.7 PAINTING AND IDENTIFICATION:

A. Painting shall be by painting contractor, in accordance with Section 9900 - Painting.

B. Piping, Ductwork, and Equipment Identification shall be as in Section 15010 - General Requirements.

3.8 FIELD INSPECTION:

A. Visually inspect to ensure that materials used and workmanship conform to specifications. Inspect installations for compliance with requirements.

B. Verify that no raw fiberglass edges are exposed. All fiberglass joints and ends shall be sealed with mastic or foil tape.

**TABLE 1**
**INSULATION MATERIAL FOR PIPING**

| SERVICE | MATERIAL | SPEC | TYPE | CLASS | VAPOR BARRIER REQUIRED |
|---|---|---|---|---|---|
| **Hot Water** Supply and Return | Mineral Fiber | ASTM C 547 | | | No |
| | Flexible Unicellular | | | | No |
| | Urethane Foam | | | | No |
| **Chilled Water** Supply and Return | Flexible Unicellular | | | | No |
| | Urethane Foam | | | | Yes |
| **A/C Condensate** | None | | | | |
| **Steam** Piping and **Condensate** Return Piping | Mineral Fiber | ASTM C 547 | I | 1 | No |

ADDENDUM 2 1/29/02 AT
**Add** "Computer Room Glycol Supply & Return"

**TABLE 2**
**PIPING INSULATION WALL THICKNESSES**
**FOR TYPICAL FIBERGLASS & ELASTOMERIC PIPE INSULATIONS**
**(BASED ON ASHRAE 90.1-1999)**

| Operating Temperature Range °F | CONDUCT. Btu-in./ hr-ft$^3$-°F | RATING TEMP. °F | NOMINAL PIPE DIAMETER (inches) | | | | |
|---|---|---|---|---|---|---|---|
| | | | <1 | 1 - <1½ | 1½ - <4 | 2½ - 4 | 4 - 8 |
| **HEATING SYSTEMS** (Hot Water, Glycol, Steam and Condensate) | | | | | | | |
| >350° | 0.32-0.34 | 250 | 2.5 | 3.0 | 3.0 | 4.0 | 4.0 |
| 251-350° | 0.29-0.31 | 200 | 1.5 | 2.5 | 3.0 | 3.0 | 3.0 |
| 201-250° | 0.27-0.30 | 150 | 1.5 | 1.5 | 2.0 | 2.0 | 2.0 |
| 141-200° | 0.25-0.29 | 125 | 1.0 | 1.0 | 1.0 | 1.5 | 1.5 |
| 105-140° | 0.22-0.28 | 100 | 0.5 | 0.5 | 1.0 | 1.0 | 1.0 |
| **DOMESTIC HOT WATER SYSTEMS** | | | | | | | |
| 105° | 0.24-0.28 | 100 | 0.5 | 1.0 | 1.0 | 1.5 | 1.5 |
| **COOLING SYSTEMS** (Chilled Water, Brine, or Refrigerant) Requires Vapor Barrier Jacket or Insulation Material | | | | | | | |
| 40-60° | 0.22-0.28 | 75 | 0.5 | 0.5 | 0.75 | 1.0 | 1.0 |
| Below 40° | 0.22-0.28 | 75 | 1.0 | 1.0 | 1.5 | 1.5 | 1.5 |

END OF SECTION

SECTION 15325

SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 SCOPE OR WORK,

A. NFPA 13 area wet-pipe sprinkler system for all area protection upgraded to code requirements for all existing space utilization.

B. The existing building is protected only on the first level with a wet pipe sprinkler system. The remainder of the building is protected with standpipes in the existing stair towers and extending onto the roof. The existing sprinkler system shall be re designed to meet upgraded density requirements and room partitioning. The stand pipe in the east stair tower shall be extended up one level to cover new construction. An existing computer room on the fourth floor is protected with a pre action sprinkler system supplied off of the stand pipe. This system shall remain unchanged

C. Inspect and test the existing wet pipe alarm valve, replace or add components as required for current code compliance update to the existing system.

D. The work includes designing and providing a new automatic wet pipe fire protection system with uniform water distribution to afford complete fire protection throughout the indicated areas. Exterior canopies and overhangs and other spaces subject to freezing shall have a dry pipe pendants. Design density shall be increased in areas with higher hazard classifications. Provide full compliance with applicable sections of NFPA, BOCA and the state of NH.

E. Obtain current water flow test data for system design.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

A. Placement of sleeves.

1.3 RELATED SECTIONS

A. Section 15190 - Mechanical Identification.

1.4 REFERENCES

A. NFPA 13 - Installation of Sprinkler Systems.

1.5 SYSTEM DESCRIPTION

A. System to provide coverage for building areas indicated

B. Provide system to NFPA 13 LIGHT hazard requirements adjust water density for storage areas as required by NFPA.

C. Interface system with building fire and smoke alarm system.

D. Provide fire department connections for zones as indicated

E. Upgrade standpipes for code compliance with new construction.

1.6 SUBMITTALS

A. Submit under provisions of Section 01300.

B. Preliminary Shop Drawings: Prior to detailed submission, submit preliminary layout of finished ceiling areas indicating only head locations coordinated with ceiling installation.

C. Shop Drawings: Indicate hydraulic calculations, detailed pipe layout, hangers and supports, fire pump, alarm valves, misc. components and accessories. Indicate system controls.

D. Product Data: Provide data on sprinkler heads, valves, and specialties, including manufacturers catalogue information. Submit performance ratings rough-in details, weights, support requirements, and piping connections.

E. Submit shop drawings, product data, hydraulic calculations to authority having jurisdiction for approval. Submit proof of approval to Architect/Engineer.

F. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and code requirements

1.7 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700.

B. Record actual locations of sprinkler heads and deviations of piping from drawings. Indicate drain and test locations.

1.8 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01700.

B. Maintenance Data: Include components of system, servicing requirements, Record Drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.9 QUALITY ASSURANCE

A. Perform Work in accordance with NFPA 13 and other related sections.

B. Equipment and Components: Provide with UL and or FM label or marking.

C. Design and install each system to give full consideration to blind spaces, piping, electrical equipment, ductwork, structure and other construction features and equipment.

D. Maintain one copy of document on site.

1.10 QUALIFICATIONS

A. Installer: Company specializing in performing work of this Section with minimum three years experience.

B. Design sprinkler system under direct supervision of a Professional Engineer experienced in design of this work and licensed in the State of Maine.

1.11 REGULATORY REQUIREMENTS

A. Hydraulic Calculations, Product Data, Shop Drawings: Bear stamp of approval of authority having jurisdiction.

1.12 DELIVERY, STORAGE, AND HANDLING

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

B. Store products in shipping containers and maintain in place until installation. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.13 EXTRA MATERIALS

A. Furnish under provisions of Section 01700.

B. Provide extra sprinkler heads under provisions of NFPA 13.

C. Provide suitable wrenches for each head type.

D. Provide metal storage cabinet in vicinity of wet pipe alarm valve, coordinate final location with building owner.

PART 2 PRODUCT

2.1 SPRINKLER HEADS

A. Suspended Ceiling:

1. Type: Early Suppression Fast Response Glass bulb Semi recessed type with recessed escutcheon plate assembly. Central model GB-QR recessed pendant

2. Head Finish: Painted enamel; color white .

3. Escutcheon plate finish: Enamel, color white.

4. Glass bulb type temperature rated for specific area hazard.

B. Exposed Area Type:

1. Type: Early Suppression Fast Response Glass bulb Standard upright, sidewall or pendant type as required.

2. Head Finish: natural bronze.

3. Glass bulb type temperature rated for specific area hazard.

2.2 PIPING SPECIALTIES

A. Wet Pipe Sprinkler Alarm Valve: Check type valve with divided seat ring, rubber faced clapper to automatically actuate electrically and] hydraulically operated alarms, with pressure retard chamber and variable pressure trim.

B. Water Motor Alarm: Hydraulically operated impeller type alarm with aluminum alloy red enameled gong and motor housing, nylon bearings, and inlet strainer.

C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two contacts rated 10amp at 115 volt AC.

D. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch.

2.3 FIRE DEPARTMENT CONNECTION:

A. Upgrade as required to current code and local requirements

PART 3 INSTALLATION

3.1 PREPARATION

A. Coordinate work of this Section with other affected work.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturers instructions.

B. Provide check valves and backflow protection indicated.

C. Locate fire department connection with sufficient clearance from walls, obstructions, or adjacent siamese connectors to allow full swing of fire department wrench handle.

D. Locate outside alarm gong on building wall as indicated.

E. Place pipe runs to minimize obstruction to other work.

F. Place piping in concealed spaces above finished ceilings.

G. Center heads in one direction only in ceiling tile with location in other direction variable, dependent upon spacing and coordination with ceiling elements.

H. Apply masking tape or paper cover to ensure concealed sprinkler head cover plates do not receive field paint finish.

I. Install and connect fire pumps in accordance with NFPA 13.

J. Flush entire piping system of foreign matter.

K. Hydrostatically test entire system.

L. Invite test be witnessed by authority having jurisdiction Owner's insurance underwriter and Architect/Engineer at their option.

END OF SECTION

SECTION 15410

PLUMBING PIPING

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Pipe and pipe fittings.

B. Valves.

C. Sanitary sewer piping system.

D. Domestic water piping system.

E. floor drains.

F. Cleanouts.

G. Backflow preventers.

H. Water hammer arrestors.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

A. Section 01010 - Summary of Work: Owner furnished Kitchen equipment.

1.3 RELATED SECTIONS

A. Section 02200 - Excavating.

B. Section 02200 - Backfilling.

C. Section 02550 - Disinfection of Water Distribution System.

D. Section 09900 - Painting.

E. Section 15190 - Mechanical Identification.

F. Section 15170 - Vibration Isolation.

G. Section 15260 - Piping & Equipment Insulation.

H. Section 15450 – Plumbing Fixtures and Equipment.

1.4 REFERENCES

A. State of Maine Plumbing Code

B. ANSI B31.1 - Power Piping.

C. ANSI B31.9 - Building Service Piping.

D. ASME - Boiler and Pressure Vessel Code.

E. ASME Sec. 9 - Welding and Brazing Qualifications.

F. ASTM A74 - Cast Iron Soil Pipe and Fittings.

G. ASTM B32 - Solder Metal.

H. ASTM B75 - Seamless Copper Tube.

I. ASTM B88 - Seamless Copper Water Tube.

J. ASTM D1785 - Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

K. AWS A5.8 - Brazing Filler Metal.

L. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.

M. ANSI/ASSE 1012 - Backflow Preventers with Immediate Atmospheric Vent.

N. ANSI/ASSE 1013 - Backflow Preventers, Reduced Pressure Principle.

O. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.

P. ANSI A112.21.1 - Floor Drains.

Q. ANSI A112.26.1 - Water Hammer Arrestors.

R. AWWA C506 - Backflow Prevention Devices - Reduced Pressure Principle and Double Check Valve Types.

S. PDI WH-201 Water Hammer Arresters.

1.5 SUBMITTALS

A. Submit under provisions of Section 01340.

B. Shop Drawings: Indicate dimensions, weights, and placement of openings, valves and holes

C. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings. Provide component sizes, rough-in requirements, service sizes, and finishes.

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

1.6 PROJECT RECORD DOCUMENTS

A. Submit under provisions of Section 01700.

B. Record actual locations of valves, cleanouts, backflow preventers and equipment.

1.7 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01700.

1. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALITY ASSURANCE

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

B. Welding Materials and Procedures: Conform to ASME Code and applicable state labor regulations.

C. Welders Certification: In accordance with ASME Sec 9.

D. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

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

B. Installer: Company specializing in performing the work of this section with minimum 2 years experience.

1.10 REGULATORY REQUIREMENTS

A. Perform Work in accordance with the State of Maine and Local plumbing codes.

B. Conform to applicable code for installation of backflow prevention devices.

C. Provide certificate of compliance from authority having jurisdiction indicating approval of installation of backflow prevention devices.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01620.

B. Accept valves on site in shipping containers in original factory packaging

C. Provide two of loose keys for freeze proof wall hydrants with labeling in place.

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

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

1.12 ENVIRONMENTAL REQUIREMENTS

A. Do not install underground piping when bedding is wet.

PART 2 PRODUCTS

2.1 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

A. Cast Iron Pipe: CISPI 301, hubless, service weight.

1. Fittings: Cast iron.

2. Joints: ASTM C564, neoprene gasket system.

B. PVC Pipe: ASTM D2729.

1. Fittings: PVC.

2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

2.2 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: ASTM A74, service weight.

1. Fittings: Cast iron.

2. Joints: ASTM C564, neoprene gasket system.

B. Cast Iron Pipe: CISPI 301, hubless, service weight.

1. Fittings: Cast iron.

2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

C. PVC Pipe: ASTM D2665 DWV.

1. Fittings: PVC.

2. Joints: ASTM D2665, solvent weld with ASTM D2564 solvent cement.

2.3 DOMESTIC WATER PIPING

A. Copper Tubing: ASTM B88, Type L, hard drawn. for use in water mains 1" and smaller

1. Fittings: ASME B16.18, cast bronze or ASTM B16.22 wrought copper and bronze.

2. Joints: 95-5 tin-antimony solder. (Lead Free)

B. Copper Tubing: ASTM B88, Type K, soft annealed for use in underslab conduits and for fixture connections as required.

1. Fittings: ASME B16.26, cast bronze.

2. Joints: Flared.

C. CPVC Pipe: not allowed.

D. Cross-linked polyethylene plastic Tubing: not allowed.

2.4 ISOLATION VALVES

A. GATE VALVES not allowed, see ball or butterfly valves

B. BALL VALVES

1. For general shut off and isolation service in copper piping. Up to and including 3 Inches: two piece bronze or stainless steel body, stainless steel ball, Teflon seats and stuffing box ring, lever handle.

2. For general shut off and isolation service in CPVC piping. Up to and including 3 Inches: one piece CPVC body, UHMW ball, wing nut type handle.

C. BUTTERFLY VALVES

1. Bronze body, stainless steel disc, resilient replaceable seat, threaded ends, extended neck, infinite position lever handle with memory stop.

2. Cast or ductile iron body, chrome plated ductile iron disc, resilient replaceable EPDM seat, wafer or lug ends, extended neck, infinite position lever handle with memory stop.

D. Acceptable Manufacturers:

1. Watts

2. Apollo

3. Nibco

4. Armstrong.

5. Jenkins.

6. Walworth

7. Stockham

8. Hammond.

9. Powell.

10. Milwaukee.

11. or approved equal.

2.5 GLOBE VALVES, THROTTLEING SERVICE

1. Up to and including 2 Inches (50 mm): Bronze body, bronze trim, rising stem, handwheel, inside screw, renewable composition disc, solder or screwed ends, with back seating capacity (repackable under pressure).

2. Over 2 Inches (50 mm): Iron body, bronze trim, rising stem, handwheel, OS&Y, plug-type disc, flanged ends, renewable seat and disc.

3. Acceptable Manufacturers:, see isolation valves list.

2.6 HOSE BIBS

A. Interior: Bronze or brass with integral mounting flange, replaceable hexagonal disc, hose thread spout, with handwheel.

B. Acceptable Manufacturers:

1. Watts
2. Nibco
3. Armstrong
4. Jenkins
5. or approved equal.

2.7 CHECK VALVES

A. 15° SWING CHECK VALVES

1. Up to and including 2 Inches (50 mm): Bronze swing disc, solder or screwed ends.
2. Over 2 Inches (50 mm): Iron body, bronze trim, swing disc, renewable disc and seat, flanged ends.

B. SPRING LOADED CHECK VALVES

1. Iron body, bronze trim, stainless steel spring, renewable composition disc, screwed, wafer, or flanged ends.

C. WATER PRESSURE REDUCING VALVES

1. Up to 2 Inches (50 mm): Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded and single union ends.
2. Over 2 Inches (50 mm): Cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged.

D. Acceptable Manufacturers:

1. Taco
2. Bell and Gossett
3. Watts
4. or approved equal.

2.8 RELIEF VALVES

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

B. Acceptable Manufacturers:

1. Taco
2. Bell and Gossett
3. Watts
4. or approved equal.

2.9 STRAINERS

A. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.

B. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged iron body for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

2.10 FLOOR DRAINS, BASEMENT LEVEL

A. ANSI A112.21.1; Dura coated cast iron body with uniform diameter integral trap, adjustable nickel-bronze collar, 3" extension when installed in concrete slabs. With adjustable type E funnel top strainer, Z-453 polished, nickel bronze round with round openings, Provide with trap primer connection.

B. Manufacturers:

1. Zurn Model Z-453-E-#NH (-U ) -P.
2. Other acceptable manufacturers offering equivalent products.
   a. Josam
   b. Jay R. Smith

2.11 FLOOR DRAINS, ROOFTOP PENTHOUSE

A. ANSI A112.21.1; Dura coated cast iron body with uniform diameter remote P-trap Z-1000, adjustable nickel-bronze collar, 3" extension when installed in concrete slabs. With adjustable type E funnel strainer, Z-415 polished, nickel bronze round with round openings, Provide with trap primer connection.

B. Manufacturers:

1. Zurn Model Z-415-E-#NH (-U ) -P.

2. Other acceptable manufacturers offering equivalent products.

a. Josam

b. Jay R. Smith

2.12 CLEANOUTS

A. Interior Finished Floor Areas: Galvanized cast iron, two piece body with double drainage flange, weep holes, reversible clamping collar, and adjustable nickel-bronze strainer, round with scoriated cover in service areas and round with depressed cover to accept floor finish in finished floor areas; Model Z-1400 manufactured by Zurn.

B. Interior Finished Wall Areas: Line type with lacquered cast iron body and round epoxy coated gasketed cover, and smooth nickel bronze wall access cover and frame; Model Z-1447 manufactured by Zurn.

C. Interior Unfinished Accessible Areas Zurn Z-1446, hubless type.

D. Acceptable Manufacturers:

1. Zurn

2. Josam

3. Jay R. Smith

2.13 WATER HAMMER ARRESTORS

A. Precharged, suitable for operation in temperature range -100 to 300 degrees F and maximum 250 psig working pressure.

B. Acceptable Manufacturers

1. Watts

2. Amtrol

3. Vent-Rite

4. or approved equal.

2.14 FREEZE-PROOF WALL HYDRANTS

A. Wall Hydrant: Encased non-freeze, self-draining type with stainless steel box and face with copper casing, ¾" hose thread spout, removable key,

integral vacuum breaker, all bronze interior parts, ½ turn ceramic disc cartridge and WATER stamped on the cover. Zurn Model Z-1320 or equal

B. Acceptable Manufacturers

1. Zurn.

2. Josam

3. Jay R. Smith

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify excavations under provisions of Section 01039.

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

3.2 PREPARATION

A. Ream pipe and tube ends. Remove burrs.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

D. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions

B. Provide all components required for a complete system, all items required are not shown in detail. The drawings are schematic in nature only intended to show the general requirements for the systems and equipment to be installed. Provide water hammer arrestors, access doors, drains and isolation valves as dictated by good trade practice and plumbing code requirements in locations normally associated with this equipment.

C. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

D. Route piping in orderly manner and maintain gradient.

E. Install piping to conserve building space and not interfere with use of space.

F. Group piping whenever practical at common elevations.

G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Required expansion loops, bends and offsets are not shown on the drawings.

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

I. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Section 08305.

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

K. Provide support for utility meters in accordance with requirements of utility companies.

L. Prepare pipe, fittings, supports, and accessories not pre-finished, ready for finish painting. Refer to Section 09900.

M. Excavate in accordance with Sections 02200 for work of this Section.

N. Backfill in accordance with Sections 02200 for work of this Section.

O. Install bell and spigot pipe with bell end upstream.

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

Q. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.

R. Pipe relief from back flow preventer to nearest drain.

S. Install water hammer arrestors complete with accessible isolation valve as per good trade practice and as needed for all hot and cold water supply piping, and at each branch with a flush valve. Provide at least one arrestor in each main and at the last fixture on a group and spaced not more than 100 feet apart.

T. See other specification sections for abatement of vinyl asbestos floor tile in areas of the existing building where new plumbing work is to be installed below existing floor slab. This work is not by plumber.

3.4 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

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

C. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers. Gate valves are not used.

D. Install shutoff valves as required by BOCA and the Maine plumbing code. Provide access to valves.

E. Install globe or ball valves for throttling, bypass, or manual flow control services.

3.5 ERECTION TOLERANCES

A. Establish invert elevations, slopes for drainage to 1/4 inch per foot (2 percent) minimum. OR at 1/8 inch per foot only on indicated main drain. Maintain gradients. Pitch all vents for proper drainage. Install vents with each bend 45 degrees from the horizontal when structure permits.

B. Slope water piping and arrange to drain at all low points.

C. Install pipes to clear beams and obstructions, do not cut into structural members so that load carrying capacity is reduced.

3.6 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Prior to starting work, verify system is complete, flushed and clean.

B. PH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

C. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.

D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

E. Maintain disinfectant in system for 24 hours.

F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

H. Take samples no sooner than 24 hours after flushing, from 5 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.7 SERVICE CONNECTIONS

A. Before commencing work check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

B. Verify the invert of existing piping tie-in connections and ensure that these can be properly connected with slope for drainage.

END OF SECTION

SECTION 15450

PLUMBING FIXTURES & EQUIPMENT

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Water Closets.

B. Lavatories.

C. Showers.

D. Emergency showers/eyewash.

E. Electric Water Coolers

1.2 RELATED SECTIONS

A. Division 16 - Electrical

B. Section 06200 - Custom Casework: Preparation of counter for sinks.

C. Section 07900 - Joint Sealers: Seal fixtures to walls and floors

D. Section 15510 - Supports and Anchors.

E. Section 15410 - Plumbing Piping and Specialties.

1.3 ALLOWANCES

A. Cash Allowance: Include under provisions of Section 01020.

B. Allowance includes purchase and delivery of owner selected fixtures. Installation is included in this section and is part of the Contract Sum/Price.

1.4 REFERENCES

A. ANSI/NFPA 70 - National Electrical Code.

B. ANSI/ASME A112.6.1 - Supports for Off-the-Floor Plumbing Fixtures for Public Use.

C. ASME A112.18.1 - Finished and Rough Brass Plumbing Fixture Fittings.

D. ANSI/ASME A112.19.2 - Vitreous China Plumbing Fixtures

E. ANSI/ASME A112.19.3 Stainless Steel Plumbing Fixtures(Designed for Residential Use).

F. ANSI/ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks, and Urinals (Dimension Standards).

G. IAPMO/ANSI Z124.2 - Plastic Shower Receptors and Shower Stalls.

H. ANSI/ARI 1010 - Drinking Fountains and self-contained mechanically refrigerated drinking water coolers.

1.5 SUBMITTALS

A. Submit under provisions of Section 01340.

B. Product Data:

1. Include dimension drawings of equipment indicating components and connections to other equipment and piping.

2. Provide electrical characteristics and connection requirements.

3. Provide catalogue illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.

4. Manufacturer's Installation Instructions.

1.6 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 01700.

B. Include operation, maintenance, and inspection data, replacement part numbers and availability, and service depot location and telephone number.

C. Include fixture trim exploded view and replacement parts and lists.

1.7 REGULATORY REQUIREMENTS

A. Conform to Maine State Plumbing Code and local standards.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 01600 and 01620.

B. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

C. Accept fixtures on site in factory packaging. Inspect for damage.

D. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.9 FIELD MEASUREMENTS

A. Verify that field measurements are as indicated on shop drawings, instructed by the manufacturer.

B. Confirm that millwork is constructed with adequate provision for the installation of countertop lavatories and sinks.

1.10 WARRANTY

A. Provide warranty under provisions of Section 01700.

PART 2 PRODUCTS

2.1 WATER CLOSET (HANDICAPPED) (P-1A)

A. Bowl

1. Manufacturer: American Standard Model No. 2294.011 "AFWALL ADA 1.6 RETROFIT for locations where existing plumbing can be reused. **OR** American Standard Model NO. 2257.103 "AFWALL" where plumbing must be replaced

2. Wall mounted siphon jet, elongated bowl, vitreous china, top spud, Retrofit unit installations are for where centerline of existing outlet is 5 ¼" above the floor.

B. Seat.

1. Olsonite No. 95, white, open front, less cover.

C. Flush Valve.

1. Manufacturer: Re-use existing

2.2 LAVATORY (P-2A)

A. Basin

1. Manufacturer: American Standard Model 0356.421 "Lucerne".

2. Other acceptable manufacturers offering equivalent products.

a. Eljer

b. Universal Rundle

c. Kohler

3. ANSI/ASME A112.19.2; vitreous china wall-hung lavatory 20-1/2x18-1/4 inch minimum, for concealed arm support, with 4 inch high back, 1-3/8" center drilling, "D" shaped basin with splash lip and front overflow.

B. Trim

1. Manufacturer: American Standard Model 1340M.000X Vandal resistant with mixing valve or approved equal.

2. ANSI A117.1; chrome plated metered mixing faucet with aerator and cover plate, open grid strainer, chrome plated 17 gage brass P-trap with clean- out plug and arm with escutcheon. Provide offset for handicap clearances.

3. Offset drain and trap and angle valve insulation kit, Lav Guard

C. Wall Mounted Carrier

1. Manufacturer: Zurn Model ZR-1231.

2. Other acceptable manufacturers offering equivalent products.

a. Josam

b. Jay R. Smith

3. ANSI/ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs

2.3 URINAL (P-3A)

A. Bowl

1. Manufacturer: American Standard Model No. 6541.132 "Allbrook." Vitreous China, ¾ top spud.

B. Flush Valve

1. Sloan: Re-use existing.

2.4 SHOWER(P-4)

A. Cabinet

1. Manufacturer: ?? Model ??.

2. Other acceptable manufacturers offering equivalent products.

a. Aquarius

b. Fiat

3. ANSI Z124.2 one piece reinforced acrylic, 32 x 32 x 75 inch high, with integral soap dish, grab bar, removable chrome plated strainer and tail piece rubber gasket.

4. Shower Door:

a. 4mm (3/16") tempered safety glass

b. Opaque finish

c. **Framing:** Anodized aluminum extrusions, 1- 5/8" (4.1cm) wall jambs to accommodate acrylic modules, Frame Colour: Brite #11, Water tight seals

B. Trim

1. Manufacturer: Symmons Model No. 96-1-150 "Temptrol".

2. Other acceptable manufacturers offering equivalent products.

a. Leonard

b. or approved equal

3. ASME A112.18.1; vandal proof shower supply with pressure balanced thermostatic mixing valves, vandal resistant shower arm with flow control and adjustable spray, 18 Gauge brushed stainless steel cover, 2.75 gpm flow restrictor.

2.5 SHOWER(P-4A)

A. Cabinet

1. Manufacturer: ??? Model ???.

2. Other acceptable manufacturers offering equivalent products.

a. Aquarius

b. Fiat

3. ANSI Z124.2 one piece reinforced acrylic, 62 x 38 x 75 inch high, with soap dish, integral seat, grab bars, curtain rod, removable chrome plated strainer and tail piece rubber gasket.

B. Trim

1. Manufacturer: Symmons Model 96500-B24 or approved equal.

2. Concealed shower pressure actuated shower valve, bronze construction, Diverter valve, adjustable limit stop set at 110 degrees F, single handle operation, color codes dial. Wall or hand option with 24" slide bar

2.6 SHOWER HEAD

A. Manufacturer: Leonard Model 500P or approved equal.

B. Hand held shower head with inline vacuum breaker, chrome hose, 2 wall hooks, 2 gpm flow rate.

2.7 S.S. KITCHEN SINK (P-5)

A. Bowl

1. Manufacturer: Elkay model LR-1716 lustertone sink; 1-1/2" cast brass P-trap, cup strainer. Provide stops. Note Individual 3/8" or 1/2" ips x 3/8" compression angle stops.

B. Trim: American Standard, Reliant No.4205.029, hand spray, with single lever handle.

C. Water filter, Provide filter cartridge on cold water to fixture with isolation valves as required, McMaster-Carr part No. 4422K5, 5 micron taste, odor filter rated for 2.5 GPM

2.8 WATER COOLER (P-6)

A. Manufacturer: Elkay model EBFSA-8 w/ Glass filler LK-1110, air cooled.

B. Cabinet: heavy gauge stainless steel finish.

C. Cooler shall deliver 8.0 GPH of 50°F

D. 4.8 full load amps.

E. Water filter, Provide filter cartridge on cold water to fixture with isolation valves as required, McMaster-Carr part No. 4422K5, 5 micron taste, odor filter rated for 2.5 GPM

2.9 JANITOR'S MOP BASIN (P-7)

A. Re-use existing

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.

B. Verify that electric power is available and of the correct characteristics.

3.2 PREPARATION

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

3.3 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install each fixture with trap, easily removable for servicing and cleaning.

C. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.

D. Install components level and plumb.

E. Install and secure fixtures in place with wall carriers and bolts. Solidly block wall internal pipe supports to make deflection of fixture flush valves rigid.

F. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07900, color to match fixture.

G. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.

3.4 INTERFACE WITH OTHER PRODUCTS

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

3.5 ADJUSTING

A. Adjust work under provisions of Section 01700.

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

3.6 CLEANING

A. Clean work under provisions of 01700.

B. At completion clean plumbing fixtures and equipment.

3.7 PROTECTION OF FINISHED WORK

A. Protect finished work under provisions of Section 01620.

B. Do not permit use of fixtures.

3.8 FIXTURE HEIGHTS

A. Install fixtures to heights above finished floor as indicated.

B. Water-Closet

1. Standard 15 inches to top of rim.

2. Handicapped 16-1/8 inches to top of rim.

C. Lavatory

1. Handicapped 34 inches to top of basin rim.

D. Drinking Fountain

1. Standard 44 inches to top of basin rim.

2. Handicapped 34 inches to top of basin rim.

E. Water Closet Flush Valves

1. Standard 11 inches min. above bowl rim.

F. Shower Heads

1. 75 inches to bottom of head.

END OF SECTION

SECTION 15510

PIPE, PUMPS, VALVES, AND SPECIALTIES

(FILED SUB-BID)

PART 1 GENERAL

1.1 WORK INCLUDED

A. Labor and materials for complete HVAC piping systems as indicated on the drawings, including valves, supports, sleeves, gauges and related components.

B. All pumps except where integral with a manufactured piece of equipment. Pump controls where self controlled.

1.2 RELATED WORK

A. Section 15170 - Motors, Drives and Accessories

B. Section 15260 - Piping, Ductwork, and Equipment Insulation.

C. Section 15835 - Terminal Heating and Cooling Units.

D. Section 15855 - Air Handling Units.

E. Section 15900 - Automatic Temperature Controls

1.3 QUALITY ASSURANCE

A. Welding materials and Labor to conform to ASME Code and applicable State Labor Regulations.

B. Use welders fully qualified and certified.

1.4 SUBMITTALS

A. Submit shop drawings in accordance with Section 15010.

B. Manufacturer's Data:

1. Valves.

2. Hanger Systems.

3. Grooved Piping Systems.

4. Thermometers.

5. Pressure Gauges.

6. Strainers.

7. Air Separators.

8. Expansion Tanks.

9. Steam Traps

10. Pumps

    a. Submit manufacturer's data and shop drawings indicating materials of construction, dimensions, weight, etc.

    b. Submit certified pump curves for each pump showing pump performance characteristics with pump and system operating point plotted. Include NPSH and horsepower curves.

11. Air Conditioning Condensate Pumps

    a. Submit shop drawings with dimensions, reservoir capacity, pump performance, and electrical characteristics.

12. Flexible Pipe Connectors.

13. Expansion Compensators.

PART 2 PRODUCTS

2.1 HEATING AND CHILLED WATER PIPE

A. Piping for hot water systems in exposed and concealed locations shall be steel as listed in table 1.

B. At the contractors option, sweat jointed copper tubing or oxygen barrier type PEX tubing may be used instead of steel in concealed locations as listed in table 1. Copper or plastic tubing shall not be used in exposed locations or locations where piping may be subject to abuse.

1. ACCEPTABLE MANUFACTURERS – PEX Tubing

    a. Wirsbo hePEX

    b. Thermal Ease

    c. Plasco

    d. Polytech Energy Systems Heat Link

    e. Stadler

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**Table 1: Acceptable Pipe Materials**

| Service | Material |
|---|---|
| Hot water, chilled water, and glycol systems | Steel Schedule 40, black, ASTM A-120 or A-53 as applicable. |
| Alternative materials for hot water and glycol systems concealed in walls or mechanical rooms. | Copper Type L |
| Steam supply piping | Steel Schedule 40, black, ASTM A-120 or A-53 as applicable. |
| Steam condensate piping | Steel Schedule 80, black, ASTM A-120 or A-53 as applicable. |
| Equipment Drains and overflows | Copper Type L, or Schedule 40 PVC |

2.2 FITTINGS FOR STEEL PIPE

A. Fittings shall be 125 lb., screwed for piping 2½" and smaller. Fittings shall be cast or malleable, conforming to ASTM A-126.

B. For piping 3" and larger, fittings shall be butt-welded carbon steel, conforming to ASTM A-234.

C. 150 lb. forged steel flanged joints conforming to ASTM A-234 shall be provided in welded piping systems at all connections to equipment, valves and wherever access to piping is required.

D. Unions shall be used in all screwed piping at connections to equipment, valves and wherever access to piping is required. Dielectric unions shall be used when joining dissimilar metals.

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E. The "Victaulic" type coupling and grooved or rolled edge steel schedule 10 pipe system is an acceptable alternate to the above for water service operating at temperature from -30°F. to +230°F., utilizing grade E, EPDM gasket compound. Equivalent grooved piping systems such as Grinnell Gruvloc or approved equal may also be used.

F. Pipe nipples shall conform to the requirements of U. S. Dept. of Commerce Std. CS-5, "Pipe Nipples: Brass, Copper, Steel and Wrought Iron." Nipples shall be of the same material and weight as the piping system, except where the unthreaded length exceeds 1-1/2", extra strong pipe nipples shall be used.

2.3 STRAINERS

A. Size 2" Inch and Under: Screwed brass or iron body. Y pattern with 1/32 inch stainless steel perforated screen.

B. Size 2-1/2" to 4": Flanged iron body Y pattern with 3/64 inch stainless steel perforated screen.

C. Screen free area minimum three times area of inlet pipe. Provide blowdown valve (valve with hose connection) off strainer bottom where indicated.

D. ACCEPTABLE MANUFACTURERS

1. Taco.

2. Armstrong.

3. ITT.

4. Sarco.

5. Barnes and Jones.

2.4 STEAM TRAPS

A. Provide floating and thermostatic type for heating coils.

B. Provide thermostatic type for all drips and radiators.

C. ACCEPTABLE MANUFACTURERS

1. Armstrong.

2. ITT.

3. Sarco.

4. Barnes and Jones.

2.5 PIPE HANGERS AND SUPPORTS

A. Hangers

1. Pipe sizes 1/2 inch to 1-1/2 inch: adjustable wrought steel ring.

2. Pipe sizes 2 inches and above, adjustable wrought steel clevis.

B. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods, cast iron roll and stand for hot pipe sizes 6" and over.

C. Wall Support: Pipe sizes to 3 inches, cast iron or steel hook.

D. Wall support for pipes sizes 4" and over: Welded steel bracket and wrought steel clamp, adjustable steel yoke and cast iron roll for hot pipes 6" and larger.

E. Vertical support: Steel riser clamp.

F. Floor Support for pipes to 4" and all cold pipe sizes: Cast Iron adjustable pipe saddle, locknut nipple, floor flange and concrete pier or steel support.

G. Floor Support for hot pipe 6" and larger: Adjustable cast iron roll and stand, steel screws and concrete pier or steel support.

H. Design hangers to impede disengagement by movement of supported pipe.

I. Provide copper-plated hangers and supports for copper piping or provide sheet lead packing between hanger or support and piping.

J. ACCEPTABLE MANUFACTURERS

1. Grinnell.

2. B-Line.

3. Unistrut.

4. Or approved equal.

2.6 HANGER RODS

A. Provide steel hanger rods, threaded both ends, threaded one end, or continuous threaded.

2.7 SLEEVES

A. Pipes through floors, beams, walls, fireproofing, potentially wet floors: Form with 18 gauge galvanized steel or with steel pipe.

B. Size large enough to allow for movement due to expansion and to provide for continuous insulation.

2.8 VALVES

A. N.R.S. Gate Valves: Flanged iron body, 125-lb. S.W.P., 200 lb. W.O.G., solid wedge, bronze-mounted. Federal Specification WW-V-58 Class I type I and MSS SP-70 Include hand wheel operator.

B. Bronze Gate Valves (Rising Stem): Solid wedge, 125 lb. S.W.P., 200 lb. W.O.G. Federal Specification WW-V-54, Class Q, Type II and MSS SP-80. Include hand wheel operator.

C. Bronze Ball Valves: (Up to 3" size), chromium-plated ball, full-port design, 600 psi, W.O.G. rated threaded ends. Provide lever operator.

D. OS&Y Gate Valves: Flanged , Iron body, 125 lb. S.W.P., 200 lb. W.O.G., solid wedge. Federal specification WW-V-58, class I, type I and MSS SP-70.

E. Bronze Globe Valve: Class 150, conforming to Federal specification WW-V-51, class B, type I and MSS SP-80.

F. Silent Check Valves: Globe-style bronze check valve, 150 psi rated.

G. Bronze Globe Valves: Class 150, conforming to Federal Specification WW-V-51, class B, type I, and MSS SP-80.

H. ACCEPTABLE MANUFACTURERS

1. Armstrong.
2. Apollo.
3. Watts.
4. Nibco.
5. Jenkins.
6. Walworth
7. Stockham
8. Hammond.
9. Powell.
10. Milwaukee.

2.9 COMBINATION FLOW MEASURING, SHUT-OFF AND BALANCING VALVE

A. Balancing valves shall be globe or ball type valves: 150 psi working pressure, 250°F. operating temperature, with integral pressure taps, memory stop, indicator dial, drain, and tight shut-off features.

B. Provide permanent calibration curve to be mounted on each valve. Curves shall be on a metal tag.

C. Provide any special tools required to use or service valves.

D. At project closeout, deliver one portable meter with fittings and calibration wheel or chart to the owner for use on all balancing valves used in the project.

E. ACCEPTABLE MANUFACTURERS

1. Tour & Anderson.

2. Armstrong.

3. Taco.

4. Bell & Gossett.

2.10 PRESSURE GAUGES

A. Trerice No. 600B, bourdon-tube type, with phosphor bronze tube, silver brazed to forged brass socket, ¼" NPT socket, 4-1/2" diameter cast aluminum flangeless casing with black finish, 0 - 60 psig range scale or maximum reading 50% higher than anticipated pressures.

B. Provide ¼" brass shut-off cock or ¼" ball valve for each pressure gauge.

C. Provide brass snubbers for pressure gauges mounted within 6 feet of pump inlet or discharge.

D. Provide siphon tube for steam applications.

E. ACCEPTABLE MANUFACTURERS

1. Trerice.

2. Marshalltown.

3. Amtek.

2.11 THERMOMETERS

A. Thermometers shall be universal angle bimetal dial type, 4-1/2" diameter case, with union hub and separable brass wells. Scale range shall be 30 to 240°F for hot water heating system applications. Graduations shall be 2°F.

B. ACCEPTABLE MANUFACTURERS

1. Trerice.

2. Amtek.

3. Ernst.

4. Trend.

2.12 THERMOMETER WELLS

A. Provide a thermometer well for each thermometer fabricated of heavy brass, sized to project a minimum of 2" into the fluid, with extension to the face of insulation. Caps and chains shall be provided for each well. Pipe size shall be a minimum of 2" where wells are installed.

2.13 AIR VENTS

A. Manual air vents at piping high points shall be provided with air chambers with minimum chamber diameter of 3/4" and minimum chamber length of 10". Provide reducers and 1/4" brass petcock or ball valve to vent air chamber.

B. Automatic air vents shall be equal to Honeywell-Braukman. Provide 10" high air chamber at all vents full line size up to 2" pipe and 2" size for all larger paper. Provide brass petcock or screwed ball valve at connection to each air vent to allow changing the vent without draining pipes.

C. Acceptable Manufacturers

1. Honeywell-Braukman

2. Spirovent

3. Armstrong

4. Taco

5. Bell & Gossett.

2.14 EXPANSION TANKS

A. Vertical pressurized diaphragm or butyl rubber bladder type tank, factory charged to 15 psig and rated for 125 psig working pressure. Tank shall be steel construction and ASME certified and stamped.

B. Provide lock-shield manual shut-off valve between the tank and the system.

C. Tanks shall have minimum acceptance and total volumes as indicated on the drawings.

D. Acceptable Manufacturers

1. Taco

2. Bell & Gossett

3. Amtrol

4. Vent-Rite

5. Armstrong

2.15 FLEXIBLE CONNECTORS

A. Flexible stainless steel bellows type with braided stainless steel cover and flanged ends.

B. Flexible Connectors shall be full line size and rated for minimum 150 psig working pressure and 250°F.

C. Provide all necessary guides and anchors as recommended by the manufacturer.

D. Acceptable Manufacturers

1. Flexonics

2. Keflex

3. Metraflex

2.16 EXPANSION COMPENSATORS

A. Provide expansion compensation devices or expansion loops as required and shown on the plans to compensate for thermal expansion and contraction of all piping.

B. Expansion compensation device shall be constructed of multi-ply, flexible, stainless steel bellows with square or guided telescoping shroud to prevent torsional stress and/or external damage.

C. End fittings shall be female pipe thread connections for sizes 3 inches and under. Provide flanged ends for larger sizes.

D. Provide unions at connections of screwed fitting expansion compensators to facilitate service or replacement of expansion fittings.

E. Expansion compensators shall be full line size and rated for minimum 150 psig working pressure and 250°F.

F. Provide all necessary guides and anchors as recommended by the same manufacturer of the expansion joints.

G. Acceptable Manufacturers

1. Keflex

2. Flexonics

3. Metraflex

2.17 PRESSURE RELIEF VALVES

A. Provide ASME rated water pressure relief valves where shown on the plans and where necessary to meet BOCA and boiler codes.

B. Furnish and install relief valves in hot water, chilled water, and heat recovery systems.

C. Acceptable Manufacturers

1. Watts

2. Taco

3. Bell & Gossett

4. Armstrong

2.18 AIR SEPARATOR

A. In line air separator with threaded tap for attachment of automatic air vent. Air separator shall be sized as noted on the plans and details, not to exceed 4 feet pressure drop.

B. Air separator shall be equipped with integral strainer, designed to be easily removed and cleaned.

C. Furnish and install separator in hot and chilled water systems.

D. Acceptable Manufacturers

1. Bell & Gossett.

2. Taco

3. Armstrong

2.19 PUMPS

A. ACCEPTABLE MANUFACTURES

1. Taco

2. Grundfos

3. Weinman

4. Armstrong

5. Bell & Gossett

6. Paco

B. GENERAL

1. Casings shall be rated for greater of 125 psi or 1.5 times actual discharge working pressure. Provide suction and discharge gage ports, drain plug, flanged suction and discharge.

   a. Casings and flanges shall be cast iron for closed circulating water systems.

   b. Provide non-corroding cases and flanges made of bronze or stainless steel for open systems, such as domestic water recirculation or drain back systems.

C. VERTICAL IN-LINE PUMPS

1. Type: Centrifugal, single stage, close coupled, in-line, back pullout design, suitable for vertical operation supported by suction and discharge flanges or hung by impeller casing.

2. Casing: Provide air vent, replaceable wear rings, seal flush connection.

3. Impeller: Bronze, fully enclosed, keyed to shaft and secured with locknut.

4. Shaft: Stainless steel or carbon steel with bronze or stainless steel sleeve through steel chamber.

5. Seals: Provide replaceable seals made of carbon rotating against a stationary ceramic seat.

6. Motor: Provide permanently lubricated sealed ball bearings for motor. Provide motor starter as specified in Section 15170.

D. IN-LINE CIRCULATORS

1. Type: Centrifugal, single stage, in-line, suitable for horizontal or vertical operation, supported by suction and discharge flanges or hung by impeller casing.

2. Casing: Provide air vent, replaceable wear rings, seal flush connection.

3. Impeller: Bronze, fully enclosed, keyed to shaft and secured with locknut.

4. Shaft: Stainless steel or carbon steel with bronze or stainless steel sleeve through steel chamber.

5. Seals: Carbon rotating against a stationary ceramic seat.

6. Coupling: Provide close coupled or flexible "Woodruff" type rubber/elastomer coupling. Multiple spring type couplings are not acceptable.

7. Motor: Provide resilient mounted motor with permanently lubricated sealed ball bearings. Provide internal thermal overload for single phase motors, and motor starter for three phase motors as specified in Section 15170 – Motors and Drives.

E. WET ROTOR INLINE PUMPS (Alternative to inline circulators)

1. Type: Centrifugal, single stage, water lubricated (wet rotor) close coupled in-line circulators.

2. Casing: Motor housing shall be directly attached to casing. Provide vent plug to purge air.

3. Impeller: Bronze, stainless steel, or resin, fully enclosed, keyed to shaft and secured with locknut.

4. Shaft: Stainless steel, carbon steel, or ceramic with bronze or stainless steel sleeve through steel chamber.

5. Motor: Armature shall be sealed cartridge rotating inside sealed field windings. Provide internal thermal overload for single phase motors, and motor starters for three phase motors per section 15170 - Motors and Drives.

F. BASE MOUNTED PUMPS

1. Type: Centrifugal, single stage, mounted on steel channel support base.

2. Casing: Provide air vent, replaceable wear rings, seal flush connection.

3. Impeller: Bronze, fully enclosed, keyed to shaft and secured with locknut.

15510

**Add** Paragraph 2.19.H as follows:

1. BOILER FEED PUMPSET/RECEIVER
   a. Furnish and install where shown on the drawings duplex boiler feed pump and receiver unit of the size and capacity as scheduled. Unit shall consist of one (1) condensate receiver, two (2) 3500 rpm pumps, inlet strainer, float operated makeup water valve, and all accessories as hereinafter specified.
   b. The condensate receiver shall be cast iron construction and shall include a float operated makeup water valve with a minimum capacity equal to one pump flow, an isolation valve installed between each pump and the receiver to permit servicing without draining the receiver, and an inlet strainer with bronze or stainless steel screen.
   c. The pumps shall be centrifugal design, permanently aligned, bronze fitted with enclosed bronze impellers, renewable bronze wearing rings, stainless steel shaft, and mechanical seals suitable for operation up to 220 degrees F. Pump shall be close coupled to a vertical drip-proof motor.

ADDENDUM 2
1/29/02 AT

   d. Each unit shall be provided with a unit mounted control panel (NEMA 2) with the following included:
      i. Hinged door and fused disconnect with door interlock.
      ii. Magnetic motor starters with 3 phase thermal overload protection with HOA selector switches.
      iii. 115 volt control circuit with fused control transformer.
      iv. Electric alternator to vary lead pump. Lag pump shall be started whenever lead pump fails or is unable to handle in-coming condensate flow.
      v. Single point of connection for electric power.
   e. Units shall be UL labeled.
   f. Units shall be manufactured by Skidmore, Weinman, Domestic, or approved equal.

15510

3.2. **Add** Paragraph 2.19.I as follows:

1. AIR CONDITIONING CONDENSATE DRAIN PUMPS
   a. Acceptable Manufacturers:
      **i. Little Giant**
      **ii. Hartell**
   b. Packaged unit including rustproof tank, pump and motor, float switch and cord with plug.
   c. All materials in contact with condensate liquid shall be either ABS polystyrene or stainless steel.
   d. Provide check valve at discharge connection.
   e. Low Head pumps (lift of 20 ft. or less) shall have a minimum capacity of 50 GPH at 15 feet head.
   f. Pumps shall operate on 120 volt single phase 60 cycle power and shall be rated for liquid temperatures up to 120°F.

15510

Add Paragraph 2.19.G as follows:

1. CONDENSATE RETURN PUMPSET/RECEIVER

a. Furnish and install where shown on the drawings duplex condensate pump and receiver unit of the size and capacity as scheduled. Unit shall consist of one (1) condensate receiver, two (2) 3500 rpm pumps, inlet strainer, float switches, and all accessories as hereinafter specified.

b. The condensate receiver shall be cast iron construction and shall include a float switch for each pump operation, an isolation valve installed between the pump and the receiver to permit servicing without draining the receiver, and an inlet strainer with bronze screen.

c. The pumps shall be centrifugal design, permanently aligned, bronze fitted with enclosed bronze impellers, renewable bronze wearing rings, stainless steel shaft, and mechanical seals suitable for operation up to 220 degrees F. Pump shall be close coupled to a vertical drip-proof motor.

i. Each unit shall be provided with a unit mounted control panel (NEMA 2) with the following included:

ii. Hinged door and fused disconnect with door interlock.

iii. Magnetic motor starters with 3 phase thermal overload protection with HOA selector switches.

iv. 115 volt control circuit with fused control transformer.

Electric alternator to vary lead pump. Lag pump shall be started whenever lead pump fails or is unable to handle in-coming condensate flow.

Single point of connection for electric power.

2. Units shall be UL labeled.
3. Units shall be manufactured by Skidmore, Weinman, Domestic, or approved equal.

ADDENDUM 2 1/29/02 AT

(CONT. ON OPPOSITE SIDE)

4. Shaft: Stainless steel or carbon steel with bronze or stainless steel sleeve through steel chamber.

5. Seals: Provide replaceable seals made of carbon rotating against a stationary ceramic seat.

6. Motor: Provide permanently lubricated sealed ball bearings for motor. Provide motor starter as specified in Section 15170 - Motors and Drives.

7. Provide suction diffuser where drop or elbow into suction is less than 6 pipe diameters from the suction inlet.

ADD THREE (3) PARAGRAPHS PER ADDENDUM 2 1/29/02 AT (SEE PREVIOUS PAGE)

## PART 3 EXECUTION

### 3.1 PREPARATION

A. Ream pipes and tubes. Clean off scale and dirt, inside and outside, before assembly. Remove welding slag or other foreign material from piping.

### 3.2 PIPE CONNECTIONS

A. Screw joint steel piping up to and including 2-1/2 inch. Weld piping 3 inch and larger, including branch connections.

B. Make screwed joints with full cut standard taper pipe threads with Teflon tape or other approved non-toxic joint compound applied to male threads only.

C. Use main sized saddle type branch connections or directly connecting branch lines to mains in steel piping if main is at least one pipe size larger than the branch for up to 6-inch mains and if main is at least two pipe sizes larger than branch for 8-inch and larger mains. Do not project branch pipes inside the main pipe.

D. Use grooved mechanical couplings and mechanical fasteners only in accessible locations.

E. Make connections to equipment and branch mains with unions.

F. Provide non-conducting type connections wherever jointing dissimilar metals in open systems. Brass adapters and valves are not acceptable.

### 3.3 PIPING INSTALLATION

A. All pipe used shall be new material, and threads on piping must be full length clean cut with inside edges reamed smooth to full inside bore.

B. Caulking of threads will not be allowed on any piping.

C. Pipe joint compound shall be put on male threads only.

D. In the erection of mains, special care must be used in the support, working into place without springing or forcing, and proper allowance made for expansion.

E. Pipes shall be anchored and guided, where necessary, to prevent vibration or to control expansion.

F. Make such offsets as are shown and required to place the pipes and risers in proper position to avoid other work.

G. Install a sufficient number of unions or flanged fittings to facilitate making possible future alterations or repairs. Unions shall be installed at all equipment, fixtures and risers.

H. Piping shall be erected so as to provide for the easy passage and noiseless circulation of water under all working conditions.

I. All steel piping shall be installed by the use of the oxyacetylene or electric welding process, except immediate connections to accessible equipment may be threaded. Piping shall have butt welds with welding fittings, standard factory-fabricated tees, elbows, reducers, caps, etc. Branch outlets 2-1/2" and smaller shall be made by the use of approved welding type 1/2 couplings, "Weldolet" or "Threadolet" fittings.

J. Piping smaller than 3" may be installed at the Contractor's option with welding type, or threaded type fittings, except all piping regardless of size concealed in trenches or building construction upon completion of building construction, shall be welded.

K. Offsets shall be installed with long radius welding elbows.

L. All welding shall be executed only by certified welding technicians in accordance with the best practice of the trade and ASME section 9.

M. All copper piping shall be assembled using 95/5 tin antimony solder.

N. PEX tubing shall be assembled using the tubing manufactures recommended connections and fittings.

3.4 PIPING SYSTEM AIR VENTS

A. Furnish and install, where indicated on the plans and where required, manual air vent valves, as detailed, at all high points in piping systems. Install air chamber for each manual vent unless located in radiation enclosure.

B. Take downfeed and upfeed branch lines off bottom of mains or at 45 degree bottom angle, as space permits.

C. Provide ball valve type 3/4" valved draw-offs with hose end connections and caps at all low points of the piping systems, and at apparatus.

3.5 ROUTE AND GRADES

A. Route piping in orderly manner and maintain proper grades. Install to conserve headroom and interfere as little as possible with use of space. Run exposed piping parallel to walls. Group piping whenever practical at common elevations. Install concealed pipes close to building structure to keep furring to a minimum.

B. Water Piping: Slope water piping 1 inch in 40 feet and arrange to drain at low points.

C. Steam Piping: Slope steam supply and condensate piping a minimum of ¼" per foot towards drip legs and traps. There shall be no low points in condensate drain piping which could allow water to accumulate.

D. Air Conditioner Condensate Piping: Slope condensate drain piping a minimum of ¼" per foot from drain pan trap to discharge at floor drain or standpipe. There shall be no low points in condensate drain piping which could allow water to accumulate. Provide a minimum 1" air gap between discharge of condensate piping and its drain.

E. Make reductions in water pipes with eccentric reducing fittings installed to provide drainage and venting.

F. Install piping to allow for expansion and contraction without stressing pipe or equipment connected.

G. Provide clearance for installation of insulation and for access to valves, air vents, drains and unions.

3.6 PIPE HANGERS AND SUPPORTS

A. Support horizontal steel and copper piping as follows:

**Table 2: Pipe Hanger Spacing – Steel & Concrete Framing**

| Nominal Pipe Size (in.) | Distance Between Supports (feet) | | Hanger Rod Diameter (in.) |
|---|---|---|---|
| | Steel | Copper | |
| 1/2 | 6 | 5 | 1/4 |
| 3/4 | 6 | 6 | 1/4 |
| 1 | 6 | 6 | 1/4 |
| 1-1/4 | 8 | 8 | 3/8 |
| 1-1/2 | 8 | 8 | 3/8 |
| 2 | 10 | 8 | 3/8 |
| 2-1/2 | 10 | 8 | 3/8 |

| | | | |
|---|---|---|---|
| 3 | 12 | 10 | 3/8 |
| 4 - 6 | 12 | NA | 1/2 |
| 8 | 18 | NA | 5/8 |

B. HANGER INSERTS

1. Use insert for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams wherever practical.

2. Set inserts in position in advance of concrete work. Provide reinforcement rod in concrete for inserts carrying pipe over 4 inch or in ducts 60 inches wide.

3. Where concrete slabs form finish ceiling inserts shall be flush with slab surface.

4. Where inserts are omitted, drill through concrete slab from below and provide rod with recessed square steel plate and nut above slab.

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

D. Place a hanger within one foot of each horizontal elbow.

E. Use hangers which are vertically adjustable 1-1/2 inch minimum after is erected.

F. Pipe supports on copper tubing shall be copper or copper-plated steel.

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

H. Support vertical piping at every floor.

I. Support riser piping independently of connected horizontal piping.

J. Pipe anchors and guides shall be installed where indicated on the drawing and as necessary for control of expansion and contraction of all piping systems. Anchors shall be secured to the building structure at locations where the thrust force will not damage the building structure or material. Guides and anchors shall be secured to one or more beams. Provide all miscellaneous steel to install all anchors and guides.

K. Prime coat exposed steel hangers and supports.

3.7 SLEEVES

A. Where piping or ductwork passes through floor, ceiling or wall close off space between pipe or duct and construction with non-combustible insulation. Provide tight fitting metal caps on both sides and caulk.

B. Install chrome-plated escutcheons where piping passes through finished surfaces.

C. Set sleeves in position in advance of concrete work. Provide necessary reinforcement around sleeves.

D. Extend sleeves through potentially wet floors 1 inch above finished floor level. Caulk sleeves full depth and provide floor plate.

3.8 VALVE CONNECTIONS

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

B. Thread pipe sizes 2 inches and smaller.

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

D. Use grooved body valves with mechanical grooved jointed piping.

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

F. Provide valves for shut-off and isolating service, to isolate equipment, parts of systems, or vertical risers.

G. Bronze Gate Valves or Bronze Ball Valves: Shall be used for general shut-off service in heating and cooling system piping (2" and smaller) and at all heating terminal units.

H. N.R.S. Gate Valves: Shall be used for general shut off service in heating system piping 2-1/2 inch and larger.

I. Use Globe valves or angle valves for throttling service, control device or meter bypasses, and in expansion tank connection.

J. Silent Check or Triple duty valve: Shall be used at the discharge of each pump.

K. Spring loaded check valves or combination (triple duty) valves shall be installed on discharge of condensate pumps and condenser water pumps.

L. Drain valves at main shut off valves and at all low points of piping and equipment.

M. Combination Flow-Measuring, Shut-Off and Balancing Valves: Shall be used where indicated.

N. OS&Y gate valves shall be installed at boiler supply and return connections in accordance with Maine State Boiler Rules And Regulations.

3.9 PUMP INSTALLATION

A. Pumps shall be installed in accordance with the manufacturer's printed instructions. Vertical inline pumps shall be installed vertically, wet rotor pumps shall be installed horizontally.

B. Decrease from line size to pump connection size with eccentric reducers so top of piping remains level. Support piping adjacent to pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and over.

C. Provide flexible piping connectors on inlet and outlet of vertical inline and base mounted pumps with capacity of 25 GPM or more. Hang or support vertical inline pumps using flexible spring isolators mounted inboard (close to pump) of flexible piping connectors.

D. Pumps shall be installed with startup strainers, inlet and outlet shut off valves, discharge check valve, balance, and flow measuring valves, and pressure gauges on suction and discharge.

E. Provide suction diffuser for inlet to each base mounted pump.

F. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, operate within 10% of midpoint of published maximum efficiency curve.

G. Provide necessary brackets or hanger supports as required to relieve the stress on the pumps and piping.

3.10 CONDENSATE PUMP INSTALLATION

A. Pumps shall be installed in accordance with the manufacturer's printed instructions. Discharge from pump shall be run in copper or PVC piping to the closest drain connection and as shown on the drawings. Support discharge piping to provide a continuous pitch down after the initial vertical lift, without sagging.

B. Hard wire pump to power supply with disconnect to prevent unintentional disconnection of pump.

3.11 CLEANING

A. Water Systems:

1. After satisfactory completion of pressure tests, before permanently connecting new piping to existing piping and equipment, strainers, and the like, clean equipment thoroughly, blow and flush piping for a sufficient length of time as directed, so that interiors will be free of foreign matter.

2. After system has been completely filled, start zone pumps and circulate cold water for a short time to dislodge small air bubbles, and return them to air extraction device.

3. Raise water temperature to 200 degrees f. while operating pumps.

4. Stop pump and vent radiation and high points of the system. Normal operation may now be started at any time.

3.12 TESTING

A. No joint or section of new piping shall be left untested.

B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, other parts, which are not designed to stand test pressures.

C. Test hydrostatically all new water piping for all services, to one and one-half times the maximum systems operating pressure, but in no case to less than 75 psig, for at least 4 consecutive hours, during which time pressure shall remain constant without pumping. Subject welded joints to hammer test while under hydrostatic pressure.

D. Test all piping for leaks, under 100 psig air pressure with soap suds; this test shall precede the previously specified hydrostatic test.

E. Do not paint, cover, or conceal piping, before testing and obtaining approval.

END OF SECTION

SECTION 15535

REFRIGERATION PIPING AND SPECIALTIES

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Refrigeration Piping

B. Liquid Indicators

C. Refrigerant Dryers

D. Solenoid Valves

E. Strainers

F. Filter-Dryers

G. Flexible Connections

H. Expansion Valves

I. Refrigerant

1.2 RELATED WORK

A. Section 15010 - General Requirements

B. Section 15671 - Air Cooled Condensing Units

1.3 SUBMITTALS

A. Submit shop drawings and product data in accordance with Section 15010.

B. Submit manufacturer's installation and operational data for all valves and specialties.

C. Submit product data for all pipe, valves, and specialties.

PART 2 PRODUCTS

2.1 REFRIGERANT PIPING

A. Refrigeration piping shall be nitrogen charged dehydrated copper refrigeration tubing. Type AC-R, hard drawn ASTM B 88. Fittings shall be

wrought copper brazing or solder-joint type ANSI B16.22. All elbows shall be long radius type.

2.2 INSULATION

A. All Suction lines shall be insulated during installation with performed flexible non-slit unicellular foam, 3/4 " thick, as specified in section 15260.

B. Provide UV resistant paint as recommended by the insulation manufacturer for coating insulation exposed outdoors, or provide welded PVC jackets.

2.3 BRAZING MATERIALS

A. AWS 5.8 brazing filler metal type Bag-5 with AWS type 3 flux, except type BCuP-5 or BCuP-6 may be used for brazing copper to copper joints.

2.4 HANGERS & SUPPORTS

A. Provide copper plated hangers and clamps.

2.5 VALVES

A. Service Valves shall be back seating globe type. Valves shall be wing type sealed cap, valves 1" and under shall be of the diaphragm packing type.

B. Solenoid Valves shall be UL listed and conform to ARI 760. Provide sealed capped manual opening valves stems constructed so that they may be serviced without being removed from the line.

C. Thermostatic Expansion Valves (Direct-Operated) shall be diaphragm and spring-loaded type with external equalizers, bulb, tubing and external superheat adjustment with seal cap. Provide external removable strainer. Power assemblies and valve cage assemblies shall be removable and replaceable without breaking valve connections. Valves shall be tested and rated in accordance with ANSI 17 and ARI 750 for capacities up to 135,000 Btu/hr.

D. Safety Relief Valves shall be forged brass with non ferrous, corrosion resistant internal working parts or cast iron bodies conforming to ASTM A 126, Grade B with Corrosion resistant internal parts. Set valve in accordance with ANSI 15.

2.6 LIQUID LINE DRYERS AND SUCTION LINE FILTER-DRYERS

A. Filter-Dryers shall conform to ARI 710. Dryers 50 cubic inches and larger shall be the replaceable cartridge type. Provide with valved bypass same size as the liquid line. Dryers shall be capable of withstanding 350 psig pressure. Suction line dryers shall be sized for a maximum pressure

drop of 2 psi, and liquid line dryers shall be sized for a maximum pressure drop 1 psi.

2.7 MOISTURE INDICATORS

A. Brass, bronze, or copper plated steel, rated for 350 psig. Indicating material with register varying levels of moisture content by change of color. Sensitivity shall be in the range of 45 to 180 particles per million in R22 refrigerant. Combination Moisture indicators and sight glass may be used.

2.8 LIQUID LIINE SIGHT GLASS

A. Double port, see through type with bulls eyes and cover cap. Bodies shall be brass or bronze. Entire unit shall be rated for 350 psig

2.9 FLEXIBLE CONNECTIONS

A. Shall consist of rubber, tetrafluoroethylene resin, corrosion resistant steel, bronze, monel, or galvanized steel. Material and configuration shall be suitable for pressures, vacuums and medium circulated. Provide wire braided cover suitable for service intended.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install refrigerant piping in accordance with the condensing unit and chiller unit manufacturer's printed instructions.

B. Size R-22 refrigerant suction lines for a maximum pressure loss of 3 psi while maintaining minimum gas velocities of 1000 fpm in risers and 500 fpm on horizontal runs and drops. Size refrigerant liquid lines for a maximum pressure loss of 6 psi. Size R134A or other HFC refrigerant lines in accordance with chiller manufacturer's recommendation.

C. Pitch all lines in direction of flow a minimum of 1/2 inch per 10 feet.

D. To provide for proper oil return to compressors, trap all suction and hot gas risers having a vertical lift of more than 5 feet and at every 25 feet of vertical lift and as recommended by unit manufacturer and indicated on the drawings. Keep horizontal dimension of traps as small as possible.

E. Provide service valves on suction and liquid pipes at condensing unit.

F. Locate remote sensing bulb on expansion valve between evaporator coil outlet and expansion valve external equalizer connection in suction line.

G. Provide separate expansion valves for each liquid line connection in multi circuited coils.

H. Provide each liquid line with charging valves, gauge ports, service valves, driers with bypass as required, moisture indicators, sight glass, solenoid valve and expansion valves and flexible connection at condensing unit (units larger than 5 tons) to isolate refrigerant piping from vibration of condensing units.

I. All parts of refrigerant system not factory charged and all field installed piping shall be evacuated to within 0.10 mm/mercury of a perfect vacuum. Hold vacuum overnight for leak test. Break vacuum to 0 psig with oil free nitrogen.

J. Install piping to meet all codes and regulations applicable to the installation. Brazing shall be done with piping filled with nitrogen.

3.2 TESTING

A. Every part of the refrigerant system shall be tested to the following:

1. High pressure side 300 psi

2. Low pressure side 150 psi

3.3 INSULATION

A. Insulation shall be non-slit type, slipped over refrigerant piping during fabrication of piping.

B. Insulation on suction lines shall be continuous through hangers and supports from condensing unit up to air handling unit connection. Use protective saddles at hangers and supports to avoid compressing insulation excessively.

C. Joints both longitudinal and butt shall be sealed with adhesive supplied by insulation manufacturer.

D. Outdoor portion of insulation shall be covered with UV resistant solvent welded PVC jacket or UV resistant paint as recommended by the insulation manufacturer.

END OF SECTION

SECTION 15671

AIR COOLED CONDENSING UNITS

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Condensing unit package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Refrigerant piping connections.

E. Electrical power connections.

1.2 RELATED SECTIONS

A. Section 15170 - Motors and Drives.

B. Section 15535 - Refrigerant Piping and Specialties.

C. Section 15855 - Air Handling Units.

D. Section 15880 - Air Energy Recovery Equipment.

E. Section 15900 - Automatic Temperature Controls.

F. Division 16 - Electrical.

1.3 REFERENCES

A. ASHRAE 14 - Methods of Testing for Rating Positive Displacement Condensing Units.

B. ASHRAE 15 - Safety Code for Mechanical Refrigeration.

C. ASHRAE 90A - Energy Conservation in new Building Design.

D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

E. NEMA MG 1 - Motors and Generators.

F. UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical.

G. UL 303 - Refrigeration and Air-Conditioning Condensing, and Air-Source Heat Pump Equipment.

1.4 SUBMITTALS

A. Submit shop drawings and product data in accordance with section 15010.

B. Shop Drawings: Indicate components, assembly, dimensions, weights, 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.

C. Product Data: Provide rated capacities, weights specialties and accessories included, options included, electrical nameplate data, and wiring diagrams. Make submission with air handling units with coils, refer to Section 15855 to ensure capacities are complementary.

1.5 SUBMITTALS AT PROJECT CLOSE-OUT

A. Provide Operation and Maintenance Data in accordance with section 15010. Include start-up instructions, maintenance instructions, parts lists, controls, and accessories.

1.6 REGULATORY REQUIREMENTS

A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc.

1.7 DELIVERY, STORAGE, AND PROTECTION

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units on site from physical damage. Protect coils.

1.8 WARRANTY

A. Provide a minimum one year warranty to include coverage for refrigerant compressors, refrigerant charge, and all accessories.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Trane

B. York

C. McQuay

D. Carrier

2.2 MANUFACTURED UNITS

A. Units: Of the same manufacturer as the Air Handling Unit it serves. Self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, and screens.

B. Construction and Ratings: In accordance with ARI 210/240, ARI 365, UL 207, and UL 303. Testing shall be in accordance with ASHRAE 14.

C. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance COP not less than prescribed by ASHRAE 90.1, 1989 or the Maine Energy Code.

2.3 CASING

A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.

B. Mount starters, disconnects, and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.

C. Provide removable access doors or panels with quick fasteners.

2.4 CONDENSER COILS

A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig (2900 pa), and vacuum dehydrate tubes. Seal with holding charge of nitrogen or refrigerant.

B. Provide Coil Guards of galvanized and painted expanded metal.

2.5 FANS AND MOTORS

A. Vertical or top side discharge direct driven propeller type condenser fans with fan guard on discharge.

B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in thermal overload protection. (Refer to Section 15170.)

C. Motors as indicated, in compliance with Section 15170.

2.6 COMPRESSORS

A. Compressor: Hermetic or semi-hermetic reciprocating or scroll type.

B. Mounting: Statically and dynamically balance rotating parts and mount on rubber-in-shear vibration isolators. Internally isolate hermetic units on springs.

C. Lubrication System: Centrifugal oil pump with oil charging valve, oil level sight glass, and magnetic plug or strainer.

D. Motor: Constant speed 3600 rpm suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Furnish with starter.

E. Crankcase Heater: Evaporates refrigerant returning to sump during shut down. Energize heater thermostatically.

2.7 REFRIGERANT CIRCUIT

A. Provide each unit with one or two independent refrigerant circuits, as scheduled and factory supplied and piped. Refer to Section 15535 - Refrigerant Piping and Accessories.

B. For each refrigerant circuit, provide:

C. Filter dryer: replaceable core type.

D. Liquid line sight glass and moisture indicator.

E. Thermal expansion valve for maximum operating pressure.

F. Insulated suction line.

G. Suction and liquid line service valves.

H. Liquid line solenoid valve.

I. Charging valve.

J. Discharge line check valve.

K. Compressor discharge service valve.

L. Condenser pressure relief valve.

2.8 CONTROLS

A. Provide factory wired unit with single point power connection. In unit, provide all power and control wiring, starters, and overloads. Wall mounted or unit mounted disconnect switch by division 16 - Electrical.

B. For the compressor provide starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls

power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.

C. Provide safety controls arranged so any one will shut down machine:

D. High discharge pressure switch.

E. Low suction pressure switch with automatic reset for each compressor.

F. Oil Pressure switch (manual reset).

G. Temperature Controls by ATC contractor (Section 15900).

H. Low ambient thermostat to lock out compressor at low ambient temperatures.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.

C. Provide for connection to electrical service. Refer to Division 16 - Electrical.

D. Install units on concrete pads on the ground or wooden sleepers flashed into the roof for roof mounted units, as indicated on the plans.

E. Provide connection to refrigeration piping system and evaporators. Refer to Section 15535. Comply with ASHRAE 15.

F. Furnish charge of refrigerant and oil.

3.2 STARTUP

A. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.

B. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.

C. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.

D. Provide cooling season start-up, and winter season shut-down for first year of operation.

E. Inspect and test for refrigerant leaks every six months during first year of operation. Repair leaks and replace lost refrigerant as required at no charge to owner during the warrantee period.

END OF SECTION

SECTION 15680

WATER CHILLERS

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Chiller package.

B. Charge of refrigerant and oil.

C. Controls and control connections.

D. Chilled water connections.

E. Starters.

F. Electrical power connections.

1.2 RELATED SECTIONS

A. Section 15535 - Refrigeration Piping and specialties.

B. Section 15980 - Automatic Temperature Controls.

C. Section 16000 - Equipment Wiring Systems.

1.3 REFERENCES

A. ANSI/ARI 590 - Positive Displacement Compressor Water - Chilling Packages.

B. ANSI/ARI 550 - Centrifugal or Rotary Water -Chilling Packages.

C. ANSI/ASHRAE 15 - Safety Code for Mechanical Refrigeration.

D. ANSI/ASHRAE 90A - Energy Conservation in New Design.

E. ANSI/ASME SEC 8 - Boiler and Pressure Vessel Code

F. ANSI/NEMA MG 1 - Motors and Generators.

G. ANSI/UL 465 - Central Cooling Air Conditioners.

H. ANSI/UL 984 - Safety Standard for Hermetic Motor Compressors.

I. ANSI/AFBMA 9-1978 - Load Ratings and Fatigue Life for Ball Bearings. Bearings must have life of not less than 200,000 hours.

J. ASTM B117 - Standard Method of Salt Spray (Fog) Testing

K. ASTM A123 - Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

L. ASTM A525 - Zinc (Hot-Dip Galvanized) Coatings on Sheet Steel Products

1. ASTM D1654 - Evaluation of Painted or Coated Specimens, Subjected to Corrosive Environments

1.4 SUBMITTALS

A. Submit drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate accessories where required for complete system.

B. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.

C. Submit manufacturer's installation instructions.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation data.

1. Include start-up instructions, maintenance data, controls, and accessories.

2. Submit maintenance data.

1.6 REGULATORY REQUIREMENTS

A. Conform to ANSI/ARI 590 Standard for testing and rating of Positive Displacement Compressor Water - Chilling Packages or conform to ANSI/ARI 550 Standard for testing and rating of Centrifugal and Rotary Screw Water - Chilling Packages.

B. Conform to ANSI/UL 465 code for construction of water chillers and provide UL label.

C. In the event the unit is not UL approved, the manufacturer shall, at his expense, provide for a field inspection by an UL representative to verify conformance to UL standards. If necessary, contractor shall perform modifications to the unit to comply with UL, as directed by the UL representative.

D. Conform to ANSI/ASME SEC 8 Boiler and Pressure Vessel Code for construction and testing of water chillers.

E. Conform to ANSI/ASHRAE 15 code for construction and operation of water chillers.

1.7 STORAGE AND HANDLING

A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.

B. Protect units from physical damage. Factory coil shipping covers shall be kept in place until installation.

C. Unit controls shall be capable of withstanding 160°F storage temperatures in the control compartment for an indefinite period of time.

1.8 WARRANTY

A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

B. Provide five year warranty for replacement compressors including all material.

1.9 MAINTENANCE SERVICE

A. Furnish service and maintenance of complete assembly for one year from Date of Substantial Completion.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Trane.

B. York

C. Carrier.

D. McQuay.

2.2 GENERAL

A. The contractor shall furnish and install air-cooled liquid chillers with a remote (indoor) evaporator, suitable for cooling water to 40°F, as shown and scheduled on the drawings. The chillers shall be installed in accordance with this specifications and perform at the specified conditions. The chiller shall be rated to operate between 25°F to 115°F.

B. Provide factory assembled and tested outdoor air-cooled liquid chillers consisting of helical rotary (screw) compressors, condenser, evaporator, electronic expansion valve, refrigeration accessories, starters, and control

panel. Construction and ratings shall be in accordance with ANSI/ARI 550 or ANSI/ARI 590.

2.3 COMPRESSORS

A. Chiller shall be equipped with two semi-hermetic helical rotary screw compressors with rotors of high grade steel on rolling element bearings with all sealing surfaces immersed in oil.

B. Statically and dynamically balance rotating parts.

C. Provide oil lubrication system with oil pump, oil charging valve and oil filter to ensure adequate lubrication during starting, stopping, and normal operation.

D. Provide compressor with automatic capacity reduction equipment consisting of capacity control slide valve. Compressor must start unloaded for soft start on motors.

E. Provide constant speed 1800 or 3600 rpm direct drive compressor motor, suction gas cooled with solid state sensor and electronic winding overheating protection, designed for across-the- line or wye delta starting. Furnish with starter. Compressor motor power factor shall be .90 or greater. If the compressor motor power factor is less than .90, power factor correction capacitors shall be installed.

F. Provide crankcase heater to evaporate refrigerant returning to crankcase during shut down. Energize heater when compressor is not operating.

2.4 EVAPORATOR

A. Provide skid mounted remote evaporator for mounting indoors, designed to be field connected to the outdoor air cooled condensing unit.

B. Evaporator shall be shell and tube type, seamless or welded steel construction with cast iron or fabricated steel heads, seamless internally finned copper tubes, roller expanded into tube sheets.

C. The evaporator shall be designed, tested, and stamped in accordance with ASME for a refrigerant side working pressure of 200 psig, and water side working pressure of 150 psig, in accordance with ANSI/ASME section 8.

D. Insulate evaporator with 0.75 inch (20 mm) minimum thickness flexible elastometric rubber closed cell insulation with maximum K value of 0.26.

E. Provide water drain connection, vent and fittings for factory installed leaving water temperature control and low temperature cutout sensors.

F. Water connections shall be victaulic or flanged. Evaporator shall have only one entering and one leaving connection. If manufacturer provides 2

separate evaporators, contractor shall provide manifold and pressure gauges to ensure equal flow is provided to each evaporator.

2.5 CONDENSER AND FANS

A. Construct condenser coils of aluminum fins mechanically bonded to internally finned seamless copper tubing. Provide integral sub-cooling circuits. Air test under water to 440 psig.

B. Provide vertical discharge direct driven propeller type condenser fans with fan guard on discharge. Entire fan assembly and each individual fan shall be statically and dynamically balanced and fan assembly shall be either painted or zinc coated steel. Fan guard shall be either PVC, chrome or zinc coated or stainless steel.

C. Provide factory mounted, louvered, painted steel, "architecturally pleasing" guard panels. Panel louvers shall cover condenser, evaporator and compressor sections so all machinery under the unit is hidden from sight. Panels shall be easily removable without tools to enable easy access to the equipment located under the unit. Wire screens or wire mesh will not be allowed.

D. Provide fan motors with permanently lubricated ball bearings and built-in thermal overload protection.

2.6 ENCLOSURES

A. House components in 12 gauge galvanized steel frame and mounted on welded structural steel base. Hot-dip galvanized steel frame coating shall be Underwriters Laboratories Inc. (UL) recognized as G90-U, UL guide number DTHW2.

B. Unit panels, decorative louvered panels, and control panels shall be finished with a baked on powder paint. Control panel doors shall have door stays. Paint system shall meet the requirements for outdoor equipment of Federal Government Agencies.

C. Mount starters and disconnects in weatherproof panel provided with full opening access doors. Provide lockable disconnect operating handle external to panel and clearly visible from outside of unit indicating if power is on or off.

D. Casings fabricated from steel that do not have a Zinc coating conforming to ASTM A 123 or ASTM A525 shall be treated for the prevention of corrosion with a factory coating or paint system. The coating or paint system shall withstand 500 hours in a salt-spray fog test in accordance with ASTM B 117. Each specimen shall have a standard scribe mark as defined in ASTM D 1654. Upon completion of exposure, the coating or paint system shall be evaluated and rated in accordance with procedures A and B of ASTM D 1654. The rating of failure at the scribe mark shall be not less than six (average creepage not greater than 1/8 inch). The rating

of the unscrewed area shall not be less than ten (no failure). Thickness of coating or paint system on the actual equipment shall be identical to that on the test specimens with respect to materials, conditions of application, and dry-film thickness.

2.7 REFRIGERANT CIRCUITS

A. All units shall have 2 independent refrigeration circuits, each with a separate single compressor for capacity modulation and standby operation.

B. Provide for each refrigerant circuit:

1. Liquid line shutoff valve.

2. Filter dryer (replaceable core type).

3. Liquid line sight glass and moisture indicator.

4. Electronic expansion valve sized for maximum operating pressure.

5. Charging port.

6. Discharge and oil line check valves.

7. Compressor suction and discharge service valves.

8. High side pressure relief valve.

9. Full operating charge of R-134a and oil.

10. Unit factory leak tested at 200 psig.

C. Capacity Modulation: Provide capacity modulation by slide valve. Unit shall be capable of operation down to 15% of rated capacity.

2.8 VIBRATION ISOLATION

A. Provide resilient mounting for all rotating parts, including compressor and condenser fans, rubber in shear or spring type isolators according to factory recommendations.

2.9 CONTROLS

A. Mount weatherproof control panel on chiller containing microprocessor controller, display, starters, power and control wiring, molded case disconnect switch (UL approved) with external lockable operator handle. Provide single point power connection on units with MCA less than 500 amps. Provide primary and secondary fused control power transformer.

B. Provide wye-delta starters for each compressor motor.

C. 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 shut-down.

6. Loss of refrigerant charge protection.

7. Motor current overload.

8. Phase reversal/unbalance/single phasing.

9. Over/under voltage.

10. Failure of water temperature sensor used by controller.

11. Compressor status (on or off).

D. Provide the following operating controls:

1. Eight (8) or more step leaving chilled water temperature controller which cycles compressors and activates slide valve based on PI algorithms.

2. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Controls shall insure accurate temperature control in light load applications.

3. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance tripouts.

4. Low ambient controls for operation down to 20 degrees F or lower.

5. High ambient unloader pressure-stat that unloads compressors to keep head pressure under control and help prevent high pressure nuisance tripouts on days when outside ambient is above design.

6. Compressor current sensing unloader unit that unloads compressors to help prevent current overload nuisance tripouts.

7. Auto lead-lag functions that constantly evens out running hours and compressor starts automatically. If contractor can not 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.

8. Low ambient lockout control with adjustable setpoint.

9. Condenser fan sequencing which automatically cycles fans in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing unit efficiency.

E. Provide digital display of % RLA on microprocessor.

F. Provide communication interface compatible with the automatic temperature control system to enable chiller setpoint readout and adjustment, chiller operating status, and any alarm conditions, for the following operating and alarm conditions:

1. Leaving chiller water temperature setpoint adjustment.

2. Display diagnostics specified above in 2.09 C.

3. Entering and leaving water temperatures.

4. Chilled water and current limit setpoint.

5. Ambient temperature

6. Failure alarms:

   a. Water temperature and ambient temperature sensors

   b. Motor contactors

   c. Unit Controller

   d. Condenser and evaporator refrigerant temperature sensors.

G. Compressor Sequencing:

1. On system startup, the lead compressor (user selectable) and the pump system shall be enabled. The lag compressor shall be enabled whenever system supply temperature exceeds system setpoint by the user-adjustable control band.

2. The lag compressor shall be shutdown whenever the sensed load is such that the lead compressor can meet the required load on its

own. An adjustable timer shall be provided to prevent unnecessary cycling of the lag compressor.

3. Lead/Lag - Lead/Lag control shall be Manual or Automatic as selected by the operator through the ATC system.

4. On chiller shutdown, the pump system shall remain on for at least one minute to provide machine protection.

H. Setpoint Control - The system chilled water setpoint shall be operator adjustable through the Automatic Temperature Control system.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install chiller and evaporator in accordance with manufacturer's instructions.

B. Align chiller package on reinforced concrete pad as shown on the site drawings.

C. Connect to electrical service.

D. Connect to chilled water piping.

E. Provide two suction and liquid refrigerant lines between indoor evaporator and outdoor condensing unit, sized, trapped, and piped in accordance with the chiller manufacturer's instructions.

F. Arrange piping for easy dismantling to permit tube cleaning.

3.2 MANUFACTURER'S FIELD SERVICES

A. Supply service of factory trained representative for a period of 1 day to supervise testing, start-up, and instruction on operation and maintenance to Owner.

B. Supply initial charge of refrigerant and oil.

END OF SECTION

SECTION 15785
ADDED PER ADDENDUM 2
1/29/02 AT

SECTION 15785

COMPUTER ROOM AIR CONDITIONING UNITS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Glycol free cooling type computer room air conditioning unit including remote drycooler and pump package.

B. Controls and control panels.

1.2 RELATED SECTIONS

A. Section 15170 - Motors: Evaporator and dry cooler fan motors and pump motors.

B. Section 15510 – Pipe, Pumps, Valves and Specialties

C. Section 15900 – Automatic Temperature Controls

1.3 REFERENCES

A. ASHRAE 52 - Air-Cleaning Devices Used in General Ventilation for Removing Particulate Matter.

B. ASME SEC 8D - Boilers and Pressure Vessel Codes - Rules for Construction of Pressure Vessels.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

D. NFPA 70 - National Electrical Code.

E. NFPA 75 - Protection of Electronic Computer/Data Processing Equipment.

F. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

G. Underwriters Laboratories.

1.4 SUBMITTALS

A. Submit under provisions of Section 15010.

B. Shop Drawings: Indicate components, assembly, dimensions, weights, required clearances and locations and sizes of field connections. Include schematic layouts showing room unit, drycooler and pump package with all required accessories.

C. Product Data: Indicate rated capacities, options and accessories included. Provide electrical data and wiring diagrams.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Company specializing in performing the work of this section with minimum three years documented experience approved by manufacturer.

1.6 REGULATORY REQUIREMENTS

A. Conform to NFPA 90A for the installation of computer room air conditioning units.

B. Products Requiring Electrical Connection: Listed and classified by testing firm acceptable to the authority having jurisdiction as suitable for the purpose specified and indicated.

1.7 WARRANTY

A. Provide warranty on entire unit for one from date of substantial completion.

B. Provide additional four year warranty (five years total) on refrigerant compressors.

1.8 MAINTENANCE SERVICE

A. Furnish service and maintenance of computer room air conditioning unit system for one year from Date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Provide two sets of filters for each unit.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. LIEBERT

B. Or Approved Equal

2.2 AIR CONDITIONING UNITS

A. Description: Computer room air conditioning unit with downflow room cabinet containing filters, compressors, evaporator coil, glycol cooled

condensers, glycol free cooling coil, humidifier, electric heating coil and complete temperature and humidity control system; remote drycooler and remote pump package.

B. Size, capacity and electrical characteristics as scheduled on the Drawings.

2.3 ROOM CABINET AND FRAME

A. Structural Frame: 14 gage welded steel suitably braced for rigidity, capable of supporting compressors and other mechanical equipment and fittings and equipped with vibration isolation pads. Height of stand shall match existing raised floor.

B. Doors and Access Panels: 18 gage steel with polyurethane gaskets, hinges to allow removal of panels, and concealed fastening devices.

C. Insulation: Thermally and acoustically line cabinet interior with one inch thick acoustic duct liner.

D. Finish of Exterior Surfaces: Baked-on textured vinyl enamel; to match computer equipment or as selected by owners representative.

2.4 EVAPORATOR FANS, MOTORS AND DRIVES

A. Fans: Double inlet, statically and dynamically balanced on steel shaft with self-aligning, permanently lubricated ball bearings, and V-belt drive.

B. Motor: Refer to Section 15170 - Motors. Drip proof, permanently lubricated ball bearing motor with built-in current and overload protection.

C. V-Belt Drive: Refer to Section 15170 – V-Belt Drives. Cast iron or steel sheaves, dynamically balanced, keyed, variable and adjustable pitch motor sheave, minimum of two matched belts, drive rated minimum 1.5 times nameplate rating of motor.

2.5 COMPRESSORS

A. Type: Semi-hermetic with suction gas cooled motors, vibration isolators, thermal overloads, oil sight glass, manual reset high pressure switch, pump down low pressure switch, suction line strainer, reversible oil pumps, 1750 rpm operating speed

B. Compressors: Individually serviceable without dismantling other components.

C. Refrigeration Circuits: Unit shall have two refrigeration circuits. Each refrigeration circuit shall have glycol cooled condenser, hot gas muffler, thermal expansion valve with external equalizer, liquid line solenoid valve, liquid line filter-drier, refrigerant sight glass with moisture indicator, service shut-off valves and charging valves.

2.6 EVAPORATOR COILS

A. Alternate row circuits, direct expansion cooling coils of seamless copper tubes expanded into aluminum fins in A-frame configuration.

B. Mount coil assembly in stainless steel drain pan.

2.7 GLYCOL FREE COOLING COIL

A. Free cooling coil shall have copper tubes and aluminum fins and shall be rated for 300 psi operating pressure. Coil shall be factory piped with a 3-way control valve. All glycol piping shall be factory insulated to prevent condensation when operating in the free cooling mode.

2.8 GLYCOL CONDENSERS

A. Glycol cooled refrigerant condenser shall be counterflow, shell and tube type, cleanable with removable heads. Condensers shall be ASME stamped and rated for 400 psi operating pressure at 200F.

B. Each condenser shall be factory piped with a head pressure operated regulating valve and parallel bypass valve.

2.9 HUMIDIFIER

A. Steam generating humidifier shall be infrared type complete with high intensity quartz lamps, stainless steel pan, automatic water supply system and factory piping needing only field connection of cold water.

2.10 ELECTRIC REHEAT COIL

A. Electric coils shall be low watt density 304 stainless steel fin tubular construction with all required thermal safety cutouts and switches. Coil shall have three stages of control.

2.11 FILTERS

A. Filter media: Pleated, lofted, non-woven, reinforced cotton or fiberglass fabric; supported and bonded to welded wire grid; enclosed in cardboard frame. Thickness as scheduled on plans.

B. Efficiency Rating per ASHRAE 52-76:

1. Dust spot efficiency: as scheduled.

2. Weight arrestance: 90-92 percent.

3. Recommended final resistance: 1.0 inch WG inch WG.

2.12 ELECTRICAL PANEL

A. Control Cabinet: NEMA 250; Type 2 enclosure, UL listed, with piano hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control circuit transformer and other controls and accessories as required.

B. Disconnect Switch: (Locking type) Non-automatic molded case circuit breaker with handle accessible with panel closed and capable of preventing access until switched to "off" position.

2.13 ELECTRONIC CONTROL SYSTEM

A. Solid state with start button, stop button, temporary loss of power indicator, manual reset circuit breakers, temperature control humidity control, and monitor panel.

B. Monitor Panel: Back lighted with no visible indicator lights until operating function is activated; indicators include cooling, humidification, loss of air flow, change filters, high temperature, low temperature, high humidity, low humidity, high head pressure (each compressor), and low suction pressure (each compressor).

C. Temperature and Humidity Control Modules: Solid state plug-in with adjustable set point, "push-to-test" calibration check button, and built-in visual indicators to indicate mode of operation.

D. Location: Through hinged door in front of unit; isolated from conditioned air stream to allow service while system is operating.

2.14 MICROPROCESSOR CONTROL SYSTEM

A. Logic Circuitry: Microprocessor shall continuously monitor operation of process cooling system; continuously digitally display room temperature and room relative humidity; sound alarm on system malfunction and simultaneously display problem. When more than one malfunction occurs, display fault in sequence with room temperature, remember alarm even when malfunction cleared, and continue to display fault until reset.

B. Malfunctions: Power Loss, Loss of Air Flow, Clogged Air Filter, High Room Temperature, Low Room Temperature, High Humidity, Low Humidity, [Smoke/Fire,] Compressor No. 1 - Overload, Compressor No. 1 - Low Pressure, Compressor No. 1 - High Pressure, Compressor No. 2 - Overload, Compressor No. 2 - Low Pressure, Compressor No. 2 - High Pressure, and Supply Fan Overload.

C. Light Emitting Diodes Display: Control Power On, System On, De-humidification taking place, Compressor No. 1 operating, Compressor No. 2 operating.

D. Push Buttons: Provide to STOP process cooling system, START process cooling system, SILENCE audible alarm, push-to-test LED indicators, and display room relative humidity.

E. Remote Signaling: Provide termination for remote signaling of system status and alarms.

2.15 REMOTE GLYCOL PUMP PACKAGE

A. Glycol pump package shall consist of two pumps with capacity and electrical requirements as scheduled on the Drawings. Pumps shall be mounted in an accessible weathertight enclosure designed to be mounted on sleepers. Pump motor starters shall be located in the drycooler electrical cabinet. Each pump shall have capacity to serve the system, with the second pump serving as stand-by. Lead pump shall be automatically alternated by factory provided control system.

2.16 REMOTE DRYCOOLER UNIT

A. Roof mounted drycooler shall have low profile cabinet with slow speed fans for quiet operation. Cabinet shall be aluminum construction. Coil shall have copper tubes with aluminum fins. Unit shall have weathertight electric panel containing disconnect switch, magnetic starters for drycooler fan and remote glycol pumps and all necessary control components for drycooler and pump operation. Pumps ashall be automatically.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that proper power supply is available and of the correct characteristics.

3.2 INSTALLATION

A. Install all components in accordance with manufacturer's instructions.

B. Provide adequate drainage connections for condensate complete with trap as detailed on drawings including all condensate piping.

C. Furnish and install adequate quantities of inhibited propylene glycol to completely fill the condenser water systems with 50% glycol solution.

D. Systems shall be manually charged through fill connection on drycooler.

E. Provide glycol maintenance kit to owner, including refraction type concentration testing device, inhibitor concentration test kit, and any other testing equipment recommended by the glycol manufacturer.

F. One year warranty shall include maintenance of specified glycol solution concentration in all systems for that period.

G. Provide chemical treatment, inhibitors, etc. as recommended by the glycol manufacturer and as approved by heating coil and pump manufacturers.

H. Acceptable Manufacturers of Propylene Glycol:

1. Dow - Dowfrost HD

2. Union Carbide - Ucartherm

3. or approved equal.

3.3 MANUFACTURER'S FIELD SERVICES

A. System shall be inspected and started up by a factory approved agent.

END OF SECTION

SECTION 15813

STEAM HUMIDIFIERS

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Dry Steam Humidifiers

B. Steam Jacketed Distribution Manifolds

1.2 RELATED SECTIONS

A. Section 15510 - Piping, Pumps, Valves, and Specialties

B. Section 15855 – Air Handling Units

C. Section 15900 - Automatic Temperature Controls

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 15010, indicating layout of system and components.

B. Product Data:

1. Provide literature which indicates dimensions, capacities, ratings, duct and service connections, and electrical characteristics and connection requirements.

2. Electrical: Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

3. Submit operation and maintenance manuals and data in accordance with Section 15010.

4. Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Dri-Steem

B. Armstrong Machine Works

## 2.2 DRY STEAM HUMIDIFIERS

A. Humidifier Construction (Dri_Steem Ultra-Sorb)

1. Ultra-Sorb Panel: Vertical steam supply header/separator, vertical condensate collection header, and bank of closely spaced slip-fit horizontal steam dispersion tubes spanning the distance between the two headers. Tubes shall be 1-1/2 in. diameter and have non-metallic discharge orifice tubelets spaced 1-1/2 in. apart; tubelets on opposite shall be staggered ¾ in. Type 304 stainless steel construction, with galvanized steel casing for duct mounting. NPT steam and condensate pipe connections. Size for full width of duct or air handling unit.

2. Separation: End of each tube protrudes into supply header, with 45-degree open end directed away from the incoming steam flow.

3. Condensate Drain: Dispersion tubes slope down in the direction of condensate flow. Tubelets protrude into tube, so condensate clinging to tube wall cannot enter tubelet.

4. Control Valve: Globe or plug type, capable of modulating flow of steam over entire stroke of operator with modulating electric operator. Shipped loose for installation at jobsite.

B. Humidifier Construction (Dri-Steem Maxi-Bank or Multi-Tube, or Armstrong Series 9000)

1. ARI 610; steam separator type receiving steam at supply pressure and providing separation ahead of control valve, discharging through internal drying and silencing chambers, and distribution manifold at atmospheric pressure.

2. Body: Cast iron or stainless steel with integral or separate metering valve, separating and drying chambers, and silencing chamber with stainless steel silencing medium.

3. Separating Chamber: To disengage and remove water droplets and particle matter when operated at maximum capacity.

4. Internal Drying and Silencing Chambers: To receive steam at atmospheric pressure and jacketed by steam at supply pressure.

5. Integral or Separate Control Valve: Steam jacketed parabolic plug, capable of modulating flow of steam over entire stroke of operator, with modulating electric operator.

6. Distribution Manifold: To provide uniform distribution over entire length, and jacketed by steam at supply pressure, with full length stainless steel internal silencing screen. Provide tube spacing as

required to meet the dispersion distance indicated. Full width of duct or air handling unit.

7. Header Piping: Header may be factory-assembled stainless steel, with black steel interconnecting piping (Maxi-Bank), or field-assembled from black steel piping (Multi-Tube), at the Contractor's option.

C. Performance: As indicated on the Drawings.

D. Controls: Provide temperature switch before steam trap to prevent humidifier from operating before start-up condensate is drained. On Maxi-Bank, Multi-Tube, or Series 9000 humidifiers, the switch is on the separator's condensate outlet pipe. On Ultra-Sorb humidifiers, the switch is on the inlet pipe to the nearest drip trap upstream of the humidifier control valve.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions. Provide clearance for access and removal of internal parts.

B. Install to ARI 630.

C. Provide galvanized steel rods to support distribution manifolds and mount in air systems plenums.

D. Connect dry steam humidifiers to steam supply and to condensate piping. Provide gate valves, inlet strainer, and inverted bucket steam trap.

END OF SECTION

SECTION 15835

TERMINAL HEATING AND COOLING UNITS

(FILED SOON ENOUGH)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Finned Tube Radiation

B. Unit Heaters

C. Cabinet Unit Heaters

D. VAV Boxes

E. Duct Mounted Heating Coils

1.2 RELATED SECTIONS

A. Section 15170 - Motors, Drives, and Accessories

B. Section 15510 - Hydronic Pipe, Valves, and Specialties

C. Section 15900 - Automatic Temperature Controls

1.3 SUBMITTALS

A. Submit shop drawing in accordance with Section 15010.

1.4 PRODUCT DATA

A. Finned Tube Radiation

B. Unit Heaters

C. Cabinet Unit Heaters

D. VAV Boxes

E. Duct Mounted Heating Coils

1.5 OPERATION AND MAINTENANCE MANUALS

A. Submit manuals and data in accordance with Section 15010.

1.6 OPERATION AND MAINTENANCE DATA:

A. Finned Tube Radiation

B. Unit Heaters

C. Cabinet Unit Heaters

D. VAV Boxes

E. Duct Mounted Heating Coils

1.7 SAFETY

A. Comply with OSHA 1910

PART 2 PRODUCTS

2.1 FINNED TUBE RADIATION

A. Heating Elements fabricated of seamless copper tubing suitable for soldered fittings, mechanically expanded into evenly spaced aluminum fins. Provide heating elements of sizes and capacities as scheduled on plans, based on 65°F entering air temperature, at average water temperature scheduled.

B. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.

C. Enclosures: Minimum 18 gauge steel, of sizes and configurations as scheduled on the plans. Provide all front panels, end panels, end caps, corners, and joiner pieces to snap together, with front panel easily removable.

D. Finish: Factory applied baked enamel color as selected by the architect.

E. Access Doors with Locks: For otherwise inaccessible valves, provide permanently hinged access doors as shown on drawings, integral with cabinet.

F. Acceptable Manufacturers:

1. Sterling

2. Vulcan

3. Dunham-Busch

4. Trane

2.2 UNIT HEATERS

A. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.

B. Casing: 0.0478 inch (1.2 mm) steel with threaded pipe connections for hanger rods.

C. Finish: Factory applied baked enamel of color as selected By the architect.

D. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.

E. Air Outlet: Adjustable pattern diffuser on projection models and two or four way louvers on horizontal throw models.

F. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 15170.

G. Capacity: As scheduled on drawings, based scheduled entering air temperature, scheduled water temperature.

H. Provide aquastat on hot water supply pipe to interlock with fan to shut fan off if the temperature drops below 120°F.

I. Acceptable Manufacturers

1. Trane
2. McQuay
3. Sterling
4. York
5. Carrier

2.3 CABINET UNIT HEATERS

A. Units shall include coil, fan, filter, fan housing, motor, and insulation.

B. Cabinet shall be 18 gauge furniture grade steel with integral stamped inlet and outlet grilles. Provide access panel with tamper proof cam lock device. Color as selected by Architect.

C. Coils shall be seamless copper tubes with mechanically bonded aluminum fins with fin collars and end supports. Tested to a maximum working pressure of 300 psig and leak tested. Supply and return connections shall be on the same side.

D. Fans shall be forward curved double width. Motors shall have integral overload protection and unit mounted type disconnect. Motor shall be

multi-speed selectable in the field. All wiring in accordance with national electric code

E. Filters shall be easily removable 1" thick, 20% efficient (by ASHRAE 52-76) pleated throw away type, Farr 20/20 or approved equal.

F. Capacity and arrangements as indicated and scheduled on the drawings.

G. Acceptable Manufacturers

1. Trane

2. McQuay

3. Sterling

4. York.

5. Carrier

2.4 VAV BOXES

A. Factory fabricated, variable air volume, pressure independent, supply air control terminals for connection to single low pressure duct. Unit shall be configured to be hung from ceiling or as indicated on the plans.

B. Casings shall be fabricated of corrosion protected welded steel, with a minimum of 18-gauge metal on the high pressure (inlet) side of the VAV damper and 22-gauge metal on the low pressure (outlet) side and unit casing. Maximum Casing Leakage shall be less than 1 percent of nominal air flow at 0.5 in WG inlet static pressure.

C. Insulation: Provide 1 inch thick fiberglass insulation, R-Value 4.2, 1.9 lb./cubic foot, with high density facing. Insulation shall be UL listed and meet NFPA-90A and UL 181 requirements. [Provide interior liner made of 26 gauge phosphatized steel (Dual Wall Construction). The interior wall shall isolate the fiberglass insulation from the airstream and allow the unit to be easily cleaned without damage to the insulation. All wire penetrations through the double wall shall be covered by grommets.]

D. Volume Damper shall be factory installed damper assembly inside unit casing. Construct from extruded aluminum or a minimum of 20 gauge (0.9 mm) galvanized steel components. Key damper blades into shaft with nylon fitted pivot points. Air volume control damper shall be a factory calibrated.

1. Provide factory installed [pneumatic] [electronic] damper actuator. Unit shall be factory tested and calibrated for sizes and capacities as scheduled on the drawings.

E. Provide factory installed and calibrated air flow sensor. Flow sensor shall be a ring or cross. Bar or single point sensing device is not acceptable.

F. Provide removable access panel for servicing interior components.

G. Plenum Air Outlets: Provide flange or slip duct connections on integral outlets. Provide factory installed air distribution manifold (Octopus) as shown or scheduled on the plans, with 6, 8, or 10 inch diameter collars, each with butterfly balancing damper with locking quadrant.

H. Identify each terminal unit with clearly marked identification label and airflow indicator. Label shall include unit nominal air flow, maximum factory set air flow, minimum factory set air flow.

I. CERTIFICATION

1. Factory set and check all controllers to within 5% of scheduled maximum and minimum settings. Base performance on tests conducted in accordance with ARI 880.

2. Shutoff terminals shall be UL listed as Room Air Terminal.

J. ACCEPTABLE MANUFACTURERS

1. Trane

2. Price

3. Enviro-Tech

4. Anemostat

5. Titus

6. Carrier

2.5 HEATING COILS

A. General

1. Provide hot water heating coils to fit into ductwork in sizes, configurations, and capacities as indicated and scheduled on the drawings.

2. Coils shall factory fabricated of 5/8 inch OD seamless copper tubes arranged in parallel or staggered pattern, expanded into aluminum plate fins, with brazed joints.

3. Coil shall be supported in die formed channel frame of 16 gage galvanized steel with 3/8 inch mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.

4. Configuration: Drainable, with threaded plugs for drain and vent.

5. Coil manufacturer shall be the same as the AHU, Unit heater, or VAV box manufacturer in as much as possible.

B. ACCEPTABLE MANUFACTURERS

1. Trane

2. York

3. McQuay

4. USA Coil and Air

5. Enviro-Tech

6. Anemostat

7. Titus

8. Carrier

PART 3 EXECUTION

3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's printed instructions and in accordance with details shown on the plans. Provide clearance for access and removal of internal parts.

B. Expansion compensation, as required, shall be installed in piping and connected to radiators.

C. Fin Tube Radiation: Provide end caps, seam covers, access doors, etc. as required for a secure, neat, installation with no exposed sheetmetal edges. Fin tube enclosures shall be extended as shown on the plans to cover supply and return piping exposed along the walls between the finned length and the piping drops or risers. Locate the finned length under windows as much as possible and as shown on the plans.

D. Unit Heaters: Locate horizontal unit heaters and cabinet unit heaters as indicated. Hang horizontal units from building structure with vibration isolation hangers. Provide manual air vent on coil piping.

E. Coils: Provide unions, valves, manual air vents and temperature/pressure taps on supply and return piping to each coil. Provide adequate service access on at least one side of coil. Provide access door to observe upstream side of each coil in accordance with section 15890 – Ductwork, Fans, and Accessories.

END OF SECTION

SECTION 15855

AIR HANDLING UNITS

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Central station Air Handling Units (AHU).

B. Hydronic Heating coils.

C. Cooling coils.

D. Condensate Drain Pans.

E. Control Dampers.

F. Fans.

1.2 RELATED SECTIONS

A. Section 15170 - Motors and Drives.

B. Section 15671 - Air Cooled Condensing Units.

C. Section 15880 – Air Energy Recovery Units

D. Section 15890 - Ductwork and Accessories.

E. Section 15900 - Automatic Temperature Controls.

1.3 REFERENCES

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

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

C. AMCA 99 - Standards Handbook.

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

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

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

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

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

I. ARI 430 - Central-Station Air-Handling Units.

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

K. ARI 610 - Central System Humidifiers.

L. NEMA MG1 - Motors and Generators.

M. NFPA 70 - National Electrical Code.

N. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

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

P. UL 900 - Test Performance of Air Filter Units.

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

1.4 SUBMITTALS

A. Submit under provisions of Section 15010.

B. Shop Drawings: Indicate assembly, unit dimensions, access door locations, motor/drive side, weight loading, required clearances, construction details, duct and piping connection sizes, locations, and other field connection details, and electrical characteristics and connection requirements.

C. Product Data:

1. Provide literature which indicates dimensions, weights, capacities, ratings, fan performance, gages and finishes of materials, and electrical characteristics and connection requirements.

2. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-87.

3. Fans: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430. Provide fan curves with specified operating point clearly plotted. Certify units at full speed fan position. Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the contractor.

4. Provide data on filter media, filter performance data, filter assembly, filter area, and filter frames.

5. Submit sound power level data for both fan outlet and casing radiation at rated capacity tested in accordance with AMCA 300.

6. Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.

D. Manufacturer's Installation Instructions.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit under provisions of Section 15010.

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

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section, who issues complete catalog data on total product.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Section 15010. Units shall ship in pieces as large as possible which still allow the efficient rigging into place at the job site, or fully assembled if possible. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate position and orientation in direction of airflow. Each section shall have lifting lugs or shipping skid to allow for field rigging and final placement of section.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.8 ENVIRONMENTAL REQUIREMENTS

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

1.9 EXTRA MATERIALS

A. Provide two spare sets of filters for each unit.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Trane. Model: IAQ Modular Climate Changer

B. York. Model: Airpak

C. McQuay. Vision Series

D. Carrier. Model: 39NX

E. Substitutions: Manufacturer must clearly define any exceptions made to Plans and Specifications. Mechanical Contractor is responsible for expenses that occur due to exceptions made.

2.2 GENERAL DESCRIPTION

A. Configuration: Fabricate central station air handling units with fan, damper, filter, and coil sections plus accessories, as scheduled and detailed on the drawings, including:

1. Mixing box section.

2. Filter Section.

3. Face and Bypass Damper Section.

4. Cooling coil section with sloped drain pan.

5. Hydronic Heating coil section.

6. Fan sections.

7. Access sections with access doors.

8. Discharge Plenum.

9. Performance Base: Sea level conditions.

10. Factory fabricate air handling units of sizes, capacities, and configurations as scheduled and detailed on drawings.

B. Central Station Air Handling Units: Provide factory installed frames to support all sections of units. Contractor shall provide additional base rails of minimum 10 gauge galvanized steel channels, I-beams, or wooded sleepers. Base rails shall have enough height to ensure proper trapping of condensate of all air handling units, in no case less than 4" high.

2.3 CASING

A. Central Station Indoor Units

1. Construct casings of minimum 16 gauge G90 galvanized steel structural frames and minimum 2 inch thick double wall panels. Construct double wall panels of minimum 18 gauge G90

galvanized steel exterior panels and minimum 20 gauge G90 galvanized steel interior panels.

2. In order to properly clean the interior of the air handler of microbial growth and other debris, the casings shall be constructed such that structural frames are free standing and double wall panels are non-load bearing.

3. Contractor shall be responsible to provide connection flanges and all other framework that is needed on unit to ensure that removal of double wall panels shall not affect structural integrity of unit.

B. Construct casing sections located upstream of supply fan for operation at 4 inches water gage negative static pressure. Seal joints between casing sections with closed cell foam or equal gasketing for leak free seal and thermal and acoustical break.

C. Panels shall be fully removable to allow for a proper way to thoroughly clean panels of microbial growth and to access internal parts. Secure panels to structural frames with zinc chromate plated or stainless steel screws. Seal joints between exterior panels and structural frames with closed-cell foam gasketing or equal for leak free seal and thermal and acoustical break. Alternatively, access doors which allow full and complete access to all sections and components of the interior of the air handler may be provided in lieu of removable panels.

D. Casings not constructed of G90 galvanized steel, casings with welds on exterior surfaces, or casings with welds on interior surfaces that have burned through to exterior surfaces shall be chemically cleaned, coated with rust inhibiting primer, and finished width rust inhibiting enamel in order to prevent premature corrosion and microbial growth.

E. Casings shall be provided with factory fabricated removable hinged access doors of similar construction as the air handling unit casing for all sections as follows:

1. Access Modules.

2. Cooling coil section (downstream).

3. Filter and damper sections.

4. Fan section (with full access to motor & drive).

F. Construct access doors of minimum 18 gauge G90-U galvanized steel exterior panels and minimum 22 gauge G90-U galvanized steel interior panels. Provide automotive style neoprene gasketing around full perimeter of access doors to prevent air leakage. Provide "ventlock" style non-corrosive alloy latches operable from the inside or outside of unit. If access doors do not open against unit operating pressure, provide safety latches that allow access doors to partially open after first handle

movement and fully open after second handle movement. Insulate access doors with 2 inch thick 1-1/2 pound per cubic foot density matt faced fiber glass insulation.

G. Insulate casing sections with 2 inch thick 1-1/2 pound per cubic foot density matt faced fiber glass insulation. Provide double wall casing construction and encase insulation between exterior and interior casing panels such that no insulation is exposed to airstream. Foil facing on insulation is not acceptable as alternate to double wall construction. Insulate all structural channels connected to casing panels and cover openings in structural channels with galvanized steel. Insulation shall comply with NFPA 90A.

H. Provide sealed double wall drain pans constructed of minimum 18 gauge G90 galvanized steel exterior pans and 304 stainless steel interior pans under all cooling coils. Encase manufacturer's standard insulation between exterior and interior walls. Drain pans shall be sloped in 2 planes; cross break interior pans and pitch toward drain connections to ensure complete condensate drainage. Drain connection shall be male type welded at the lowest point on the side or bottom of the drain pan. All drain pan connections shall be located on the access side of the unit, as scheduled and indicated on the plans, to enable proper trapping.

2.4 FANS

A. Provide horizontal fan sections for supply and exhaust air with forward curved (FC), backward inclined, double width, double inlet or airfoil wheel single inlet plenum (plug) centrifugal fan designed and suitable for class of service as indicated in the unit schedule.

B. Fan shaft shall be properly sized and protectively coated with lubricating oil. Fan shafts shall be solid and properly designed so that fan shaft does not pass through first critical speed as unit comes up to rated RPM. Fans shall be statically and dynamically tested as an assembly at the required RPM to meet design specifications. Key fan wheels to fan shaft to prevent slipping. (Backward inclined or airfoil fans also acceptable if performance is equal or better than scheduled)

C. Provide self-aligning, grease lubricated pillow-block ball bearings selected for L-50 200,000 hour average life per ANSI/AFBMA 9. Extend grease lubrication fittings to drive side of unit with plastic tubes and zerk fittings rigidly attached to casing.

D. Mount fans on minimum 16 gauge steel isolation bases. Internally mount motors on same isolation bases and internally isolate fans with 2 inch housed spring isolators. Install flexible canvas ducts between fan and casings to ensure proper isolation and prevent vibration and noise from being transmitted through the unit and ductwork.

E. Flexible canvas ducts shall comply with NFPA 90A. If no flexible canvas duct is provided, then the entire unit shall be externally isolated from the supply duct work and piping by contractor.

F. Fan sections shall have full height, double wall, hinged, removable access doors on drive side for inspection and maintenance of internal components. Construct doors in accordance with Article 2.03 Paragraph E. To facilitate inspection of internal components, provide 8 x 10 inch sealed glass and wire view windows on access doors.

G. Statically and dynamically balance fan section assemblies at the factory. Fan section assemblies include fan wheels, shafts, bearings, drives, belts, isolation bases and isolators. Allow isolators to free float when performing fan balance. Balance at design RPM's as scheduled on drawings. For fan sections controlled by variable frequency drives, balance at all speeds between 25% and 100% of design RPM.

## 2.5 MOTORS AND DRIVES

A. Factory install all motors on slide base to permit adjustment of belt tension.

B. Fan Motors shall be heavy duty, high-efficiency, open drip-proof, with electrical characteristics and capacities as scheduled on the plans. All motors shall conform to specifications in Section 15170 - Motors and Drives.

C. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch sheaves for motors 15 hp (11.2 kW) and under selected so required RPM is obtained with sheaves set at mid-position, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor. Provide adjustable sheaves for all motors, including those to be controlled by a VFD. For motors 10 HP or above, provide dual V-belt drives.

D. Variable Frequency Drive: Provide and install variable torque variable frequency drives (VFD) to regulate speed of supply and exhaust air fans, as scheduled on the drawings. VFD's shall conform to all requirements of Section 15170 - Motors and Drives.

## 2.6 COILS

A. Install coils such that headers and return bends are enclosed by unit casings.

B. Construct coils of plate fins on seamless tubes. Fins shall have collars drawn, belled and firmly bonded to tubes by means of mechanical expansion of tubes. Do not use soldering or tinning in bonding process.

C. Construct coil casings of minimum 16 gauge galvanized steel with formed end supports and top and bottom channels

D. Hot Water Heating and Runaround Coils

1. Clearly label supply and return headers on outside of units 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. Construct headers of round copper pipe or cast iron.

4. Construct tubes of 1/2 inch O.D. copper and construct fins of aluminum.

5. Fin spacing shall be no more than 12 fins per inch (144 fins per foot).

6. Provide factory installed freezestat, neatly laced across the discharge face of the hot water coil during AHU assembly. Freezestat shall be 2 pole, manual reset, twenty foot gas filled type capillary responsive to the coolest section of its length.

E. Refrigerant Cooling Coils

1. Clearly label suction and liquid connections on outside of units.

2. Proof test coils to 450 psig air under water leak test coils to 300 psig air pressure under water. Dry inside of coils after testing and seal all connections.

3. Construct suction headers of copper tubing. Suction connections shall penetrate unit casings to allow for sweat connections to refrigerant lines.

4. Coils shall have equalizing type vertical distributors sized in conjunction with capacities of coils.

5. Fin spacing shall be no more than 12 fins per inch (144 fins per foot).

6. Where two circuit coils are scheduled, the coils shall be horizontally split, and mounted at the lowest part of the air handler cross section.

F. Chilled Water Cooling Coils

1. Clearly label supply and return headers on outside of units 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. Construct headers of round copper pipe or cast iron.

4. Construct tubes of 1/2 inch O.D. copper and construct fins of aluminum.

5. Fin spacing shall be no more than 12 fins per inch (144 fins per foot).

2.7 MIXING BOXES

A. Provide mixing boxes with double wall casings to protect against intake of water with outdoor air. Mixing boxes shall be equipped with ultra low leakage, steel, airfoil type dampers with vinyl or neoprene edge seals, Ruskin CD60 or approved equal. Provide adjustable linkage to modulate outdoor air dampers inversely to return air dampers.

2.8 FACE AND BYPASS DAMPERS

A. Face and bypass dampers shall be equipped with an adjustable linkage to modulate face dampers inversely to bypass dampers.

2.9 FILTERS

A. Provide factory fabricated filter sections of the same construction and finish as unit casings. Filter sections shall have filter guides and full height, double wall, hinged, removable access doors as specified above for filter removal and inspection. Filter sections shall flanged or be integrated into other unit components. Provide spring type filter block-offs as required to prevent air bypass around filters and ensure snug filter fit. Filters shall be removable from access side of filter sections.

B. Provide 2 inch thick pleated prefilter sections with maximum face velocity of 500 feet per minute. Prefilters shall be disposable, pleated-media, 30% efficiency rating and 90% arrestance in accordance with ASHRAE 52.1-92. Filters shall be equal to Farr 30/30 with integral frames made of rigid, high wet strength beverage board, and have a media area of at least 4.6 square feet per square foot of face area with 15 pleats per linear foot. Media shall be supported by welded wire grid on the downstream side with minimum 96% free area.

C. Provide high efficiency filter sections with maximum face velocity of 500 feet per minute with throw-away 12" deep pleated cartridge filters and

disposable panel pre-filters. High efficiency filters shall be 85% dust spot efficient and UL class 1 or class 2 equal to Farr Rigi-Flo series. Filter media shall have at least 14 square feet of surface area per square foot of face area.

D. Provide Filter Switch, with adjustable pressure differential between 0.5 - 1.5 in WG., piped internally to both sides of filter assembly, to provide alarm contact for the automatic temperature control system.

E. Provide one spare set of prefilters and high efficiency filters for each unit.

F. Acceptable Manufacturers

1. Farr

2. American Air Filter (AAF)

3. Airguard

4. Purolator

G. Filter face areas shall be adequate to provide a maximum face velocity of 350 FPM for prefilters, 500 FPM for final filters at design conditions, or not less than the minimum area scheduled on the drawings.

2.10 DISCHARGE PLENUMS

A. Provide factory fabricated supply air discharge plenum for each unit as scheduled and detailed on the drawings. Discharge plenums shall have perforated steel inner liner backed by high density fiberglass insulation as used in the rest of the unit. Plenum unit shall be suitable for field cutting of plenum and installation of ductwork

2.11 SOUND RATINGS

A. Unit discharge, inlet, and radiated sound levels shall be tested to AMCA 300 and bear AMCA Certified Sound Rating Seal.

B. Discharge sound ratings shall not exceed the following in any octave band.

TABLE 1 – MAXIMUM SOUND RATINGS

| HZ | 63 | 125 | 250 | 500 | 1000 | 2000 | 4000 | 8000 |
|---|---|---|---|---|---|---|---|---|
| DB DISCHARGE | 94 | 90 | 85 | 81 | 80 | 78 | 78 | 74 |

2.12 UNIT CONFIGURATIONS

A. AHU-1A & AHU-1B shall have the following sections, starting at the inlet to the unit: Filter/mixing section with TRAQ airflow measuring dampers on back outdoor air inlet, return air damper on top inlet and access doors; Medium blank section; Plenum fan section with access doors; Medium blank section; Small coil section with vertically and horizontally split precooling coils (4 coil sections total); Cartridge filter section with access doors; Medium coil section with drain pan and vertically and horizontally split chilled water cooling coils (4 coil sections total); Medium large access section with drain pan and access doors; Small coil section with vertically and horizontally split reheat coils (4 coil sections total); Discharge plenum section with perforated liner, openings sized and located as shown on Drawings and with access doors. AHU-1A & AHU-1B shall have access doors on both sides of units.

B. AHU-2 shall have the following sections starting at the inlet to the unit: Angle filter section with access door; Cartridge filter section with access door; Medium large coil section with hot water heating coil and access door; Vertical coil section with chilled water cooling coil and access door; Fan section with bottom inlet and top discharge; Discharge plenum section with perforated liner, access door and openings sized and located as shown on Drawings. Access doors shall be on the right hand side of the unit, when facing into the discharge of the unit.

C. AHU-3 shall have the following sections starting at the inlet to the unit: Filter/mixing section with access door; Cartridge filter section with access door; Medium large coil section with hot water heating coil and access door; Vertical coil section with chilled water cooling coil and access door; Supply fan section with bottom inlet and top discharge; Discharge plenum section with perforated liner, access door and openings sized and located as shown on Drawings. Access doors shall be on the right hand side of the unit, when facing into the discharge of the unit. The return fan is located on top of AHU-3 and shall have the following sections starting at the inlet to the unit: Return fan section with back inlet and front discharge; Mixing section with bottom return air opening and top exhaust air damper and access door. Access doors shall be on the left hand side of the unit when facing into the discharge of the unit.

D. AHU-4 has the same configuration as AHU-3 except the access doors on AHU-4 shall be on the left hand side and the access doors on the return fan sections shall be on the right hand side.

E. AHU-5 shall have the following sections starting at the inlet to the unit: Filter/mixing section with access door; Cartridge filter section with access door; Medium large coil section with hot water heating coil and access door; Vertical coil section with chilled water cooling coil and access door; Supply fan section with bottom inlet and top discharge; Discharge plenum section with perforated liner, access door and openings sized and located as shown on Drawings. Access doors shall be on the left hand side of the unit, when facing into the discharge of the unit.

F. AHU-6 shall have the following sections starting at the inlet to the unit: Angle filter section with access door; Internal face and bypass damper section; Small coil section with hot water heating coil and access door; Medium access section with access door; Vertical coil section with DX refrigerant cooling coil and access door; Supply fan section with bottom inlet and top discharge. Access doors shall be on the right hand side of the unit, when facing into the discharge of the unit.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in conformance with ARI 435.

END OF SECTION

SECTION 15781 ADDED PER ADDENDUM 2 1/29/02 AT

SECTION 15781

PACKAGED ROOF TOP AC UNIT

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Packaged Roof Top AC Unit.

B. Unit Controls.

C. Mounting Frame and Base

D. Maintenance Service.

1.2 RELATED SECTIONS

A. Section 15170 - Motors, Drives, and Accessories

B. Section 15890 - Ductwork and Ductwork Accessories

C. Section 15900 - Automatic Temperature Controls

D. Division 16 - Electrical

1.3 REFERENCES

A. NFPA 90A Installation of Air Conditioning and Ventilation Systems.

B. ARI 210 Unitary Air Conditioning Equipment

C. ARI 240 Air Source Unitary Heat Pump Equipment

D. ARI 270 Sound Rating Of Outdoor Unitary Equipment

1.4 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 01300.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data under provisions of Section 01340.

1.6 WARRANTY

A. Provide manufacturer's extended 5 year warranty on refrigeration compressors.

1.7 MAINTENANCE SERVICE

A. Furnish complete service and maintenance for a period of one year from date of acceptance by owner.

1.8 EXTRA MATERIALS

A. Provide two spare sets of filters. Store filters on site and obtain written receipt from owner.

B. Provide one complete change of refrigerant for each unit. Store refrigerant on site and obtain written receipt from owner.

1.9 START UP SERVICE

A. Provide start up and check out services by a qualified service organization approved by the unit manufacturer.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. TRANE

B. CARRIER

C. YORK

D. McQUAY

E. or Approved Equal

2.2 MANUFACTURED UNITS

A. Furnish and install a UL Listed packaged outdoor roof top air conditioning unit, with electric heating elements and electric refrigeration fully charged with refrigerant, and compressor and shipped in one piece, suitable for mounting on field fabricated supports.

B. Unit shall consist of cabinet and frame, supply fan, air filters, refrigerant coil, compressor, condenser coil, condenser fans, electric heating coil, economizer package and complete factory wired control system. Unit shall be factory tested piped and wired with a single point power connection. All specified components shall be factory installed. Cooling performance shall be rated in accordance with ARI 360.

2.3 FABRICATION

A. Steel base and frame shall be heavy gauge galvanized steel with hinged quick release access panels to provide access to control panels, filters,

all fans, cooling coil, and compressors. All access panels shall be gasketed.

B. Cabinet shall have indoor air sections completely insulated with minimum 1" thick heavy density rigid fiberglass insulation. Electrical wiring diagrams shall be attached to control panels access doors. Unit shall have name plate securely attached to front of control panel.

C. Compressor Section of unit shall have direct drive reciprocating or scroll compressors. Compressor motor shall not exceed 3600 RPM. Compressors shall have vibration isolation mountings, integral suction accumulation, centrifugal oil pump, oil filter screen and magnetic disks, oil level sight glass, oil charging valves, crankcase heater, double mesh suction inlet screen, suction and discharge service valves, gauge ports, flexible connections on suction and discharge, and filter dryers. Compressor motors shall be thermally protected.

D. Condensing Section shall have multi-row type condenser coils fabricated with seamless copper tubing, mechanically bonded to aluminum fins. Factory test coil to 450 psig air pressure and vacuum dehydrate. Condensing fans shall be direct driven, propeller type fans with vertical discharge. Motors shall permanently lubricated ball bearing type with thermal overload protection and weather tight slinger over bearings.

E. Cooling coil shall be fabricated from seamless copper tubing, mechanically bonded to aluminum fins. Provide insulated, drainable drip pan under coil section. Drip pan shall have threaded connection for drain trap and shall be pitched to drain. Factory leak test coils to 300 psig.

F. Supply Fan Section shall house a centrifugal forward curved blade fan. Fans shall be statically and dynamically balanced. Fan RPM shall be below fan critical speed. Fan motor, bearings and drives shall be provided in accordance with Section 15170. Fan and motor shall be vibration isolated with double deflection rubber in shear or spring type vibration isolators. Provide extended grease fittings for all bearings. Fan discharge shall be isolated from duct connection with flexible duct between the fan scroll and the unit casing.

G. Filter Section shall have filter holders for 2 inch thick pleated type 30% efficient (by ASHRAE 52-76) filters. Provide complete set with spares as specified above.

H. Outdoor Air and Return Air Section shall form a plenum. The outdoor air damper shall be arranged to admit a fixed quantity of outdoor air as scheduled on the drawings and shall close tightly whenever unit is shut down. Dampers shall be low leakage type conforming to AMCA standards not to exceed 6 cfm/sq.ft. at 4" WG pressure differential. Damper operators shall produce twice the required thrust to overcome damper friction, and provide the required close of rating to achieve damper leakage ratings. Operators shall have spring return features to close outdoor air damper and open return air damper.

I. Electric Heat Section shall be factory wired and tested, shall be UL listed and shall meet all requirements of the NEC. Heaters shall be provided with all required fusing, contactors, high limits and controls.

J. Electrical wiring of all components shall be completed and tested at the factory. Wiring shall comply with the National Electric Code and applicable U.L. Standards. Components shall include fused 120 volt and 24 volt control circuit transformers, return air smoke detectors, non fused disconnect, single point connection for power source, and terminal strip connection for external controls.

K. Refrigerant Controls shall include a liquid line solenoid valve, oil pressure switch, refrigerant high pressure and low pressure switches, compressor control switch with pumpdown control. Each compressor shall have an anti-short-cycle timer. Provide air flow proving switch to prevent compressor starting when supply fan is not moving air. Provide compete factory controls with safety interlocks to operate compressor capacity control. Compressors shall be started and stopped from external controls.

L. Unit controls shall be factory wired and require only the field connection of a space sensor. Control package shall provide control of refrigeration system, economizer package and electric coil. Space sensor shall be programmable type with night setback and seven day programming with override capability.

M. Utility requirements and unit capacity shall be in accordance with ARI as scheduled.

PART 3 EXECUTION

3.1 INSTALLATION

A. Verify proper electrical supply is available.

B. Install in accordance with manufacturer's written instructions.

C. If drain pan is not pitched, install unit at a slight tilt so that drain pan is pitched to drain at ¼ inch per foot.

END OF SECTION

SECTION 15880

AIR ENERGY RECOVERY UNITS

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Air to Air Enthalpy Recovery Exchanger Units

1.2 RELATED SECTIONS

A. Section 15010 - General Requirements

B. Section 15855 - Air Handling Units

C. Section 15890 - Ductwork and Accessories

D. Section 15900 - Automatic Temperature Controls

E. Section 15990 - Testing, Adjusting, and Balancing

1.3 SUBMITTALS

A. Submit shop drawings in accordance with Section 15010.

B. Product Data:

1. Provide literature which indicates dimensions, weights, capacities, ratings, fan performance, gages and finishes of materials, and electrical characteristics and connection requirements.

2. Filters: Provide data on filter media, filter performance data, filter assembly, filter area, and filter frames.

3. Electrical: Submit electrical requirements for power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring and no wiring required.

4. Energy Recovery: Energy Recovery Core Materials and Construction and defrost strategy and equipment. Provide data on temperature recovery and moisture recovery, pressure loss for both exhaust and supply air streams under operating conditions scheduled on the drawings for both summer and winter.

5. Sound: Provide information on sound attenuation characteristics of energy recovery core, based on fan noise indicated on fan schedule.

6. Submit operation and maintenance manuals and data in accordance with Section 15010.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Renewaire

B. Des Champs Laboratories (DLI)

2.2 PACKAGED AIR TO AIR HEAT EXCHANGER

A. General

1. The unit shall be constructed so that at no time will the exhaust air and supply air be mixed.

2. The heat exchanger shall be self-contained and operate passively: i.e. with no moving parts. Enthalpy wheels are not acceptable.

3. The heat exchanger shall provide sound isolation between the fan and the supply and return terminals in the served spaces.

4. The units shall be designed to automatically prevent the buildup of frost in all weather below freezing, with no loss in heat exchanger capacity.

B. Casing

1. Unit casing shall be constructed of minimum 20 gage galvanized steel or zinc coated steel. All seams to be welded or gasketed and bolted.

2. Provide hinged access doors with Camlock type latch for service, inspection, and cleaning of all internal parts and air pathways. Access doors shall be operable without tools.

3. Insulate cold portions of casing with 1" thick rigid high density board insulation with FSK facing or approved elastomeric duct liner such as Armaflex SA.Heat Exchanger

4. Plate type heat exchanger shall be constructed of material suitable for transferring both heat and moisture (enthalpy exchange), Renewaire elements, or approved equal by one of the listed manufacturers.

5. Heat exchanger shall be sized to transfer heat and moisture with pressure loss not to exceed pressure drops scheduled on the drawings.

6. The enthalpy exchanger shall transfer sufficient moisture to prevent condensate or frost formation under the operating conditions scheduled.

C. Filters

1. Energy Exchange elements shall be protected by filters on the return air faces of the heat exchanger. The outside air faces shall be protected by filters inside the associated air handling unit.

2. The ERU cabinets shall be provided with heavy gauge steel or aluminum filter tracks which hold filters tightly in place, prevent bypass or air around filters, and allow easy installation and removal of filters without bending the filter frames.

3. Filters shall be sized for a maximum face velocity of 300 fpm for a maximum pressure loss of 0.15 inches through clean filters.

4. Filters shall be disposable, pleated media, 30% "Dust Spot" efficiency when tested in accordance with ASHRAE Standard 52-92. Filters shall be 2" thick by 20 x 20 or other standard size. Filter frames shall be die cut of heavy weight beverage board. Filters shall contain a minimum filter media area of 4.6 square feet per square foot of filter face area (15 pleats per foot). Filters shall be Farr 30/30 or equal by American Air Filter, Purolator, or Airguard. Provide one complete extra set of filters for each unit.

## PART 3 EXECUTION

### 3.1 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions. Provide clearance to fully open access doors on service side of casing for easy access and removal of filters and of internal parts.

B. Heat recovery units shall be set on and bolted down to wood sleepers, metal channel, or manufacturer's base rails, or as indicated on the plans.

C. Provide plenums as required to connect exhaust and supply air sections together and connect to air handling units. Seal all plenums with silicone duct caulk for a leak free connection.

END OF SECTION

SECTION 15890

DUCTWORK, FANS, AND ACCESSORIES

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Ductwork

B. Dampers

C. Flexible Duct and Connectors

D. Boiler Stack

E. Bird screens

F. Diffusers, Registers, and Grilles

G. Duct liner

H. Fans

I. Filter Holders and Filters

1.2 RELATED WORK

A. SECTION 15170 - Motors, Drives, and Accessories

B. Section 15260 - Pipe, Ductwork, & Equipment Insulation.

C. Section 15855 - Air Handling Units

D. Section 15900 - Automatic Temperature Controls.

E. Section 15990 - Testing, Adjusting and Balancing.

1.3 SUBMITTALS

A. Submit shop drawings and manufacturers' data in accordance with section 15010.

B. Shop Drawings

1. Submit duct construction standards including all gauges, reinforcing and spacing. Do not submit SMACNA Manual alone. Note or highlight standards to be used.

2. Galvanized steel, stainless steel, and aluminum sheets.

3. Where manufactured ductwork is used, provide ductwork configuration and sizes of components to be used. Include connection fittings and sealing systems used.

4. Duct sealing materials and standards.

5. Flexible ducts and connectors.

6. Dampers.

7. Access doors.

8. Louvers.

9. Bird screens.

10. Duct liner.

11. Diffusers, Registers and Grills

    a. Submit a schedule of all inlets and outlets indicating tag number, location, model number, manufacturer, dimensional information, sound pressure level rating, nominal rated volumetric flow rate (CFM), neck or face velocity at specified CFM, pressure drop at specified CFM, throw and drop for outlets, range for diffusers, and maximum and minimum CFM modulation.

12. Duct Silencers

    a. Submit a schedule of all silencers, with dimensions, pressure loss, and acoustic performance of each scheduled unit at the scheduled airflow rates and sizes.

13. Fans

    a. Submit shop drawings with dimensional data on fans & curbs.

    b. Submit fan curve with operating point plotted on curves. Include brake horsepower requirements and sound data.

14. Filter Holders and Filters

    a. Submit shop drawings with dimensional data for each filter holder shown or scheduled on the drawings.

    b. Submit filter media data, filter construction methods, area of media surface, and pressure losses.

15. Roof Hoods and Louvers

a. Submit a schedule of all roof hoods and louvers, with dimensions, pressure loss at scheduled air flows, effective free area, and rain penetration data.

1.4 QUALITY ASSURANCE

A. Conform to AMCA Bulletins regarding construction and testing. Fans shall bear AMCA certified rating seal.

*B.* SMACNA Duct Construction Manuals: The SMACNA recommendations shall be considered as mandatory requirements. Substitute the word "shall" for the word "should" in these manuals. No negative pressure construction for 4 inch, 6 inch or 10 inch water gauge is provided herein.

C. Submit manufacturer's printed installation instructions.

1.5 JOB CONDITIONS

A. Do not operate fans for any purpose until ductwork is clean, filters are in place, bearings have been lubricated, and fan has been run under observation.

PART 2 PRODUCTS

2.1 BASIC MATERIALS (FOR METAL DUCT)

A. Galvanized Steel Sheets: ASTM A527, coating designation G90 or G60.

B. Galvanized Steel Hot Dipped After Fabrication ASTM A123.

C. Exposed ducts to be field painted

1. Ductwork shall be fabricated of galvannealed steel sheets with A60 coating, heat treated after coating.

2. Alternatively, G60 galvanized steel sheets may be bonderized, with a thin phosphate coating which readily accepts paint.

D. Aluminum Alloy Sheets: Mil. Spec. MIL-A-52174.

E. Stainless Steel Ducts: ASTM A167, Type 304.

2.2 PRESSURE CLASSIFICATION

A. Ratings as indicated on the drawings.

B. If no ratings are indicated, ductwork shall be rated for the external static pressure of the system plus twenty-five percent.

C. If 4 dampers (of any type) or less can isolate a duct system, that portion of the system shall be rated for the shut-off pressure of the system fan(s).

2.3 DUCT LEAKAGE

A. Acceptable Manufacturers and Materials for Duct Sealing

1. Latex flexible paint-on sealant.

a. Ductmate Proseal (water based).

b. United McGill United Duct Sealant (water based).

c. Carlisle Iron Grip (water based).

2. Silicone caulking.

a. 3M Duct Caulk.

b. Dow Corning Silicone Duct Caulk

c. GE Silicone Duct Caulk.

3. Hardcast tape.

4. Ductmate with gaskets.

B. All ductwork shall be sealed as outlined in the HVAC Duct Construction Standards Metal and Flexible by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (hereinafter referred to as SMACNA HVACDCS). All ductwork shall be sealed to a minimum of Class C as outlined in the manual.

C. All seams, transverse, as well as duct penetrations in all duct systems shall be sealed with flexible duct sealant or caulk (up to 1/4" gap) or "Hardcast" tape with mastic.

D. All duct systems shall be sealed as required to limit duct air leakage to no more than 5 percent of the total system capacity. Test each system as outlined in Part 3 of this section.

2.4 GENERAL DUCT CONSTRUCTION

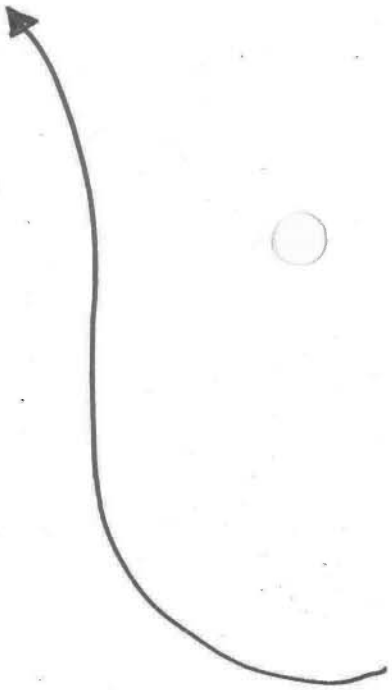
A. Construct HVAC ducts of galvanized steel. Construct dishwasher exhaust and other moisture laden exhausts of aluminum or stainless steel, or as noted on the drawings.

B. Construction: Duct construction, metal gauges and hangers and support reinforcements shall conform with the SMACNA HVACDCS. Ducts shall not pulsate or vibrate when in operation.

**Add** Paragraph 2.4.H.

A. Plenums at louvers and at inlet and discharge of fans and AHUs shall be constructed of minimum 18 gauge galvanized steel. Where double wall construction is indicated, exterior solid panel shall be min. 18 gauge and interior perforated panel shall be min. 22 gauge. Plenum shall be constructed with reinforcing, hangers, supports, etc. to conform to SMACNA HVAC duct construction standards. Double wall plenums shall have 1 inch space between panels filled with fiberglass insulation, 2.0 lb/cf density and UL listed as a duct liner material.

ADDENDUM 2 1/29/02 AT



C. Joints: Construct joints to meet the requirements of the leakage test specified herein. Duct components shall fit so that joints are not mismatched. Do not use duct sealant and tape to compensate for mismatched connections. Longitudinal locks or seams known as "Button Punch Snap Lock" are not acceptable

D. Reinforcement: Bracing angles or flat bars shall be used as stiffeners on all ducts over 18" wide. Uninsulated ducts over 18" wide mat be siphoned by cross breaking. Uninsulated exposed duct shall have either cross breaking or flat bar reinforcement and flush seams in lieu of bracing angles and projecting seams.

E. Fittings: Square elbows, round elbows, fittings, branch takeoffs, transitions, splitters, duct volume dampers, fire dampers, flexible connections and access doors shall conform with the SMACNA HVACDOS Section 2.

1. Rectangular branches shall be 45 degree takeoffs. Conical, or bellmouth takeoffs shall be used for round branches. Each branch line shall have a volume damper installed.

2. Rectangular Elbows or Curved Elbows: shall have a centerline radius not less than 1-1/2 times the width of ducts. All rectangular elbows shall have single thickness turning vanes with trailing edges.

3. Round Elbows: Provide 45 degree and 90 degree elbows of 2 piece die stamped construction for ducts 8 inches or less in diameter. For ducts over 8 inches in diameter, provide 5 mitered piece for 90 degree and 3 mitered piece for 45 degree.

F. Round and Oval Ducts: SMACNA HVACDCS, Section 3, provide spiral type duct for all round duct.

G. Rectangular Ducts: Make joints between sections of duct and between ducts and fittings with either gasketed flanged connection, welded flange joints or other joints recommended in SMACNA HVACDCS, Section 1, and reinforce at the joints and between the joints as recommended.

ADD PARAGRAPHS

2.5 FLEXIBLE DUCTS

A. FLEX DUCT

1. UL 181, Class I, UL listed, SMACNA HVACDCS and additional requirements herein specified. Use to connect between rigid ducts and outlets or terminals. There shall be no erosion, delimitation, loose fibers or odors from the ducts into the air stream. At 250°F, minimum rating pressures shall be 2 inches water positive and 1-1/2 inches negative up to 2500 CFM flexible ducts. Flexible ducts shall be maximum 5 feet in length. Minimum bend radius shall be twice the duct diameter.

2. Materials: Interlocking spiral or helical corrugated type constructed of corrosion resistant steel, with chloroprene or chlorosulphonated polyethylene impregnated, minimum 30 ounces per square yard fabric.

3. Insulation and Vapor Barrier: ASTM C553, minimum one inch nominal thickness and one pound per cubic foot density. The insulation shall be sheathed with a vapor barrier having a maximum water vapor permeance of 0.02 perm per ASTM E96, Procedure C. Coat ends of insulation with cement to prevent erosion and delamination.

4. Joints: Make airtight slip joints, seal with pressure sensitive vapor seal adhesive tape or duct sealer, and secure with sheet metal screws. To prevent insulation compression, place 2 inch wide by one inch thick closed cell foam plastic spacers over the joints under vapor barriers. To provide a vapor tight joint, use a corrosion resistant steel or plastic clamp over such spacers.

B. FLEXIBLE CONNECTIONS

1. Flexible connections (typically between fans or rotating equipment and ductwork) shall be neoprene coated glass fabric with sewed seams minimum 8" wide. Provide sheetmetal edges for connection to ducts.

C. ACOUSTIC FLEX DUCT

1. Acoustic flex duct or flexible sound attenuators shall be comprised of an inner perforated core of triple lock flexible aluminum air duct, enclosed in ½ lb. density 1½" thick fiberglass blanket covered with an unperforated triple lock flexible aluminum duct, "Buck Duct" aluminum flexible silencer, or approved equal.

2. Acoustic flex duct shall include factory installed aluminum end caps sealing the insulation between the inner core and outer cover, to minimize air leakage.

2.6 SOUND ATTENUATORS

A. ACCEPTABLE MANUFACTURERS

1. Industrial Acoustics Company (IAC)

2. United McGill

3. Semco

4. Anemostat

5. Landab Spiro

B. DUCT SILENCERS

1. Provide rectangular or tubular silencers of types and sizes as indicated and scheduled on the drawings.

2. Outer casing shall be factory fabricated of 22 gauge or thicker galvanized steel sheets designed in accordance with SMACNA duct construction standards or ASHRAE design guide for high pressure ductwork.

3. Inner casing shall be factory fabricated of at least 26 gauge perforated galvanized steel.

4. Filler (sound absorptive) material, where needed, shall be inorganic mineral or glass fiber of density adequate to obtain specified acoustic performance. Filler shall be compressed at least 5% into casing to eliminate any voids. Filler shall be vermin and moisture proof. Flame spread and Smoke Developed ratings of filler material shall not exceed 20, when tested in accordance with ASTM E84, NFPA 255, or U.L. No. 723. Filler shall be completely enclosed and supported by casing such that it is protected by perforated and/or solid sheetmetal on all sides.

5. Acoustic performance shall be rated in accordance with ASTM specification E477. Acoustic ratings shall include Dynamic Insertion Loss (DIL) and Self Noise (SN) Power Levels for both forward and reverse flow vs. noise with at least 2000 fpm entering air velocity. Submit acoustic performance ratings in accordance with 15010.

6. Static pressure loss due to silencers shall not exceed scheduled values. Submit pressure loss ratings for each scheduled silencer.

2.7 MANUFACTURED DUCTWORK

A. ACCEPTABLE MANUFACTURERS

1. United McGill

2. Semco

3. Landab Spiro

B. Provide factory fabricated spiral round or oval ductwork as indicated on the drawings. At the contractors option, factory fabricated ductwork may be used in lieu of field or shop fabricated ductwork.

C. Factory fabricated ductwork shall be made of G60 or G90 galvanized steel sheets. Where ductwork will be exposed and painted in the field, ductwork shall be fabricated from galvannealed steel or manufacturer's

recommended finish to accept paint. Spiral ductwork shall have a spiral lock seam which also increases duct rigidity.

D. All ductwork shall be the product of one duct manufacturer. All manufactured ducts shall be connected using the manufacturer's standard and custom fittings, and shall be supported in accordance with the manufacturer's directions and standards.

E. Provide ductwork manufacturer's recommended sealing systems. Double EPDM rubber gasket with wiper type edges equal to Spirosafe are acceptable as well as conventional sealing systems.

2.8 GRILLES, REGISTERS AND DIFFUSERS

A. ACCEPTABLE MANUFACTURERS

1. Anemostat
2. Halton
3. Price
4. Krueger
5. Titus

B. APPLICATION

1. Diffusers, registers, and grills shall be rated in accordance with ADC Standards.
2. Provide supply outlets with sponge rubber seal around edge.
3. Provide baffles to direct air away from walls, columns or other obstructions within radius of diffuser operation.
4. Frames shall be flush type plaster frame for diffusers located in plaster or gypsum wallboard (hard) surfaces. Generally, lay-in type frames shall be provided for lay-in type suspended ceilings, as scheduled on the drawings.
5. Provide grilles, registers and diffusers in accordance with the schedules on the plans and equal to the model specified.

C. RECTANGULAR/SQUARE DIRECTIONAL SUPPLY DIFFUSERS

1. Rectangular or square neck, directional pattern, louvered face type diffuser to discharge air in pattern indicated and scheduled on the plans.

2. Diffusers shall have lay-in type frame for suspended grid ceilings and 1¼ inch wide frame for hard ceilings.

3. Fabricate of aluminum with white baked enamel or lacquer finish.

4. Provide throw reducing vanes if required to meet short throw requirements scheduled.

5. Provide plenum connector for each diffuser as detailed on the drawings.

6. Equal to Anemostat "XDF" or "XDP".

D. DOUBLE DEFLECTION SUPPLY DIFFUSER

1. Diffusers shall have aluminum blades, 0.170 tapering to 0.025 inch thickness, arranged to discharge air in a [22°][45°] spread pattern (adjustable) as indicated on the drawings.

2. Blades shall be adjustable in both horizontal and vertical planes and shall be mounted in synthetic bearings pressed into the diffuser frame.

3. Frame shall be 1¼ inch wide of 0.055 inch thickness aluminum, with countersunk screw holes for direct duct mounting.

4. Provide aluminum mill finish.

5. Equal to Anemostat X2VO.

E. BAR GRILLS

1. Provide extruded aluminum removable core bar grills of width, bar spacing, bar deflection angle, and with frames as scheduled on the drawings, with the performance, throws, noise levels, and distribution as scheduled on the drawings. Lengths shall be as scheduled or indicated on the plans.

2. Provide reinforcing bars for floor mounted applications.

3. Provide anodized or baked enamel finish as scheduled on the drawings. Provide alignment bars and false sections as required for a neat, continuous installation as indicated on the plans.

4. Anemostat "AL or TAL Airline" Series, or approved equal.

F. LINEAR SLOT DIFFUSERS

1. Provide length, number of slots, slot widths, and frames as scheduled on the drawings, to provide the performance, throws, noise levels, and distribution as scheduled on the drawings.

2. Fabricate adjustable slot diffusers of aluminum extrusions, designed to fitted to a steel slot diffuser plenum.

3. Provide slot diffuser plenum for each slot diffuser, sized to fit the diffuser snugly. Diffuser plenums shall have round neck, of sufficient length for secure attachment of round flex duct. Diffuser plenums shall be painted flat black inside, and have externally applied one inch thick insulation.

4. Provide inlet volume damper where scheduled. Do not use adjustment vanes as dampers.

5. Equal to Anemostat Model "SLAD".

G. PLENUM SLOT DIFFUSERS

1. Provide length, number of slots, and slot widths as scheduled on the drawings, to provide the performance, throws, noise levels, and distribution as scheduled on the drawings.

2. Fabricate adjustable slot diffusers with integral plenum of minimum 24 gauge galvannealed steel, suitable for use in lay-in type suspended ceilings. Diffuser plenums shall have round neck, of sufficient length for secure attachment of round flex duct. Diffuser plenums shall be painted flat black inside, and have externally applied 1/2 inch thick insulation. Diffuser face shall be painted white to match the ceiling.

3. Provide inlet volume damper where scheduled. Provide T-bar mounting clips and side T-bars as required for a secure and neat installation.

4. Equal to Anemostat Model "SCD".

H. GRID CORE RETURN, EXHAUST AND TRANSFER GRILLES

1. Fabricate fixed "eggcrate" grills of aluminum extrusions with 1/2 inch x 1/2 inch x 1/2 inch cells.

2. Provide 1.5 inch margin frame with countersunk screw holes for hard ceilings, or lay-in frame for suspended grid ceilings.

3. Fabricate of aluminum.

4. Equal to Anemostat "GC5".

I. LOUVERED RETURN, EXHAUST AND TRANSFER GRILLES

1. Fabricate fixed louvered grills of aluminum extrusions with 45° horizontal blades on ¾" centers.

2. Provide 1.5 inch margin frame with countersunk screw holes for hard ceilings or direct duct mounting, or lay-in frame for suspended grid ceilings.

3. Fabricate of aluminum.

4. Equal to Anemostat Model "X3HD", "XRC3HOD", or "AC3LD".

2.9 DUCT SLEEVES AND PREPARED OPENINGS

A. Duct Sleeves and Closure Collars: Fabricate from minimum 20 gauge galvanized steel. Where sleeves are installed in bearing walls, provide structural steel sleeves.

B. Prepared Openings: Provide one inch clearance between the duct and the sleeve.

2.10 DEFLECTORS

A. TURNING VANES

1. Factory fabricated and factory or field assembled units consisting of curved turning vanes for uniform air distribution and change of direction with minimum turbulence and pressure loss. Provide curved single vanes with trailing edges for mitered elbows.

B. TAKE OFFS

1. For round ducts taking off from rectangular ducts, where duct size permits, provide factory fabricated, galvanized sheet metal, bellmouth or mini bellmouth fittings.

2. For rectangular takeoffs or round takeoffs where space is tight, provide 45 degree tap type takeoffs.

2.11 ACCESS DOORS

A. ACCEPTABLE MANUFACTURERS

1. Ruskin

2. Buckley

3. Greenheck

4. Elmdor

5. Ductmate

B. Access doors shall be provided and installed in casings, plenum chambers and ducts where shown and wherever required for ready access for inspection and servicing of operating components, heating and cooling coils, motorized dampers, fire dampers, counterbalanced dampers, smoke dampers, volume dampers, automatic control components, etc. Reach-through type access doors, wherever possible, shall be 12 inches by 16 inches. Access doors shall be Ruskin model ADH24, or approved equal by approve listed manufacturer.

1. Door Construction: Access doors and door frames shall be constructed of minimum 24 USS gauge galvanized sheet metal. All access doors shall be double panel construction with 1 inch rigid fiberglass insulation between the metal panels and equipped with 2 Camloc winghead studs and receptacles.

2. Door Frames: All access doors shall be mounted on the door frame with minimum of two steel or aluminum butt hinges on maximum spacing of 24". Provide sponge rubber or EPDM gasket on door frame for a leak free seal when door is closed.

3. Insulated Duct or Casing: On insulated duct or apparatus casings, an extension collar made of the same material and thickness to which it is attached shall be tack welded to the door frame. Length of collar shall be determined by the thickness of insulation added to duct or apparatus casing.

2.12 DAMPERS

A. ACCEPTABLE MANUFACTURERS

1. Ruskin

2. Halton

3. Greenheck

4. Continental Fan

5. Tamco

6. American Warming and Ventilating

7. Buckley

8. Penn Ventilator

B. MANUAL BALANCING VOLUME DAMPERS

1. Volume Dampers for rectangular ducts greater than 10" in depth shall be of the multiple opposed blade type, Ruskin Model MD35 or approved equal. Multiple blades shall be 16 gauge steel and less than 12 inches wide, and shall be gang-operated. Axles shall be supported by synthetic sleeve bearings in damper frame. Axles shall be square or hexagonal positively locked onto damper blade. Damper axle end shall be positioned by a lever and quadrant with locking device. Shop fabricated dampers that do not meet these criteria will not be accepted.

2. Volume dampers for rectangular ducts 10" and smaller shall be of the single blade butterfly type, two (2) gauges heavier than the ductwork where installed, Ruskin Model MD25 or approved equal. Axles shall be supported by synthetic sleeve bearings in damper frame. Axles shall be square or hexagonal positively locked onto damper blade. Damper axle end shall be positioned by a lever and quadrant with locking device. All damper shafts shall be clearly marked to show blade orientation from outside the duct. Shop fabricated dampers that do not meet these criteria will not be accepted.

3. Volume dampers for round ducts 16" or smaller shall be of the butterfly or iris type, with frame and blade of 22 gauge galvanized steel or heavier.

   a. Butterfly dampers: Axles shall be positively locked or welded onto damper blade. Axles shall rotate on round plastic sleeve snapped into the ductwork. Damper axle end shall be positioned by a heavy gauge steel lever and quadrant with locking wing nut. All damper shafts shall be clearly marked to show blade orientation from outside the duct. Factory fabricated dampers shall be Ruskin Model MDRS25 or approved equal. Shop fabricated dampers that do not meet these criteria will not be accepted.

   b. Iris dampers: Halton Model PRA, Continental SPI or approved equal. Damper shall provide pressure taps for flow measurement and be labeled with pressure differential-flow curves. Damper shall be adjusted by a locking knob which actuates internal synthetic gear to position multiple overlapping metal blades hinged at the circumference of the frame. Provide where air flow measurement is required.

C. AUTOMATIC CONTROL DAMPERS

1. Automatic Control Dampers shall be as specified under "Automatic Temperature Controls". Dampers shall be installed by the sheet metal contractor under the control contractor's

supervision. Provide 12"x16" minimum (or as indicated) access door in duct at each control damper. Provide closure pieces and sealant as required to seal between damper frame and ductwork. [or Provide all automatic control dampers not specified to be integral with other equipment.]

2. Modulating Dampers shall be airfoil type, equal to Ruskin CD-60. Frames shall not be less than 16 gauge galvanized steel channel with corner reinforcements. Blades shall not be over 8 inches wide and shall be roll formed steel, extruded aluminum airfoil type, or extruded aluminum insulated type with vinyl or neoprene edge seals mechanically locked onto the edges of the blades. Bearings shall be oilite, ball-bearing, nylon, or lubricated stainless steel sleeves. Axles shall be minimum ½" diameter hexagonal or square positively locked onto the center of each damper blade. Side jamb seals shall be stainless steel of the tight-seal spring type. Control shaft shall be removable ½" diameter steel.

3. Two position dampers at outside air and exhaust louver plenums or rooftop fan or hood discharges shall be the same as modulating dampers, or at the contractor's option may use galvanized steel triple-V-groove type parallel blades with seals in lieu of airfoil blades. Dampers shall be equal to Ruskin CD-36. Frames shall not be less than 18 gauge galvanized steel channel with corner reinforcements. Blades shall not be over 8 inches wide and shall be 16 gauge galvanized steel with three longitudinal grooves for reinforcement. Blade edge seals shall be PVC coated polyester fabric or neoprene, suitable for -25°F to 180°F, mechanically locked onto the edges of the blades. Bearings shall be synthetic sleeve type. Axles shall be minimum ½" diameter hexagonal or square positively locked onto the center of each damper blade. Side jamb seals shall be flexible stainless steel tight-seal spring type. Control shaft shall be removable 1/2" diameter steel.

4. All proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel blade types.

5. Dampers shall be ultra-low leakage type, the blade edges shall be fitted with vinyl or neoprene edge seals mechanically locked onto the edges of the blades to limit damper leakage to 4 CFM per square foot at 1.0 inch WG. The temperature control manufacturer shall submit leakage data for all control dampers with the temperature control submittal.

D. FIRE & SMOKE DAMPERS

1. Fire Dampers shall be designed, constructed, located and installed in accordance with the standards of the National Board of Underwriters' Bulletin 90A and applicable to local codes and

ordinances. Dampers shall be provided where indicated on the drawings, and include the following:

a. Each fire damper shall be constructed with steel blades and collars, 212°F fusible link, chains and catches. Provide access doors in the ductwork at each damper to give access for resetting the fusible links.

b. Dampers shall be located within a sleeve or frame of the same gauge as the fire damper, secured by perimeter angles on both sides of the opening through wall or floor.

c. Dampers shall be factory fabricated with UL labels.

d. All fire dampers shall be installed with blades out of the airstream and shall be suitable for high velocity rectangular, round or flat oval ductwork as indicated.

e. Fire dampers shall be Ruskin Model IBD2, Style B, for square or rectangular ducts and IBD2, Style CR or CO, for round or oval, 1.5 hour rated fire damper, or approved equal. Dampers shall be gravity operated for vertical installation or spring assisted for horizontal installations as determined by space requirements.

2. Automatic Smoke Dampers: UL listed multiple blade type, with electric actuator supplied by smoke damper manufacturer as part of the assembly. Qualified under UL 555S with a leakage rating no higher than Class I (4 CFM/square foot at 1" WG) at an elevated temperature category of 250°F [350°F] or [550°F]for 30 minutes. Allow maximum pressure drops of 0.1 inch WG in damper open position with average duct velocities of 2500 fpm. Damper shall be Ruskin FSD60 or approved equal.

E. BACKDRAFT (BAROMETRIC) DAMPERS

1. Pressure Relief Dampers shall be Counter Balanced type, field adjustable from outside the duct or provide access door for adjustment. The adjustment shall be from 0.01 - 0.05 inches WG for full open. Relief damper shall consist of 0.09 inch thickness extruded aluminum channel frame with steel corner bracing. Blades shall be minimum 0.7 inch extruded aluminum with vinyl edge seals mechanically locked onto blade edge. Blades may be metal single or multi-leaf depending on space available. In the closed position, the leakage shall not exceed 15 CFM/square foot of damper area with 0.25" back pressure differential across the damper. Damper shall be Ruskin model CBD4, Penn Airstream, American Warming and Ventilating, or approved equal.

2. Noiseless flexible fabric dampers shall consist of extruded aluminum alloy frame with shutter dampers of neoprene coated

fiberglass material. Blade stops shall be 1/2" mesh vinyl coated galvanized screen. Unit shall be rated for maximum face velocity of 900 fpm at maximum differential pressure of 1" WG. Ruskin Model NMS2 or approved equal.

2.13 FOAM DUCT LINER

A. ACCEPTABLE MANUFACTURERS - DUCT LINER

1. Johns Manville Polycoustic.

2. Armstrong AP Armaflex SA

3. Imcoa

B. All insulation and materials shall be asbestos free and fiber free. No fibers shall be released from any duct lining material.

C. Insulation Sheets shall be flexible polyimide foam with acrylic coating or closed cell elastomeric foam approved for duct liner applications.

1. Duct liner shall have a flame spread rating of 25 or less and smoke developed rating of 50 or less when tested in accordance with ASTM E 84, latest revision. The product shall not melt or drip flaming particles, and the flame shall not be progressive. The product shall withstand temperatures of up to 250°F in accordance with ASTM C 411.

2. Duct liner material shall have a maximum thermal conductivity "K" value at 75°F, maximum 0.35 Btu-in/hr-sf °F at 75°F, when tested in accordance with ASTM C 177 or ASTM C 518, latest revisions.

3. Duct liner material shall have an acrylic polymer coating or be inherently moisture resistant. Absolute roughness of exposed surface shall not exceed 0.0013. Liner shall be resistant to erosion at air velocities up to 4,000 fpm. Lining shall not be less than 1 inch thick.

D. Sound Absorption: Duct liner shall provide, at a minimum, the following sound absorption coefficients, determined by Type "A" mounting in accordance with ASTM C423-90:

| Thickness | Frequency | | | | | | |
|---|---|---|---|---|---|---|---|
| Inch | 125 | 250 | 500 | 1000 | 2000 | 4000 | NRC |
| 1 | 0.18 | 0.29 | 0.52 | 0.93 | 0.86 | 0.85 | 0.65 |
| 1.5 | 0.16 | 0.48 | 0.90 | 0.98 | 0.79 | 0.86 | 0.80 |

E. Adhesives and Insulation Materials: Provide duct liner manufacturer's recommended adhesive or provide liner with self adhesive backing. Adhesives shall carry a composite fire and smoke hazard ratings maximum 25 or less for flame spread and 50 or less for smoke developed. Adhesives shall be water based with low odor generation and waterproof when set, equal to United McGill Uni-Tack.

2.14 FIBERGLASS DUCT LINER

A. ACCEPTABLE MANUFACTURERS – FIBERGLASS DUCT LINER

1. Owens Corning.
2. Manville.
3. Certainteed.
4. Knauf.

B. All insulation and materials shall be asbestos free. No fibers shall be released from any material with dimensions similar to asbestos fibers.

C. Acoustic Lining: Rigid fiberglass insulation, with matt faced finish on air stream side, approved for duct liner applications with "K" value at 75°F, maximum 0.24 Btu/in-sf °F/hr. Absolute roughness of exposed surface shall not exceed 0.0013, coated with an impervious coating to prevent fiber erosion at air velocities up to 4,000 fpm, 1.5 lbs/cf minimum density. Lining shall not be less than one inch thick. Increase duct sizes indicated to compensate for the thickness of lining.

D. Preformed Duct Liner: Preformed round duct liner designed for insertion in round ducts may be used in the sizes commercially available. Provide duct liner sections with slip lap joints not less than 2 inches wide. Make joints in accordance with the printed instructions of the manufacturer. Tubular sections of duct liner shall fit the metal duct snugly and without gaps between duct liner sections.

E. Adhesives and Insulation Materials: Composite fire and smoke hazard ratings maximum 25 for flame spread and 50 for smoke developed. Adhesives shall be water based with low odor generation and waterproof when set, equal to United McGill Uni-Tack.

2.15 CHIMNEYS & BOILER BREECHING

A. ACCEPTABLE MANUFACTURERS

1. Selkirk Metalbestos.
2. Ampco.

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3. Metal-Fab.

4. Van Packer.

B. GENERAL

1. Provide Factory fabricated metal chimney system of sizes and configurations as indicated on the drawings, for safe removal of combustion products in accordance with the appliance manufacturer's recommendations and instructions.

2. Factory Fabricated Chimney systems shall carry the manufacturer's 10 year warrantee. Field built chimney systems shall be warranted by the installer for 10 years against excessive corrosion, excessive leakage, bending, and structural failure.

3. Chimney installation shall be in accordance with NFPA 211 and all applicable codes and standards.

C. FACTORY FABRICATED CHIMNEYS - "B" Vent - negative draft type for gas fired appliances with flue gas temperatures of 400°F or less.

1. Chimney system for natural gas or propane fired boiler shall be type "B" as described in NFPA 54 and NFPA 211. Chimney systems shall be type "B" by one of the above listed manufacturers.

2. Chimney shall be double wall construction with:

   a. Outer jacket with a minimum thickness of 0.025 inch fabricated of aluminized coated steel. Sections exposed to weather (outside) shall be fabricated of type 430 or type 304 stainless steel.

   b. Inner Liner with a minimum thickness of 0.015 inch minimum thickness aluminized steel.

   c. The outer jacket and the inner liner shall be separated by at least 0.5 inch air space, except as required for construction of pipe.

3. The chimney installation shall be complete with all necessary fittings and accessories as recommended by the manufacturer, including:

   a. Open termination (chimney shall discharge straight up) and drain tee.

   b. Supports, guides, and plate support assembly, and all supports as required by chimney manufacturer to comply

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with UL listing. Support hardware exposed to the weather shall be made of stainless steel.

D. FACTORY FABRICATED CHIMNEYS - Negative or neutral draft type for #2 oil or gas fired appliances with flue gas temperatures of 1000°F or less.

1. Chimney system for gas fired boiler shall be tested and listed by Underwriters' Laboratories (UL Standard 103) for use as "Building Heating Appliance Chimney", as described in NFPA 211. Chimney systems shall be Metalbestos type DF or approved equal by above listed manufacturer.

2. Chimney shall be double wall construction with:

   a. Outer jacket with a minimum thickness of 0.025 inch fabricated of aluminized coated steel. Sections exposed to weather (outside) shall be fabricated of type 430 stainless steel.

   b. Inner Liner with a minimum thickness of 0.015 inch, fabricated of type 430 stainless steel.

   c. The outer jacket and the inner liner shall be separated by at least 0.5 inch air space, except as required for construction of pipe.

3. The chimney installation shall be complete with all necessary fittings and accessories as recommended by the manufacturer, including:

   a. Open termination (chimney shall discharge straight up) and drain tee.

   b. Supports, guides, and plate support assembly, and all supports as required by chimney manufacturer to comply with UL listing. Support hardware exposed to the weather shall be made of stainless steel.

   c. Assemble sections using stainless steel sheet metal screws.

E. FACTORY FABRICATED CHIMNEYS – positive pressure type

1. Chimney system for gas fired boiler shall be tested and listed by Underwriters' Laboratories (UL Standard 103) for use as "Building Heating Appliance Chimney", as described in NFPA 211. Chimney system shall be designed and approved for continuous venting of pressurized flue gases not exceeding 1,000°F. Chimney systems shall be Metalbestos type PS and/or IPS or approved equal.

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2. Chimney shall be double wall construction with:

   a. Outer jacket with a minimum thickness of 0.025 inch fabricated of type 304 stainless steel.

   b. Inner Liner with a minimum thickness of 0.015 inch, fabricated of type 304 stainless steel.

   c. The outer jacket and the inner liner shall be separated by at least 1.0 inch air space, except as required for construction of pipe.

3. All joints shall be sealed leak free with V-bands and high temperature sealant as recommended by the chimney manufacturer.

4. Provide mounting flange and gasket for leak tight connection to the boiler smoke hood. Weld or seal and clamp mounting flange to smoke hood. Provide companion flange in first breeching section.

5. Provide thimbles, insulated sections, etc. as required to maintain clearances to combustible building materials in accordance with the manufacturers instructions and the chimney system's UL listing.

6. The chimney installation shall be complete with all necessary supports, fittings and accessories as recommended by the manufacturer, including:

   a. Open termination (chimney shall discharge straight up) and drain tee.

   b. Supports, guides, and plate support assembly, and all supports as required by chimney manufacturer to comply with UL listing. Support hardware exposed to the weather shall be made of stainless steel.

2.16 FANS

A. ACCEPTABLE MANUFACTURERS

1. Loren Cook

2. Greenheck

3. Penn

4. Acme

B. PRODUCT REQUIREMENTS:

1. Equivalent fan selections shall not decrease motor horse power (wattage), increase tip speed by more than 10%, or increase inlet air velocity by more than 20%, from that specified.

2. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.

3. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.

4. Fabrication: Conform to AMCA 99.

5. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.

6. Fan performance shall be based on standard air at sea level.

C. MOTORS AND DRIVES

1. Factory install all motors on slide base to permit adjustment of belt tension.

2. Fan Motors shall be heavy duty, premium efficiency for 3 HP and above, high-efficiency for 2 hp and below, open drip-proof, with electrical characteristics and capacities as scheduled on the plans. All motors shall conform to specifications in Section 15170 - Motors and Drives.

3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts and keyed. Variable and adjustable pitch sheaves for motors 15 hp (11.2 kW) and under selected so required RPM is obtained with sheaves set at mid-position, matched belts, and drive rated as recommended by manufacturer or minimum 1.5 times nameplate rating of the motor. Provide adjustable sheaves for all motors 15 hp or less, including those to be controlled by a VFD. For motors 10 hp or above, provide dual V-belt drives.

4. Variable Frequency Drive: Provide and install variable torque variable frequency drives (VFD) to regulate speed of supply, return, and exhaust air fans, as scheduled on the drawings. VFD's shall conform to all requirements of Section 15170 - Motors and Drives.

D. SELECTION AND BALANCING

1. Provide fans capable of accommodating static pressure variations of plus or minus 10%.

2. Provide balanced variable sheaves.

3. Statically and dynamically balance fans.

4. Provide belt guards on belt driven fans.

5. Provide inlet and outlet safety screens where inlet or outlet is exposed.

E. COATINGS

1. Prime coat fan wheels and housing inside and outside. Prime coating of aluminum parts is not required.

F. ROOFTOP EXHAUSTERS

1. Fan Unit: V-belt or direct driven with upblast or downblast spun aluminum housing as scheduled on the drawings. ; resilient mounted motor; 1/2 inch mesh, 16 gage aluminum birdscreen; square base to fit roof curb with continuous curb gaskets.

2. Roof Curb: minimum 12 inch high self-flashing roof curb of galvanized steel or aluminum with continuously welded seams, built in cant strips, [one inch insulation and curb bottom] [interior baffle with acoustic insulation, curb bottom] [ventilated double wall] [hinged curb adapter], and factory installed nailer strip.

3. Disconnect Switch: Provide factory wired, non-fusible disconnect switch.

4. Provide magnetic starters for 3 phase fans in accordance with section 15170, motors and drives.

5. Backdraft Damper: Provide motorized backdraft damper for each fan except for kitchen exhaust service or where specifically excluded on the plans or schedules. See section 15890, ductwork and accessories.

(ADD PARAGRAPH) →

G. CABINET FANS

1. Cabinets shall be acoustically lined with provisions for hanging cabinet from structure with threaded rods. Provide access for removal of fan and motor from cabinet mounted access door.

2. Motors shall be permanently sealed ball bearing type having electrical characteristics as scheduled. Motors shall meet requirements of section 15170. Motors shall have either integral thermal overload protection or separate thermal overload switch. Provide starters or variable frequency drives, as scheduled on the drawings.

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15890

**Add** Paragraph 2.16.F. as follows:

F. SIDEWALL EXHAUSTERS

1. Fan Unit: V-belt or direct driven with horizontal discharge spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 16 gage aluminum birdscreen; flanged base to fasten fan to wall construction.
2. Disconnect Switch: Provide factory wired, non-fused disconnect switch.
3. Solid state speed controller: Provide speed controller for each direct driven fan.
4. Backdraft Damper: Provide gravity backdraft damper for each fan except where specifically excluded on the plans or schedules. See section 15890, ductwork and accessories.

3. Drive shall be belt drive with adjustable sheaves or direct drive, as scheduled on the drawings and as specified in section 15170. Fan shaft bearings shall meet requirements of section 15170.

4. Fans shall be centrifugal wheel type, with forward curved, backward inclined, or airfoil type blades as scheduled on the drawings.

5. Provide rubber-in-shear or spring type vibration isolation mounts for fan and motor mounts. Provide internal flex connection for discharge ductwork.

6. Provide vibration isolation threaded hanger rods designed for fan weight and operating characteristics complete with rubber in shear in steel housing vibration isolation mounts.

7. Motorized dampers as indicated on the drawings shall be as specified in section 15890.

8. Accessory wall caps, grilles, and time delay controls shall be provided as scheduled and indicated on drawings.

H. PROPELLER FANS

1. Furnish and install propeller fans, as shown on the drawings and of capacities and arrangements as scheduled and detailed.

2. Motor shall be ball bearing type open drip proof with single speed windings. Motor characteristics shall be as scheduled. Provide thermal overload protection. See section 15170 Motors and Drives for motor and motor starter specifications.

3. Direct Drive Motors shall be resiliently mounted with Rubber-In-Shear vibration isolation motor mounts to a heavy gauge wire basket blade gauge of concentric rings meeting OSHA standards.

4. Propeller blades shall be statically and dynamically balanced for vibration free quiet operation.

5. Fans shall be mounted to a square heavy gauge steel mounting panel with a spun steel inlet venturi and welded corners.

6. Motorized dampers as indicated on the drawings shall be as specified in section 15890.

I. INLINE FANS

1. Inline fans shall be centrifugal wheel type with steel or aluminum housing designed for inline mounting in ductwork.

2. Housing: Provide tubular aluminum or square housing fabricated from galvanized steel as scheduled on the drawings. Housing shall have integral spun bellmouth inlet for smooth airflow into the fan wheel. Housing at fan discharge shall be designed for easy connection of round or rectangular ductwork.

3. Motors shall be permanently sealed ball bearing type having electrical characteristics as scheduled. Motors shall meet requirements of section 15170. Motors shall have either integral thermal overload protection or separate thermal overload switch. Provide starters or variable frequency drives for three phase motors, as scheduled on the drawings.

4. Drive shall be either belt drive with adjustable sheaves or direct drive, as scheduled on the drawings and as specified in section 15170. Fan shaft bearings shall meet requirements of section 15170.

5. Provide threaded hanger rods for mounting inline fans with rubber in shear in steel housing vibration isolation mounts. Floor mounted fans shall be mounted on resilient neoprene pads or springs as required to isolate structure from fan vibrations.

6. Motorized dampers as indicated on the drawings shall be as specified in section 15890.

2.17 FILTER HOLDERS & FILTERS

A. Provide side access, single stage filter holders of sizes and configurations indicated on the drawings, equal to Farr Glide/Pack 4P.

1. Filter housings shall be factory fabricated of 16 gauge galvanized steel sheets, reinforced at corners and door edges, with flanged connections to ductwork. Housings shall allow no more than 1% leakage into or out of housing at 3 inches WG differential.

2. Filter holders shall have internal tracks fabricated of aluminum extrusions or minimum 18 gauge steel channels to accept 4 inch thick pleated filter panels securely with less than 3% leakage around filters.

3. Housing shall be equipped with a hinged access door on each side. Access doors shall be fabricated of minimum 16 Gauge galvanized steel, with Camlock, spring clamp, or wing nut type latches for a durable, easily operated leak free closure. Access doors shall have 1" thick polyurethane or neoprene foam gaskets on all sealing surfaces.

4. Filter face areas shall be adequate to provide a maximum face velocity of 350 FPM at design conditions, or not less than the minimum area scheduled on the drawings.

5. Housing shall be insulated externally with 1" thick rigid fiberglass board with FSK facing and all seams tape sealed.

6. ACCEPTABLE MANUFACTURERS

   a. Farr

   b. AirSeal

   c. American Air Filter

   d. Airguard

B. FILTERS

1. Prefilters shall be 2 or 4 inch thick sized to fit filter holders with maximum face velocity of 500 feet per minute. Prefilters shall be disposable, pleated-media, 25-30% efficiency rating and 90% arrestance in accordance with ASHRAE 52.1-92. Filters shall be equal to Farr 30/30 with integral frames made of rigid, high wet strength beverage board. Media shall be supported by welded wire grid on the downstream side with minimum 96% free area.

   a. 2" deep filters shall have a media area of at least 4.6 square feet per square foot of face area with 15 pleats per linear foot.

   b. 4" deep filters shall have a media area of at least 7.0 square feet per square foot of face area with 11 pleats per linear foot.

2. High efficiency filters shall be throw-away 12 inch deep pleated cartridge type with maximum face velocity of 500 feet per minute. High efficiency filters shall be 85% efficient and UL class 1 or class 2 rated equal to Farr Rigi-Flo series. Filter media shall have at least 14 square feet of surface area per square foot of face area.

3. ACCEPTABLE MANUFACTURERS

   a. Farr

   b. Airguard

   c. American Air Filter

   d. Purolator

   e. Glasflos

C. Provide Filter Gauges equal to Dwyer Magnehelic with 3-1/2 inch (90 mm) diameter diaphragm actuated dial in metal case with static pressure tips.

D. Provide Filter Switch, with adjustable pressure differential between 0.5 - 1.5 in WG., piped internally to both sides of filter assembly, to provide alarm contact for the automatic temperature control system.

E. Provide one spare set of prefilters and high efficiency filters for each unit.

PART 3 EXECUTION

3.1 DUCTWORK AND ACCESSORIES INSTALLATION

A. Installation shall conform to NFPA 90A, SMACNA HVACDCS, and BOCA or IMC Mechanical Codes (as applicable) Provide mounting and supporting of ductwork and accessories including, but not limited to, structural supports, hangers, vibration isolators, stands, clamps and brackets, access doors and dampers. Use electrical isolation between dissimilar metals. Electrical isolation may be fluorinated elastomers or sponge rubber gaskets. Install ductwork accessories in accordance with the manufacturer's printed instructions. Allow clearance for inspection, repair, replacement and service.

B. Ductwork: When air distribution systems are operated, there shall be no chatter, vibration or dust marks. Oil canning, vibration, and chatter problems shall be corrected by reinforcing affected ducts at no extra cost to owner. After ducts are thermally or acoustically insulated, ensure air flow area equal to duct cross section dimensions indicated.

C. Field Changes to Ductwork: Those required to suit the sizes of factory fabricated equipment actually furnished shall be designed to minimize expansion and contraction. Use gradual transitions in field changes as well as modifications to connecting ducts. Architect reserves the right to vary the size of ducts and flues to accommodate structural conditions during the progress of work without additional cost to the owner.

D. Service Clearances: All ductwork shall be installed to allow adequate and convenient service access to mechanical equipment. Where service areas are shown on the plans, no ductwork or piping (other than drops to unit coils) shall be routed through the service area space at less than 6' – 6" above finished floor.

E. Dampers: When installed in ducts to be thermally insulated, equip each damper operator with stand-off mounting brackets, bases or adapters to provide clearance between the duct and operator not less than the thickness of insulation. Stand-off mounting items shall be integral with the operator or standard accessory of damper manufacturer.

F. Volume Dampers: Provide specified volume damper for each supply, return, and exhaust outlet and major duct branches as necessary, unless

indicated otherwise on the drawings. Where mechanical equipment such as fans or VAV boxes serves only one outlet, volume damper is not necessary unless indicated on the drawings. Install volume dampers in accessible locations, as far from terminal outlet as feasible, concealed above ceilings or in mechanical spaces where possible. Where exposed ductwork is used, position actuator and quadrant on side or back of ducts to reduce visibility while retaining access for measurements and adjustments.

G. Deflectors: Provide in square elbows, duct mounted supply outlets, take-off or extension collars to supply outlets, and branch-take off connections. Adjust supply outlets to provide air volume and distribution as indicated or specified.

H. Fire Dampers: Install for ducts penetrating fire walls and where ducts systems serve two or more floors in accordance with UL 555.

I. Access Doors: Provide and install an access door in ductwork, casings, or plenums as needed for inspection and service of all:

1. Automatic control dampers and counterbalanced dampers.

2. Fire and smoke dampers, for access to fusible link and actuators.

3. Upstream of all heating or cooling coils.

4. Filters: for access for changing filters without bending or forcing filter panels.

5. Downstream of all humidifiers,

6. and for all other concealed apparatus requiring service and inspection in the duct systems.

J. Duct Sleeves and Prepared Openings: Install for duct mains, duct branches and ducts passing through roofs and ceilings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings.

K. Duct Sleeves: Allow one inch clearance between duct and sleeve or one inch clearance between insulation and sleeve for insulated ducts, except at grilles, registers and diffusers.

1. Prepared Openings: Allow one inch clearance between duct and opening or one inch clearance between insulation and opening for insulated ducts, except t grilles, registers and diffusers.

2. At each point where ducts pass through fire rated partitions, seal joints around duct with non-combustible material.

3. Closure Collars: Provide not less than 4 inches wide on each side of walls or floors where sleeves or prepared openings are installed. Fit collars snugly around ducts and insulation. Grind smooth edges of collar to preclude tearing or puncturing insulation covering or vapor barrier. Use nails with maximum 6 inch centers on collars.

4. Packing: Fed. Spec. HH-I-1030. Pack with mineral fiber in spaces between sleeve or opening and duct or duct insulation.

L. Duct Hangers and Supports: SMACNA HVACDCS, Section 4. Unless otherwise indicated, provide not less than two one inch by 1/16 inch galvanized strap iron hangers spaced one on each side of duct. Anchor risers in the center of the vertical run to allow ends of riser free vertical movements. Attach supports only to structural framing members and concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchors from puncturing the metal decking. Where supports are required between structural framing member, provide suitable intermediate metal framing. Where C clamps are used, use retainer clips.

M. Flexible Ducts: Support ducts by hangers every 3 feet. Use stretch flexible air ducts to smooth out corrugations and long radius elbows, where possible, using a minimum length to make connections.

N. Flexible Connectors: Provide flexible connectors between fans and ducts or casings, and where ducts are of dissimilar metals. For round ducts, securely fasten flexible connectors by zinc coated steel clinch type draw-bands. For rectangular ducts, lock flexible connectors to metal collars.

O. Smoke Detectors: Install smoke detectors, supplied by Division 16 – Electrical, in supply and/or return ductwork as indicated on the drawings and in accordance with applicable codes and the authority have jurisdiction.

P. Temperature Controls: Provide openings in ductwork where required to accommodate thermometers and controllers.

Q. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.

## 3.2 FLEXIBLE DUCT INSTALLATION

A. Do not use flexible duct to change direction.

B. Connect diffusers, diffuser plenums, or troffer boots to low pressure ducts with 6 foot maximum length of flexible duct (or maximum indicated on Drawings). Hold in place with strap or clamp. Clamp both inner and outer walls of flex duct at ends.

3.3 DUCT LINER INSTALLATION

A. Provide and install duct liner where:

1. Indicated on the drawings.

2. Specified.

3. As scheduled.

B. Install all duct liner in accordance with the HVAC Duct Construction Standards by the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).

C. Flexible duct liner of the specified material, thickness and density shall be furnished and installed where shown on the contract drawings.

D. Unless otherwise indicated, the net free area of the duct dimensions given on the contract drawings shall be maintained. The duct dimensions shall be increased as necessary to compensate for liner thickness.

E. The liner surface designated to be exposed shall face the airstream.

F. Each layer of duct liner shall be adhered with 90% coverage of adhesive at liner contact surface area.

G. Liner shall be folded and compressed in the corners of rectangular duct sections or shall be cut and fit to assure butted edge overlapping. Longitudinal joints in duct liner shall not occur except at the corners of ducts unless the size of the duct and standard liner product dimensions make such necessary.

H. Except as noted otherwise, mechanical fasteners shall be located with respect to interior dimensions and regardless of airflow direction as follows:

| Velocity | Transversely Around Perimeter | Longitudinally |
|---|---|---|
| fpm or less | At 3" from corners and at intervals not exceeding 12" | At 3" from transverse joints and at intervals not exceeding 18" |
| fpm to 6000 fpm | At 3" from corners and at intervals not exceeding 6" | At 3" from transverse joints and at intervals not exceeding 16" |

I. Metal nosings that are either channel or Z-profile or are integrally formed from the duct wall shall be securely installed over transversely oriented liner edges facing the airstream at fan discharge, and at any interval of

lined duct preceded by unlined duct. In addition, where velocities exceed 4000 fpm, metal nosing shall be used on upstream edges of liner at every transverse joint.

J. Where dampers, turning vane assemblies or other devices are placed inside of lined duct or fittings, the installation must not damage the liner or cause erosion of the liner. Provide metal hat sections or other build-out means. build-outs shall be secured to the duct wall with bolts, screws, rivets or welds.

K. Interior widths of duct not exceeding 8" do not require mechanical fasteners in addition to adhesive.

L. Liner shall also be installed with mechanical fastening devices meeting the following additional requirements:

1. Are spaced in accordance with SMACNA Guide.

2. When installed, are as corrosion resistant as G60 coated galvanized steel.

3. Will not adversely affect the fire resistant classification of liner and adhesives.

4. Do not damage the liner when applied as recommended by the manufacturer.

5. Do not cause leakage in the duct.

6. Do not project more than nominally into the airstream.

7. Will indefinitely sustain a 50 pound tensile dead load test perpendicular to the duct wall.

8. Are the correct length for the specified liner thickness.

M. All Outdoor Air Plenums behind Outdoor Air louvers shall be constructed with 18 gauge inner enclosure reinforced as required to prevent "oil canning" and insulated with two (2) 1" thick layers of rigid insulation with FSK facing. Bottom of outdoor air and exhaust air plenums shall be watertight and pitch to drain.

N. Do not install duct liner in outdoor air ductwork, or 10' downstream of a cooling coil or humidifier.

3.4 FIELD TESTS AND INSPECTIONS

A. Performance Testing and Balancing: Section 15990, Testing and Balancing Air and Water Systems.

3.5 FAN INSTALLATION

A. Install air distribution equipment as indicated and in accordance with the manufacturer's instructions. Provide clearance for inspection, repair, replacement, and service. Electrical work shall conform to NFPA 70 and Division 16, Electric.

B. Secure roof exhausters with stainless steel lag screws to roof curb. Extend ducts into roof curb lapped over top of curb. Install motorized backdraft dampers on inlet.

C. Connect inline fans and cabinet fans to ductwork using flexible connectors, except where fans are internally isolated with internal flex connections and resilient mounts.

D. Hang inline fans and cabinet fans using rubber in sheer or spring type vibration isolating hanger rods. Fans mounted on the floor shall be isolated with spring type mounts for heavy equipment (5 HP or more) or neoprene pads for lighter equipment.

E. Insure proper rotation of fan at startup and before balancing.

F. Control of fans shall be as specified in 15900, Automatic Temperature Controls.

3.6 CLEANING

A. The entire system installation including apparatus, motors, and inside of casings shall be left in first class condition including cleaning, oiling, and packing.

B. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings are lubricated, and fans have been test run under observation.

C. Clean duct system with forced air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment which may be harmed by excessive dirt with filters or bypass during cleaning. Cheesecloth shall be secured over each air outlet to entrain dirt and dust during this operation.

END OF SECTION

SECTION 15900

AUTOMATIC TEMPERATURE CONTROLS

(FILED SUB-BID)

PART 1 GENERAL

1.1 SECTION INCLUDES

A. A fully integrated Building Management and Control System incorporating Direct Digital Control (DDC) of all air handling, pumps, VAV boxes and heating coils, and cooling equipment, and electric control of terminal heating units, consisting of the following:

1. Microcomputer based equipment controllers interfacing directly with electronic sensors and actuators.

2. Low voltage electric thermostats controlling two position zone valves for control of terminal heating equipment.

3. Integration into Bureau of General Services graphics DDC control system, with connection to Building Control located in the Cross Building.

B. Submittals, data entry, electrical installation, programming, start up, test and validation, instruction of Owner's representative on maintenance and operation, as-built documentation, and system warranty.

1.2 SUBMITTALS

A. Submit in accordance with Section 15010 - General Requirements.

B. Submittal shall consist of:

1. System architecture showing all digital devices.

2. Data sheets of all products to be used, with exact product and its application noted on submittal sheet.

3. Valve, damper, and well and tap schedules showing size, configuration, capacity and location of all control equipment, panels, adjustments, and sensors.

4. Wiring interconnection diagrams including panel and device power and sources.

5. Equipment lists of all proposed devices and equipment.

6. Software design data including direct digital control program showing interrelationship between inputs, PI and PID functions, all other functions, outputs, etc.

7. Submit completed checklist of all points tested and confirmed operating correctly as a prerequisite for substantial completion.

8. Graphic system layout and design, including building plan and control groups proposed.

9. Submit trend logs of at least one week duration as specified herein after control system is complete, to demonstrate proper function of all automatic controls.

C. Codes and Approvals:

1. The complete temperature control installation shall be in strict accordance to the national and local electrical codes and the electrical section of these specifications. All devices designed for or used in line voltage applications shall be UL listed. All microprocessor based remote and central devices shall be UL916 Listed.

2. All electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.3 MANUALS

A. The following manuals shall be provided upon substantial completion of the project:

1. An Operators Manual shall be provided with graphic explanations of keypad/keyboard use for all operator functions specified under Operator Training. Operators Manual shall provide step by step log in instructions and starting operator names and passwords.

2. Computerized printouts of all equipment controllers' data file construction including all point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, etc.

3. A manual shall be provided including revised as-built documents of all materials required under the paragraph "SUBMITTALS" on this specification.

B. Two Operators Manuals and two As-Built Manuals shall be provided to the owner. One Operators Manual and an As-Built Manual shall be delivered to the architect/engineer for review and approval. Job shall not be considered complete until engineer approves the submitted manuals.

1.6 EXISTING HONEYWELL DELTA SYSTEM

A. Existing Honeywell Delta system panels, controllers, actuators, operator terminal, etc. shall be carefully removed and delivered to the Owner.

1.7 COMPATIBILITY

A. System shall be open architecture fully BACnet compatible for all points, allowing control and monitoring of all points via other manufacturers' automatic temperature control (ATC) systems.

ADDENDUM 1
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**Add**
1.8 COMMISSIONING

A. After automatic temperature control (ATC) system hardware and software installation is complete for each system, the ATC Contractor shall fully test control systems and certify that all actions specified in the sequences of operation are met. The ATC Contractor shall repair any controls or revise any sequences found to be faulty as necessary to assure that the automatic temperature control system operates as specified. After all testing and repairs are complete, the ATC Contractor shall provide written notice to the owner and architect/engineer that the ATC system is ready for independent testing by the commissioning agent.

B. The ATC contractor shall provide a technician on site to work with the commissioning agent to operate the DDC control system, overriding points as necessary to fully test the ATC system. The ATC technician shall repair, adjust, or reprogram any systems found to be faulty immediately, if possible, or within one week of the initial commissioning tests by the commissioning agent. The ATC technician shall be available to assist the commissioning agent for up to 8 hours per air handling system.

C. The ATC contractor shall work cooperatively with other contractors as required and specified in section 15010 – General Requirements, to correct any deficiencies found in the HVAC and ATC systems.

D. After any needed corrections are complete, the ATC technician shall again assist the commissioning agent, as required, to retest all systems to assure compliance with the contract documents, at no additional cost to the owner.

**E.** The commissioning process shall be repeated until the ATC systems fully comply with the sequences specified.

1.4 WARRANTY

A. All components, system software, parts and assemblies supplied by the temperature control contractor shall be guaranteed against defects in materials, workmanship, and programming for one year from acceptance date.

B. Labor to troubleshoot, repair, reprogram, calibrate, or replace system components shall be furnished by the temperature control contractor at no additional charge to the owner during the warranty period.

C. All corrective software modifications made during warranty service periods shall be updated on all user documentation and on user and manufacturer archived software disks.

1.5 WORK BY OTHERS

A. Access doors, installation of valves, water pressure and differential taps, installation of thermal wells, installation of dampers, and variable air volume box damper actuators.

ADD PARAGRAPHS (SEE PREVIOUS PAGE)

PART 2 PRODUCTS

2.1 ACCEPTABLE SUPPLIERS

A. Acceptable Control Equipment Manufacturers:

1. Honeywell.
2. Siemens (formerly Landis & Staefa).
3. Siebe (Barber-Colman).
4. Andover Controls.
5. Johnson Controls.

2.2 SYSTEM REQUIREMENTS

A. Provide complete direct digital control (DDC) system for control of major equipment. DDC controls shall consist of temperature sensors, control valves, dampers, operators, indicating devices, interface equipment, panels, terminals, and all other apparatus required to operate mechanical system and to perform functions specified in the sequences of operation. All DDC controls shall be electronic. DDC system shall interface with existing Honeywell XSM control systems used in other State of Maine buildings.

B. Provide DDC controls as specified herein to include the following equipment:

1. Air handling units and fans.

2. On/Off control of supply and exhaust air fans serving ERU's.

3. Control of pumps.

4. Outside Air and Exhaust Air 2 position Dampers.

5. Mixing Box Modulating Dampers.

6. Variable Air Volume (VAV) Boxes & Heating coils and fin tube radiation (FTR).

7. Direct Expansion Cooling Equipment.

8. Air-Cooled Water Chillers.

9. Heating Equipment

2.3 ROOM THERMOSTATS

A. DDC Room Temperature Sensors:

1. Provide electronic room temperature sensor in each VAV zone and for fin tube radiator control as indicated on the drawings. Temperature sensors shall be located as shown on the plans and specified in the sequence of operation, or if that information is not provided, in the worst case heating location in the VAV zone. Room temperature sensors shall be equipped with ivory colored face. Local indication of space temperature is not required.

2. Provide override button and operator accessible occupied temperature setpoint adjustment dial, lever, or keypad on each zone temperature sensor, except in bathroom, corridor, and lobby spaces.

a. Override button shall switch zone from unoccupied setting to occupied setpoints and mode for a set time (2 hours, adjustable). Override button shall be permanently and clearly labeled "OVERRIDE ON".

b. Adjustment shall allow occupant control of occupied setpoint within the range of 68°F to 74°F, limited by the DDC program. Unoccupied setpoint shall set by the DDC program and shall not be occupant accessible at the thermostat.

3. Provide flush mounted temperature sensors for public spaces in corridors, lobby, and the main auditorium. Flush mounted sensors shall be designed to blend into the surrounding wall for an almost invisible installation.

4. VAV temperature sensors shall provide modulating control of VAV box dampers, heating coil valves, and two position control of fin tube radiator located in the same room as the temperature sensor.

## 2.4 AUTOMATIC DAMPERS

A. Provide all automatic control dampers not specified to be integral with other equipment.

1. Modulating Dampers shall be airfoil type, Ruskin CD-60, or approved equal by Greenheck, American Warming and Ventilating, or control manufacturer. Frames shall not be less than 16 gauge galvanized steel channel with corner reinforcements. Blades shall not be over 8 inches wide and shall be roll formed steel, extruded aluminum airfoil type, or extruded aluminum insulated type with vinyl or neoprene edge seals mechanically locked onto the edges of the blades. Bearings shall be oilite, ball-bearing, nylon, or lubricated stainless steel sleeves. Axles shall be minimum ½" diameter hexagonal or square positively locked onto the center of each damper blade. Side jamb seals shall be stainless steel of the tight-seal spring type. Control shaft shall be removable ½" diameter steel.

2. Two position dampers at outside air and exhaust louver plenums or rooftop fan or hood discharges shall be the same as modulating dampers, or at the contractor's option may use galvanized steel triple-V-groove type parallel blades with seals in lieu of airfoil blades. Dampers shall be Ruskin CD-36, TAMCO Series 9000 insulated, or approved equal by Greenheck, Air Balance Inc., or control manufacturer. Frames shall not be less than 18 gauge galvanized steel channel with corner reinforcements. Blades shall not be over 8 inches wide and shall be 16 gauge galvanized steel with three longitudinal grooves for reinforcement. Blade edge seals shall be PVC coated polyester

fabric or neoprene, suitable for -25°F to 180°F, mechanically locked onto the edges of the blades. Bearings shall be synthetic sleeve type. Axles shall be minimum ½" diameter hexagonal or square positively locked onto the center of each damper blade. Side jamb seals shall be flexible stainless steel tight-seal spring type. Control shaft shall be removable 1/2" diameter steel.

B. All proportional control dampers shall be opposed blade type and all two-position dampers shall be parallel blade types.

C. Dampers shall be ultra-low leakage type, the blade edges shall be fitted with vinyl or neoprene edge seals mechanically locked onto the edges of the blades to limit damper leakage to 4 CFM per square foot at 1.0 inch WG. The temperature control manufacturer shall submit leakage data for all control dampers with the temperature control submittal.

## 2.5 AUTOMATIC CONTROL VALVES

A. Automatic control valves 2½" and smaller shall be screwed type, and valves 3" and larger shall be flanged. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered. Valves shall have stainless-steel stems and spring loaded Teflon packing with replaceable discs.

B. All modulating straight-through water valves shall be provided with equal-percentage contoured throttling plugs. Valves shall be sized for a pressure drop at least equal to the coil they serve but not to exceed 4 psi.

C. Unitary valves shall be straight-through type. Stems shall be polished stainless-steel and packing shall be suitable for both chilled water and 250°F hot water or ethylene-propylene glycol service. Pressure ratings shall be as required for the intended service.

D. Fin tube radiation valves shall be two-way, low voltage electric zone valves.

1. Fin tube radiation valves controlled by electric room thermostats shall be two position.

2. Fin tube radiation valves controlled by DDC controllers shall be modulating, floating valve position, based on readings from space temperature sensors as specified under VAV control.

E. All hot water heating coil valves in air handling units shall be three-way, fully modulating.

## 2.6 DAMPER AND VALVE ACTUATORS

A. All automatically controlled devices, unless specified otherwise elsewhere, shall be provided with electronic direct connected actuators (no external linkage) as manufactured by Belimo or approved equal by

control manufacturer. Actuators shall be sized to operate the attached control device with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off as applicable.

B. Where two or more actuators are to be operated in sequence with each other, sequencing shall be by digital sequencing with separate analog outputs, as specified in the sequence of operation.

C. Actuators shall be equipped with adjustable mechanical (not mercury) end switches to prove full opening of device controlled.

2.7 SAFETIES

A. Freezestat shall be two pole automatic reset twenty foot capillary gas filled type responsive to the coolest section of its length. One pole of freezestat (or 2 pole relay from freezestat) shall be hard wired to shut down AHU system if temperatures below 40°F are sensed downstream of the heating coil. The second pole of freezestat (or relay) shall be hard wired to interrupt control circuit to DX cooling units, to stop DX unit operation if temperatures lower than 40°F are sensed. Coordinate supply and installation of freezestat with air handling unit manufacturer.

B. Freezestat safety low limit shall be mounted downstream of the hot water heating coil in each air handler or each main heating coil where the air handler does not have its own heating coil.

C. Fan proof-of-flow switches shall be current transformers (CT) with adjustable set point. Set threshold on CT so that a broken or slipping drive belt will be detected as well as motor on/off events.

D. For DX systems, provide differential pressure type fan proving switch hard wired to interrupt the control circuit to DX cooling units, to stop DX unit operation if airflow from fans is not proven on.

E. Pump proof-of-flow switches shall be via current transformers.

2.8 SENSORS, INPUTS, AND OUTPUTS

A. Input/output sensors and devices shall be closely matched to the requirements of the remote panel for accurate, responsive, noise-free signal input/output. Control input response shall be high sensitivity and matched to the loop gain requirements for precise and responsive control.

B. Outside air temperature sensors shall be enclosed in weather resistant case, and installed on a north wall in a shaded location or as indicated on the plans.

C. Duct temperature sensors shall be fast response rigid stem or averaging type as required for tight discharge temperature control to within ±0.5°F.

D. Water sensors shall be provided with a separable copper, monel, or stainless-steel well.

E. Carbon Dioxide Sensors shall be diffusion type, duct mounted or wall mounted as indicated on the drawings. Wall mounted sensors shall be mounted 6 feet above the floor. Sensors shall provide linear 0-10 VDC or 4-20 ma output proportional to 0-2,000 PPM Carbon dioxide (CO2). Sensor shall have a minimum accuracy of ±50 PPM, with ±100 PPM/year drift, over 40-90°F temperature and 5%-95% relative humidity ranges.

1. $CO_2$ sensor shall be Telaire 2001VT or approved equal by the control manufacturer.

2. $CO_2$ sensor shall be easily field calibrated, with calibration adjustments for zero offset and span. Provide all tools, calibration gases, and software required in a calibration kit to the owner.

F. Humidity Sensors shall be electronic type, accurate to within ±5% relative humidity from 5% - 95% RH for at least one year without recalibration. Provide duct mounted or wall mounted sensor as indicated on the drawings or specified under the sequence of operation. Space humidity sensors shall be provided with blank commercial type locking covers to match thermostats.

G. Control relays shall be suitable for the loads encountered.

2.9 CONTROLLER HARDWARE

A. Equipment controllers shall be 16 bit or 32 bit microprocessor based with EPROM operating system (O.S.). DDC programs and data files shall be stored in non-volatile EEPROM or flash memory to allow simple additions and changes. Each equipment controller shall have an on-board real-time clock with battery backup of a minimum of 30 days.

1. Equipment controllers shall be provided for each air handler zone and where shown or specified, with capacity to accommodate input/output (I/O) points required for the equipment to be controlled plus at least 2 spare points. These controllers shall be configured with analog and digital inputs and outputs, and pulse counting totalizers, such that the primary inputs, the outputs, and all control logic shall be resident in a single microprocessor controller to provide network independent stand-alone closed loop DDC. Controllers shall be suitable for networking between all controllers at the site and a front end computer system.

2. All panel electronics shall be installed indoors in suitable electronics enclosures. Equipment room panels shall have hinged doors and shall also contain all load relays, power supplies, and associated equipment.

3. Provide clearly labeled red alarm light for each air handling unit on local panel face to signal any alarm condition in the associated air handling system.

4. Provide clearly labeled reset button for each air handling unit on panel face to reset alarm condition locally.

5. Provide clearly labeled hand-off-auto switch for each air handling system on local panel face.

6. Provide power surge protection devices for all microprocessor based controllers.

## 2.10 CONTROLLER SOFTWARE

A. Energy Management application programs and associated data files shall be stored in non-volatile memory in each equipment controller.

1. Optimum Start shall delay equipment start-up based on outdoor temperature, space temperature, and system response, to assure that occupied temperature setpoints are reached at scheduled occupancy hour. The optimum start program shall operate fully stand-alone in each local equipment controller.

2. A load reset program shall be provided to assure that only the minimum amount of heating, cooling, and electrical energy is supplied to satisfy zone temperature and ventilation requirements.

B. Control Software:

1. Control Application Software shall be customized to meet the detailed requirements of the "Sequence of Operation" specified hereinafter. All controllers shall be fully programmable. Initial software shall be fully modifiable, and not be restricted by vendor's specific configuration guidelines.

2. All equipment controller control software shall be designed via a graphic programming facility, the detailed graphic design of which shall be provided as system documentation.

3. All control strategies shall include stabilizing setpoint ramps and procedures to assure slow loading of variable load equipment and economizer modes to prevent significant overshoot, undershoot, and "hunting" for air temperature, especially during start-up and transition periods. Controls shall be adjusted to stabilize discharge temperatures of modulated equipment ±1°F during steady state operation.

C. Management Software:

1. Each equipment controller shall be provided with a trend archive capability of at least the last 100 events (digital transitions or analog value changes) of any user selected group of up to 10 points. A stored event shall include date and time, and value or status. Point events shall be displayable at local panels as trend logs for evaluation of control system performance.

2. Each equipment controller shall monitor all analog input points and specified digital points for off-normal conditions. Each alarm shall have an "alarm delay" attribute which shall determine how long (in seconds) a point must be in an off-normal state prior to being considered in an alarm state. Alarms shall be displayable at local panels as well as operator's terminals.

D. Communications Software:

1. Each equipment controller shall have a full master peer-to-peer communications module to support all global data sharing, hierarchical control, and global control strategies specified.

2.11 OPERATOR'S TERMINAL

A. The DDC system for the Maine Department of Transportation shall be networked into the control system for the State of Maine Capitol complex.

1. Provide all hardware, software, wiring, and programming required to integrate the Maine Department of Transportation control system into the graphics based control and monitoring system installed at the Building Control in the State Office Building.

2. Control software shall be provided fully programmed and configured for graphic based control of this building, based on the sequence of operation contained herein, and as approved by the architect in submittals. Control software shall also provide printouts of system variables, programming, status reports, alarms, etc. Provide a copy of the graphics controls program and software required to engineer to allow remote monitoring of control system via graphics interface.

ADD PARAGRAPH PER ADDENDUM 1 1/28/02 AT

(SEE FOLLOWING PAGE)

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**ADD** to Paragraph 2.11 ADDENDUM 1 1/28/02 AT

B. Provide a PC based graphics operator's terminal at the maintenance office. Operators terminal shall be complete with all hardware and software required to provide an easy to use graphics based control and monitoring system for the entire facility. The terminal shall have, as a minimum, the following equipment:

1. Intel Pentium III 800 Processor Unit with 128 MB RAM (expandable to at least 256 MB).
2. Windows 98 or Windows NT 4.0 Operating System complete with backup software CD and printed manuals.
3. 3.5 inch floppy disk drive.
4. CD ROM drive
5. 10 GB EIDE Hard Disk Drive.
6. 17" Non-Interlaced Energy Star and VESA Compliant Color Monitor and controller capable of SVGA (800x600) standard graphics.
7. 56 KBaud V.90 compliant modem and communications software as needed. Provide communications software to engineer as required to allow remote monitoring of control system.
8. Surge protection devices for all equipment equal to APC.
9. Inkjet or laser printer with at least 100 sheet paper tray.

**Add**

2.14 BACNET COMPATIBILITY

B. A. The ATC system shall be fully BACnet compatible at the time of installation. This means that the system must use BACnet as the native communication protocol between controllers and must, as a minimum, be Conformance Class 4 and support the following Objects.

Binary Input
Binary Output

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Binary Value
Analog Input
Analog Output
Analog Value

C. The communication network between controllers must be EIA-485, at least 78.4 kbps, using either MS/TP or 156 kbps using ARCNET at the Data Link Layer.

D. If the system is not fully BACnet compatible at the time of installation and/or cannot communicate with the entire global network of the present ATC system as specified above is not acceptable.

**ADD:**

## 2.15 GRAPHICAL SYSTEM SOFTWARE

ADDENDUM 1.
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A. Control software shall be provided fully programmed and configured for graphic based control of this building, based on the sequence of operation contained herein, and as approved by the architect in submittals. Control software shall also provide printouts of system variables, programming, status reports, alarms, etc. The graphics software shall be designed to operate under and be fully compatible with all of the Microsoft Windows 95, 98, and NT 4.0 operating systems.

1. Provide a backup copy of the software
2. Provide two backup copies of the graphics controls program and software required: one for the superintendents office and one for the architect/engineer to allow remote monitoring of control system via graphics interface.

B. The workstation shall display graphically the following system information:

1. General area maps shall show locations of controlled buildings in relation to local landmarks.
2. Floor plan maps shall show heating and cooling zones throughout the buildings in a range of colors which provide a visual display of temperature relative to their respective setpoints. The colors shall be updated dynamically as zones' comfort condition change. Locations of space sensors shall also be shown for each zone.
3. Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. It shall also provide a current status of all I/O points being controlled and applicable to each piece of equipment including analog readouts in appropriate engineering units at appropriate locations on the graphic representation.

C. Each category of software shall consist of interactive software modules. Each module shall have an associated priority level and shall execute as determined by the program controller as defined in the real time operating system.

D. Alarm Management

1. The workstation shall allow receipt of alarms and messages while in a functional mode other than energy management, i.e., incoming alarms shall be displayed while the operator is in a word processing,

CONT... ↓

(CONT...)

spreadsheet, or other operating mode. The system shall automatically switch from a non-energy management mode, respond to an alarm, and return to the exact position left in the previous functional mode.

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2. After logging into the system, the operator shall be able to immediately acknowledge and respond to alarmed equipment using simple one key or mouse click to access the alarmed equipment.

E. The building operator shall be able to communicate and direct all control functions through the use of a 2-button "mouse" operator interface to monitor and control all functions and sequences within the system.

F. The following information shall be selectable from both a WINDOWS menu environment and a button menu bar available on the bottom of the various graphics.

| | | | |
|---|---|---|---|
| 1. | Exit | Trends | Help files |
| 2. | Reports | Setpoints | Download |
| 3. | Schedules | Module Status | Upload |
| 4. | Graphs | Parameters | Print |
| 5. | Utilities | Minimize | Manual commands |
| 6. | Groups | Last view | Help |
| 7. | Alarms | Live GFB Function display* | |

* this represents a display of complete graphical programming with actual dynamic equipment and sensor values superimposed. When programming changes are made, dynamic values shall accurately display equipment or sensor value changes.

G. Provide multiple levels of password protected access, to control access to ATC system for at least the following levels (listed in order of decreasing access)

1. Programming of routines and equipment sequences
2. Reset schedule adjustments
3. Temperature setpoint adjustments
4. Occupied mode time adjustments and temporary overrides
5. Viewing of system inputs and outputs with no adjustments possible.

H. Programming, scheduling and setpoint changes shall be accessible for modification on each menu for the associated equipment. Operator shall be able to automatically download changes from the workstation to the appropriate program for the equipment being controlled. Operator shall be able to upload parameters setpoint information and schedules from the field modules to the workstation.

2.12 REMOTE (TELEPHONE) DATA COMMUNICATIONS

A. Remote access to Maine Department of Transportation DDC controls shall be through Building Control located in the State Office Building.

2.13 LOCAL DATA COMMUNICATIONS

A. All equipment controllers shall be interconnected via a primary communications network. All networks shall support sensor sharing, global application programs, and bus-to-bus communications without the presence of a host PC.

B. The equipment controllers communications network shall support true peer protocol such that loss of any single device will not cause total bus failure or failure of any other devices on the network.

ADD PARAGRAPH

PART 3 EXECUTION

3.1 INSTALLATION

A. All wiring shall be properly supported and run in a neat manner. All wiring exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals.

B. The temperature control contractor shall be responsible for all electrical installation required for a fully functional control system and not shown on the electrical plans or required by the electrical specifications. All wiring shall be in accordance with all local and national codes. All line voltage wiring, all exposed wiring, and all wiring in equipment rooms shall be installed in conduit in accordance with the electrical specifications. All electronic low voltage wiring shall be #18 AWG minimum THHN and shielded if required.

C. The temperature control contractor shall enter all computer programs and data files into the related computers including all control programs, initial approved parameters and settings, and unique English language descriptors.

D. The temperature control contractor shall maintain diskette copies of all data file and application software for reload use in the event of a system crash or memory failure. One copy shall be delivered to the owner during training session, and one copy shall be archived in the temperature control contractor's local software vault. The software copies shall be updated whenever any changes are made to system programming.

3.2 VALIDATION

A. The temperature control contractor shall completely check out, calibrate, and test all connected hardware and software to insure that the

temperature control system performs in accordance with the approved specifications and sequences of operations submitted prior to project acceptance and start of acceptance testing procedures as specified in Commissioning HVAC Systems.

B. Temperature control contractor shall provide validation demonstration in the presence of the engineer and commissioning agent as needed for quality assurance. Witnessed validation demonstration shall consist of:

1. Display and demonstrate each type of data entry to show site specific customizing capability.

2. Execute digital and analog commands.

3. Demonstrate DDC loop precision and stability via trend logs of the following inputs and outputs:

   a. Discharge air temperature from each AHU.

   b. Zone temperature from each DDC zone.

4. Demonstrate performance via trend logs and command trace of occupied/unoccupied switching for each air handling system. Submit printout or floppy disk files to engineer for review at acceptance testing.

5. Provide a checklist of all controlled points, with pass/fail indication of each point. Control hardware must be observed to assure that controls are actually driving dampers, valves, fans, etc. correctly.

3.3 TRAINING

A. All training shall be by the temperature control contractor and shall utilize specified manuals and as-built documentation.

B. Operator training shall include four four-hour sessions encompassing:

1. Sequence of Operation review.

2. Selection of all displays and reports.

3. Control system architecture review.

4. Use of all specified Operating System functions.

5. User programming of setpoints, setpoint limits, time of day scheduling, and operator overrides of system functions.

6. Handling of alarms.

7. Use of Operators Terminal.

8. Troubleshooting of sensors and actuators.

C. One training session shall be conducted on site at system completion along with review of all system functions. This session shall be used to set up user schedules and refine setpoints, reset schedules, etc. to best serve building requirements as installed. The second session shall be held at the time of final acceptance testing, and shall be used to further refine setpoints, reset schedules, etc. The two subsequent training sessions shall be conducted monthly, after system final acceptance.

3.4 ALARMS

A. Provide the capability to generate alarms, complete with individualized per point alarm message for the following conditions:

1. High and low temperature for each temperature sensor, except outside air.

2. Main Heating System Low and High Temperature.

3. Freezestat status for AHU-1.

4. Supply air fan failure (low flow) in AHU-1 and SF-2.

5. Exhaust air fan failure (low flow) in EF-2.

6. Pump failure for each or pump pair.

B. Provide local annunciation of any alarm condition via a 1"∅ red alarm signal light on the face of the air handling unit controller enclosure panel.

C. All alarms shall require acknowledgment at the operator's terminal, and shall be logged on the alarm log, regardless of automatically reset alarms current status.

1. Provide system reset button for local AHU on each control panel to reset any alarm condition at the control panel, as well as via the operator's terminal.

3.5 SEQUENCE OF OPERATION

A. AHU-1A & AHU-1B (VARIABLE AIR VOLUME SYSTEMS SERVING LEVELS 2, 3 &4)

1. System Start/Stop (Occupied/Unoccupied) functions shall be controlled by a single DDC output using relays to provide switching as required.

2. Systems AHU-1A & AHU-1B shall be started on operated in unison and in parallel.

3. System start shall be hard wired to open the two position dampers in AHU-1A & AHU-1B main supply air ducts and in the discharge air ducts from EF-1 & EF-2; start AHU-1A & 1B, RF-1A & 1B, EF-1, and EF-2; and enable the following: SF-1; two position dampers in the minimum outdoor air ducts to AHU-1A & AHU-1B from ERU-1; two position damper in the outdoor air duct to ERU-1; modulating dampers in the main outdoor air ducts to AHU-1A & AHU-1B; exhaust air dampers from RF-1A & RF-1B; mixing box return air and flow measuring outdoor air dampers and the hot water and chilled water coil valves.

4. System stop shall be hard wired to close all outdoor air and exhaust air dampers; open mixing box dampers to full return air (0% OA) position; stop AHU-1A & 1B, RF-1A & 1B, EF-1, EF-2 and SF-1; open the hot water and chilled water coil valves. Units, dampers, valves, and accessories shall fail to the system stop condition upon loss of power or other abnormal condition.

   a. Freezestats shall utilize system stop to shut down units.

   b. Smoke detectors shall utilize system stop to shut down units. Smoke detectors shall be provided by division 16, installed in the ducts by the sheet metal contractor, and wired to stop units in accordance with NFPA 90A and local codes by the automatic temperature control contractor.

   c. Failure of any fan shall shut system down.

5. Provide Occupied/Unoccupied/Auto switch on air handling system control panel to manually switch system between occupied, unoccupied and automatic(DDC system) modes. Manual override of any air handling system shall be clearly indicated at the operators terminal. Manual On/Off control shall be by system start/stop relay specified above.

6. HOT WATER COIL FREEZE PROTECTION

   a. Freeze protection thermostats shall be located immediately downstream of AHU precooling coil (first coil in the airstream).

   b. Automatic reset freezestats shall be hard wired through the start/stop relay to stop air handling unit supply, return and exhaust fans, close outside air and exhaust air dampers, fully open heating coil and chilled water coil valves, and alarm the DDC system when any part of the discharge airstream drops below 40°F(adj.).

   c. Freezestat alarm shall place unit into unoccupied mode. Provide 30 minute (adjustable) delay before allowing unit

to restart. Freezestat alarms shall require acknowledgement at the operators terminal.

7. OCCUPIED MODE

a. SYSTEM START: During the occupied cycle, both supply fans (AHU-1A &AHU-1B), both return fans (RF-1A &RF-1B), EF-1 and EF-2 shall run continuously. Two position motorized dampers in AHU-1A & AHU-1B main supply air ducts and in the discharge air ducts from EF-1 & EF-2 shall open. The flow measuring outside air damper in each mixing box shall be open to the minimum position, and the mixing box return air dampers shall be open. The following shall become enabled to be controlled by the discharge air controller: SF-1, two position dampers in the outdoor air ducts to AHU-1A & AHU-1B from ERU-1, two position damper in the outdoor air duct to ERU-1 and modulating dampers in the main outdoor air ducts to AHU-1A & AHU-1B and the exhaust air dampers from RF-1A & RF-1B.

b. SUPPLY FAN AND RETURN FAN SPEED CONTROL: AHU-1A & AHU-1B supply air fan speed shall be modulated from a minimum of approximately 40% up to 100% via VFD to maintain the lowest speed possible while still providing enough airflow/pressure to satisfy CFM setpoints of all VAV boxes on that system (adjustable). Minimum setting of fan speed control shall be established in coordination with the balancing contractor to obtain the minimum VAV box settings as scheduled on the drawings. RF-1A & RF-1B fan speeds shall track their respective supply fan speeds.

c. SUPPLY AIR TEMPERATURE CONTROL: Each AHU shall have its supply air temperature maintained by a discharge air temperature controller. When the discharge air temperature falls below its setpoint, the mixing box dampers shall be modulated closed to the minimum outdoor air position. On a continued fall in discharge temperature, ERU-1 shall be activated by opening the two position dampers in the outdoor air ducts to AHU-1A & AHU-1B from SF-1 and the two position damper in the outdoor air duct to ERU-1 and starting SF-1. As the discharge air temperature continues to fall, the main outdoor air dampers at the louvers shall be modulated closed until all of the minimum outdoor airflow is through ERU-1. On a continued fall in discharge air temperature, the heating coil valve shall be modulated open to the coil. When the discharge temperature rises above its setpoint, the system shall be modulated up to 100% outside air as described under economizer control, with the heating coil valve closed and ERU-1 de-activated. The discharge air

temperature setpoint shall be reset between 55°F to 65°F as outside air temperature varies from 80°F to 20°F (adjustable). Reset schedules, max/min setpoints and ratio shall be easily adjustable from the operators terminal without programming.

d. ECONOMIZER CONTROL: When the discharge air temperature rises above its setpoint, the economizer control shall be implemented by modulating the mixing box outdoor air dampers open, the return air dampers closed and the exhaust air dampers open to maintain discharge air temperature setpoint. A low limit control in the mixed air stream shall prevent mixed air temperature from falling below 55F (adj). When the total energy of the outdoor air exceeds the total energy of the return air, the system shall be returned to minimum outside air operation by closing the mixing box outdoor air dampers to their minimum position, opening the return air dampers and closing the exhaust air dampers.

e. CHILLED WATER COOLING: When the discharge air temperature continues to rise above its setpoint with the economizer control operating the system at 100% outdoor air, the chilled water coil valve shall be modulated open to maintain the discharge air temperature setpoint. Chilled water cooling shall be locked out when outside air temperature is less than 50°F (adjustable), or the system is off or in an alarm condition (no fan flow, freezestat trip, etc

REPLACE PER ADDENDUM 1 (SEE FOLLOWING PAGE)

f. DEHUMIDIFICATION CONTROL: Whenever the humidity in the return air rises above 60%, the dehumidification cycle shall be implemented by starting pumps HRP-1A & HRP-1B and by opening the chilled water coil valves in AHU-1A &AHU-1B to provide full flow through the chilled water coils. The discharge air controller shall be overridden during the dehumidification cycle.

g. HUMIDIFICATION CONTROL: Whenever the relative humidity in the common return air stream falls below 35% (adj.), control valves on steam humidifiers HUM-1A & HUM-1B shall be modulated open to maintain the return air humidity setpoint. A high limit humidistat, downstream of the humidifiers shall limit the downstream humidity to 90% (adj). Humidifier control valves shall be fully closed whenever system is shut off or whenever airflow is interrupted.

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**DELETE** Paragraphs 3.5.A.7.d. & e.
**REPLACE** with Paragraphs 3.5.A.7.d. & e. as follows:

d. ECONOMIZER CONTROL: When the discharge air temperature rises above its setpoint, the economizer control shall be implemented by modulating the mixing box outdoor air dampers open, the return air dampers closed and the exhaust air dampers open to maintain discharge air temperature setpoint. A low limit control in the mixed air stream shall prevent mixed air temperature from falling below 55F (adj). When the total energy of the outdoor air exceeds the total energy of the return air: (1) the system shall be returned to minimum outside air operation by closing the mixing box outdoor air dampers to their minimum position, opening the return air dampers and closing the exhaust air dampers and (2) ERU-1 shall be activated by opening the two position dampers in the outdoor air ducts to AHU-1A & AHU-1B from SF-1 and the two position damper in the outdoor air duct to ERU-1 and starting SF-1.

e. CHILLED WATER COOLING: When the discharge air temperature continues to rise above its setpoint with the economizer control operating the system at 100% outdoor air, the chilled water coil valve shall be modulated open to maintain the discharge air temperature setpoint. Chilled water cooling shall be locked out when outside air temperature is less than 50°F (adjustable).

**Delete** Paragraphs 3.5.B.2. & 3. ADDENDUM 1 1/28/02 AT

**Replace with** Paragraphs 3.5.B.2. & 3. as follows:

2. AHU-2 shall operate simultaneously with AHU-3, AHU-4 & AHU-5.

3. System start shall be hard wired to open the two position damper in the main outdoor air duct (at the outdoor air louver), the two position outdoor air damper at AHU-2 inlet and the two position exhaust air damper in the discharge from ERU-2; start the air handling unit supply fan and EF-3 and enable the hot water and chilled water coil valves.

a. During unoccupied mode, or during power outage or equipment failure, Both systems shall be shut down. All outside air and all exhaust air dampers shall close fully (fail closed); AHU-1A & AHU-1B, RF-1A & RF-1B, EF-1 & EF-2 and SF-1 shall be off; the AHU heating and chilled water coil valves shall be full open to the coil (fail open); and the mixing box return air dampers shall be fully open.

9. POINTS: See attached points list.

B. AHU-2 (100% OUTDOOR AIR CONSTANT VOLUME SYSTEM SERVING LEVEL 1)

1. System Start/Stop (Occupied/Unoccupied) functions shall be controlled by a single DDC output using relays to provide switching as required.

REPLACE PER ADDENDUM 1 (SEE PREVIOUS PAGE)

2. AHU-2 shall operate simultaneously with AHU-3, AHU-4, AHU-5 & EF-3 but shall be capable of individual operation to allow for extended occupancy of building area served by AHU-2.

3. System start shall be hard wired to open the two position damper in the main outdoor air duct (at the outdoor air louver), the two position outdoor air damper at AHU-2 inlet and the two position exhaust air damper in the discharge from ERU-2; start the air handling unit supply fan and EF-3 and enable the following: two position dampers in the outdoor air duct to and from ERU-2; and the hot water and chilled water coil valves.

4. System stop shall be hard wired to close all outdoor air and exhaust air dampers; stop air handling unit and EF-3 and open the hot water and chilled water coil valves full to coil. Units, dampers, valves, and accessories shall fail to the system stop condition upon loss of power or other abnormal condition.

a. Freezestats shall utilize system stop to shut down unit.

b. Smoke detectors shall utilize system stop to shut down unit. Smoke detectors shall be provided by division 16, installed in the ducts by the sheet metal contractor, and wired to stop units in accordance with NFPA 90A and local codes by the automatic temperature control contractor.

c. Failure of any fan shall shut system down.

5. Provide Occupied/Unoccupied/Auto switch on air handling system control panel to manually switch system between occupied, unoccupied and automatic(DDC system) modes. Manual override of air handling system shall be clearly indicated at the operators terminal. Manual On/Off control shall be by system start/stop relay specified above.

6. HOT WATER COIL FREEZE PROTECTION

a. Freeze protection thermostats shall be located immediately downstream of AHU heating coil (first coil in the airstream).

b. Automatic reset freezestats shall be hard wired through the start/stop relay to stop air handling unit supply fan, close all outside air and exhaust air dampers, fully open heating coil and chilled water coil valves to coil, and alarm the DDC system when any part of the discharge airstream drops below 40°F(adj.).

c. Freezestat alarm shall place unit into unoccupied mode. Provide 30 minute (adjustable) delay before allowing unit to restart. Freezestat alarms shall require acknowledgement at the operators terminal.

7. OCCUPIED MODE

a. SYSTEM START: During the occupied cycle, AHU-2 supply fan and EF-3 shall run continuously. Two position motorized dampers in the outdoor air duct and in the exhaust air discharge duct from ERU-2 shall open. The following shall become enabled to be controlled by the discharge air controller: SF-2, two position dampers in the outdoor air ducts to and from ERU-2 and hot water and chilled water control valves.

b. SUPPLY AIR TEMPERATURE CONTROL: AHU-2 shall have its supply air temperature maintained by a discharge air temperature controller. The setpoint of the discharge air controller shall be reset by a space temperature sensor as required to maintain space temperature. When the discharge air temperature falls below its setpoint and with AHU-3, AHU-4 & AHU-5 operating on minimum outdoor air, ERU-2 shall be activated by opening the two position dampers in the outdoor air ducts to and from ERU-2 and by starting SF-2. On a continued fall in the discharge air temperature, the main outdoor air damper at the louver shall be modulated closed until all of the minimum outdoor airflow is through ERU-2. ERU-2 shall be operated to maintain the lowest outdoor air temperature required by the discharge air controllers in AHU-2, AHU-3, AHU-4 & AHU-5, down to a minimum temperature of 55F. On a continued fall in discharge air temperature, the heating coil valve shall be modulated open to the coil.

c. CHILLED WATER COOLING: When the discharge air temperature continues to rise above its setpoint, with the heating coil valve closed and ERU-2 de-activated, the

REPLACE PER ADDENDUM 1 (SEE FOLLOWING PAGE)

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**Delete** Paragraphs 3.5.B.7.a, b & c.

**Replace with** Paragraphs 3.5.B.7.a, b & c as follows:

a. SYSTEM START: During the occupied cycle, AHU-2 supply fan and EF-3 shall run continuously. Two position motorized dampers in the outdoor air duct (at the outdoor air louver and unit inlet) and in the exhaust air discharge duct from ERU-2 shall open. The hot water and chilled water control valves shall become enabled to be controlled by the discharge air controller.

b. SUPPLY AIR TEMPERATURE CONTROL: AHU-2 shall have its supply air temperature maintained by a discharge air temperature controller. The setpoint of the discharge air controller shall be reset by a space temperature sensor as required to maintain space temperature. On a fall in discharge air temperature, the heating coil valve shall be modulated open to the coil.

c. CHILLED WATER COOLING: When the discharge air temperature rises above its setpoint, with the heating coil valve closed, the chilled water coil valve shall be modulated open to the coil to maintain the discharge air temperature setpoint. Chilled water cooling shall be locked out when outside air temperature is less than 50°F (adjustable),

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**Delete** Paragraphs 3.5.C.2 & 3.

**Replace with** Paragraphs 3.5.C.2 & 3 as follows:

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2. Systems AHU-3, AHU-4, AHU-5 shall operate simultaneously with AHU-2.
3. Each system start shall be hard wired to open the two position damper in the main outdoor air duct (at the outdoor air louver) and the two position exhaust air damper in the discharge from ERU-2; start the air handling unit supply fan, associated return fan and EF-4 & EF-5 and enable the following: modulating mixing box dampers for return air and outdoor air; modulating exhaust air damper and the hot water and chilled water coil valves.

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chilled water coil valve shall be modulated open to the coil to maintain the discharge air temperature setpoint. Chilled water cooling shall be locked out when outside air temperature is less than 50°F (adjustable), or the system is off or in an alarm condition (no fan flow, freezestat trip, etc

d. HUMIDIFICATION CONTROL: Whenever the relative humidity in the exhaust air stream from the photography area on Level 1 falls below 35% (adj.), the control valve on steam humidifier HUM-2 shall be modulated open to maintain the exhaust air humidity setpoint. A high limit humidistat, downstream of the humidifier shall limit the downstream humidity to 90% (adj). Humidifier control valve shall be fully closed whenever AHU-2 is shut off or whenever airflow at the humidifier is interrupted.

8. UNOCCUPIED MODE

a. AHU-2 shall be cycled using 100% recirculated air to maintain an unoccupied (set-back) space heating temperature setpoint and an unoccupied (set-up) space temperature cooling set-point.

b. Whenever the system is off during unoccupied mode, or during a power outage or equipment failure, all outside air and all exhaust air dampers shall close fully (fail closed); air handling unit supply fan shall be off and the AHU heating and chilled water coil valves shall be full open to the coil (fail open).

9. POINTS: See attached points list.

C. AHU-3, AHU-4 & AHU-5 (CONSTANT VOLUME SINGLE ZONE SYSTEMS SERVING LEVEL 1)

1. System Start/Stop (Occupied/Unoccupied) functions shall be controlled by a single DDC output using relays to provide switching as required.

REPLACE PER ADDENDUM 1 1/28/02 AT (SEE PREVIOUS PAGE)

2. Systems AHU-3, AHU-4, AHU-5 & EF-3 shall operate simultaneously with AHU-2 but shall be capable of individual operation to allow for extended occupancy of building areas served by each system.

3. Each system start shall be hard wired to open the two position damper in the main outdoor air duct (at the outdoor air louver) and the two position exhaust air damper in the discharge from ERU-2; start the air handling unit supply fan, associated return fan and EF-3 and enable the following: modulating mixing box dampers for return air and outdoor air; modulating exhaust air damper; two

position dampers in the outdoor air duct to and from ERU-2; and the hot water and chilled water coil valves.

4. System stop shall be hard wired to close all outdoor air and exhaust air dampers; open mixing box dampers to full return air (0% OA) position; stop all air handling units, return fans and EF-2; open the hot water and chilled water coil valves full to coil. Units, dampers, valves, and accessories shall fail to the system stop condition upon loss of power or other abnormal condition.

   a. Freezestats shall utilize system stop to shut down units.

   b. Smoke detectors shall utilize system stop to shut down units. Smoke detectors shall be provided by division 16, installed in the ducts by the sheet metal contractor, and wired to stop units in accordance with NFPA 90A and local codes by the automatic temperature control contractor.

   c. Failure of any fan shall shut system down.

5. Provide Occupied/Unoccupied/Auto switch on air handling system control panel to manually switch each system between occupied, unoccupied and automatic(DDC system) modes. Manual override of any air handling system shall be clearly indicated at the operators terminal. Manual On/Off control shall be by system start/stop relay specified above.

6. HOT WATER COIL FREEZE PROTECTION

   a. Freeze protection thermostats shall be located immediately downstream of each AHU heating coil (first coil in the airstream).

   b. Automatic reset freezestats shall be hard wired through the start/stop relay to stop each air handling unit supply fan and return fan, close all outside air and exhaust air dampers, fully open heating coil and chilled water coil valves to coil, and alarm the DDC system when any part of the discharge airstream drops below 40°F(adj.).

   c. Freezestat alarm shall place unit into unoccupied mode. Provide 30 minute (adjustable) delay before allowing unit to restart. Freezestat alarms shall require acknowledgement at the operators terminal.

7. OCCUPIED MODE

   a. SYSTEM START: During the occupied cycle, the supply and return fans in AHU-3 and AHU-4; AHU-5 and RF-3; and EF-3, EF-4 & EF-5 shall run continuously. Two position motorized dampers in the outdoor air duct and in

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**Delete** Paragraphs 3.5.C.7.a, b, c & d.

**Replace with** Paragraphs 3.5.C.7.a, b, c & d as follows:

a. SYSTEM START: During the occupied cycle, the supply and return fans in AHU-3 and AHU-4; AHU-5 and RF-3; and EF-4 & EF-5 shall run continuously. Two position motorized dampers in the outdoor air duct (at the outdoor air louver) and in the exhaust air discharge duct from ERU-2 shall open. The following shall become enabled to be controlled by the discharge air controller: modulating dampers in the mixing boxes of each air handling unit and in the exhaust air duct from each unit; hot water and chilled water control valves.

b. SUPPLY AIR TEMPERATURE CONTROL: Each AHU shall have its supply air temperature maintained by a discharge air temperature controller. The setpoint of each discharge air controller shall be reset by an associated space temperature sensor as required to maintain space temperature. When the discharge air temperature falls below its setpoint, the mixing box dampers shall be modulated closed to the minimum outdoor air position. On a continued fall in discharge air temperature in any air handling unit, the associated heating coil valve shall be modulated open to the coil. When the discharge temperature rises above its setpoint, the system shall be modulated up to 100% outside air as described under economizer control, with the heating coil valve closed and ERU-2 de-activated. Reset schedules, max/min setpoints and ratio shall be easily adjustable from the operator's terminal without programming.

c. ECONOMIZER CONTROL: When the discharge air temperature rises above its setpoint, the economizer control shall be implemented by modulating the mixing box outdoor air dampers open, the return air dampers closed and the exhaust air dampers open to maintain discharge air temperature setpoint. Whenever the modulating exhaust air damper on AHU-3, 4 or 5 is opened, the two position exhaust air damper near the exhaust louver shall open. A low limit control in the mixed air stream shall prevent mixed air temperature from falling below 55F (adj). When the total energy of the outdoor air exceeds the total energy of the return air, the system shall be returned to minimum outside air operation by closing the mixing box outdoor air dampers to their minimum position, opening the return air dampers and closing the exhaust air dampers and ERU-2 shall be energized.

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d. CHILLED WATER COOLING: When the discharge air temperature continues to rise above its setpoint, with the economizer control operating the system at 100% outdoor air, the chilled water coil valve shall be modulated open to the coil to maintain the discharge air temperature setpoint. Chilled water cooling shall be locked out when outside air temperature is less than 50°F (adjustable).

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the exhaust air discharge duct from ERU-2 shall open. The following shall become enabled to be controlled by the discharge air controller: SF-2, two position dampers in the outdoor air ducts to and from ERU-2 and modulating dampers in the mixing boxes of each air handling unit and in the exhaust air duct from each unit; hot water and chilled water control valves.

b. SUPPLY AIR TEMPERATURE CONTROL: Each AHU shall have its supply air temperature maintained by a discharge air temperature controller. The setpoint of each discharge air controller shall be rest by an associated space temperature sensor as required to maintain space temperature. When the discharge air temperature falls below its setpoint, the mixing box dampers shall be modulated closed to the minimum outdoor air position. On a continued fall in discharge temperature, with all three air handling units operating on minimum outdoor air, ERU-2 shall be activated by opening the two position dampers in the outdoor air ducts to and from ERU-2 and by starting SF-2. On a continued fall in the discharge air temperature, the main outdoor air damper at the louver shall be modulated closed until all of the minimum outdoor airflow is through ERU-2. ERU-2 shall be operated to maintain the lowest outdoor air temperature required by the discharge air controller in any air handling unit, down to a minimum temperature of 55F. On a continued fall in discharge air temperature in any air handling unit, the associated heating coil valve shall be modulated open to the coil. When the discharge temperature rises above its setpoint, the system shall be modulated up to 100% outside air as described under economizer control, with the heating coil valve closed and ERU-2 de-activated. Reset schedules, max/min setpoints and ratio shall be easily adjustable from the operator's terminal without programming.

c. ECONOMIZER CONTROL: When the discharge air temperature rises above its setpoint, the economizer control shall be implemented by modulating the mixing box outdoor air dampers open, the return air dampers closed and the exhaust air dampers open to maintain discharge air temperature setpoint. A low limit control in the mixed air stream shall prevent mixed air temperature from falling below 55F (adj). When the total energy of the outdoor air exceeds the total energy of the return air, the system shall be returned to minimum outside air operation by closing the mixing box outdoor air dampers to their minimum position, opening the return air dampers and closing the exhaust air dampers.

REPLACE PER ADDENDUM 1

d. CHILLED WATER COOLING: When the discharge air temperature continues to rise above its setpoint, with the economizer control operating the system at 100% outdoor air, the chilled water coil valve shall be modulated open to the coil to maintain the discharge air temperature setpoint. Chilled water cooling shall be locked out when outside air temperature is less than 50°F (adjustable), or the system is off or in an alarm condition (no fan flow, freezestat trip, etc

e. HUMIDIFICATION CONTROL: Whenever the relative humidity in the associated return air stream falls below 35% (adj.), the control valve on associated steam humidifier (HUM-3 in AHU-3, HUM-4 in AHU-4 & HUM-5 in AHU-5) shall be modulated open to maintain the return air humidity setpoint. A high limit humidistat, downstream of the humidifier, shall limit the downstream humidity to 90% (adj). Humidifier control valve shall be fully closed whenever associated AHU is shut off or whenever airflow at the humidifier is interrupted.

ADD PARAGRAPH

8. UNOCCUPIED MODE

a. Each system shall be cycled using 100% recirculated air to maintain an unoccupied (set-back) space heating temperature setpoint and an unoccupied (set-up) space temperature cooling set-point.

b. Whenever the system is off during unoccupied mode, or during a power outage or equipment failure, all outside air and all exhaust air dampers shall close fully (fail closed); all air handling unit supply and return fans shall be off; the AHU heating and chilled water coil valves shall be full open to the coil (fail open); and the mixing box return air dampers shall be fully open.

9. POINTS: See attached points list.

D. AHU-6 (CONSTANT VOLUME SINGLE ZONE BACK-UP SYSTEM SERVING LEVEL 4 AREAS)

1. This system serves as back-up HVAC system for the Dispatch Area and is intended to operate only when AHU-1A & 1B are inoperative. Two position dampers in the main supply air and return ducts shall be sequenced to allow the building area to be served by either AHU-iA & 1B or AHU-6.

2. System Start/Stop (Occupied/Unoccupied) functions shall be controlled by a single DDC output using relays to provide switching as required.

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**Add** Paragraph 3.5.C.7.f. as follows:

f. ERU-2 CONTROL: ERU-2 shall be controlled by the discharge air controllers of AHU-3, 4 & 5. The discharge controller calling for the lowest discharge temperature shall control ERU-2 as follows: With all three AHU's operating at 100% outdoor air, when the discharge temperature in the unit with the lowest discharge temperature setpoint falls below that setpoint, before that unit outdoor air/return air/exhaust air dampers are modulated to reduce the outdoor air quantity, ERU-2 shall be energized by opening the two position dampers in the outdoor air ducts to and from ERU-2 and starting SF-2 at minimum speed. SF-2 fan speed shall be varied up to full speed to maintain the lowest discharge air temperature setpoint. On a continued fall in discharge air temperature after SF-2 is at maximum speed, the unit outdoor air/ return air/exhaust air dampers shall be modulated to reduce outdoor air quantity. When the outdoor air dampers on all three AHU's (AHU-3, 4 &5) are at the minimum position, the two position damper in the main outdoor air at the louver shall be closed so that all outdoor air flows through ERU-2.

With all three AHU's operating at minimum outdoor air and SF-2 at maximum speed, when the discharge temperature in the unit with the lowest discharge temperature setpoint rises above that setpoint, the unit outdoor air/return air/exhaust air dampers shall be modulated to admit more outdoor air and the two position damper in the main outdoor air duct at the louver shall be opened. On a continued rise in the discharge temperature after the unit outdoor air damper is 100% open, fan SF-2 speed shall be reduced to minimum. On a continued rise in discharge temperature after SF-2 is at minimum speed, SF-2 shall be stopped and the two position dampers in the outdoor air ducts to and from ERU-2 shall be closed.

Whenever AHU-3, 4 & 5 are switched from 100% outdoor air to minimum outdoor air by the enthalpy control during the cooling season, ERU-2 shall be activated by opening the two position dampers in the outdoor air ducts to and from ERU-2, starting fan SF-2 and closing the two position damper in the main outdoor air duct at the louver.

3. System start shall be hard wired to close two position dampers in the main supply and return ducts from AHU-1A & 1B and open two position dampers in the main supply and return ducts from AHU-6; open the two position damper in the main outdoor air duct; start the air handling unit supply fan, associated return fan RF-2 and enable the following: modulating mixing box dampers for return air and outdoor air; modulating exhaust air damper; hot water coil valve and condensing unit CU-1.

4. System stop shall be hard wired to close two position dampers in the main supply and return ducts from AHU-6 and open two position dampers in the main supply and return ducts from AHU-1A & 1B; close all outdoor air and exhaust air dampers; open mixing box dampers to full return air (0% OA) position; stop all air handling unit and return fan; open the hot water coil valve full to coil and shut down condensing unit. Units, dampers, valves, and accessories shall fail to the system stop condition upon loss of power or other abnormal condition.

   a. Freezestats shall utilize system stop to shut down units.

   b. Failure of any fan shall shut system down.

5. Provide Occupied/Unoccupied/Auto switch on air handling system control panel to manually switch each system between occupied, unoccupied and automatic(DDC system) modes. Manual override of any air handling system shall be clearly indicated at the operators terminal. Manual On/Off control shall be by system start/stop relay specified above.

6. HOT WATER COIL FREEZE PROTECTION

   a. Freeze protection thermostats shall be located immediately downstream of each AHU heating coil.

   b. Automatic reset freezestats shall be hard wired through the start/stop relay to stop each air handling unit supply fan and return fan, close all outside air and exhaust air dampers, fully open heating coil and chilled water coil valves to coil, and alarm the DDC system when any part of the discharge airstream drops below 40°F(adj.).

   c. Freezestat alarm shall place unit into unoccupied mode. Provide 30 minute (adjustable) delay before allowing unit to restart. Freezestat alarms shall require acknowledgement at the operators terminal.

7. OCCUPIED MODE

   a. SYSTEM START: During the occupied cycle, the supply fan in AHU-6 and return fan RF-2 shall run continuously.

Two position motorized damper in the outdoor air duct shall open. The following shall become enabled to be controlled by the discharge air controller: modulating dampers in the mixing box and in the exhaust air duct; hot water control valves and condensing unit CU-1.

b. SUPPLY AIR TEMPERATURE CONTROL: AHU shall have its supply air temperature maintained by a discharge air temperature controller. The setpoint of each discharge air controller shall be rest by an associated space temperature sensor as required to maintain space temperature. When the discharge air temperature falls below its setpoint, the mixing box dampers shall be modulated closed to the minimum outdoor air position. On a continued fall in discharge air temperature, with outdoor air temperature above 40F (adj.), the face damper shall be full open to the coil and the heating coil valve shall be modulated open to the coil. When outdoor temperature is below 40F (adj.), the heating coil valve shall be full open to the coil and the face and bypass damper shall be modulated to maintain discharge temperature. When the discharge temperature rises above its setpoint, the system shall be modulated up to 100% outside air as described under economizer control, with the heating coil valve closed.

c. ECONOMIZER CONTROL: When the discharge air temperature rises above its setpoint, the economizer control shall be implemented by modulating the mixing box outdoor air dampers open, the return air dampers closed and the exhaust air dampers open to maintain discharge air temperature setpoint. A low limit control in the mixed air stream shall prevent mixed air temperature from falling below 55F (adj). When the total energy of the outdoor air exceeds the total energy of the return air, the system shall be returned to minimum outside air operation by closing the mixing box outdoor air dampers to their minimum position, opening the return air dampers and closing the exhaust air dampers.

d. MECHANICAL COOLING: When the discharge air temperature continues to rise above its setpoint, with the economizer control operating the system at 100% outdoor air, the condensing unit shall be energized to maintain the discharge air temperature setpoint. The condensing unit shall be locked out when outside air temperature is less than 50°F (adjustable), or the system is off or in an alarm condition (no fan flow, freezestat trip, etc

8. UNOCCUPIED MODE

**Add** Paragraph 3.5.E.4. as follows:
ADDENDUM 1 1/28/02 AT

4. Exhaust fan EF-3 shall be interlocked with AHU-2 and shall operate continuously whenever AHU-2 is in the occupied mode. A two position motorized damper in the discharge from ERU-2 shall be open whenever fan is energized.

a. AHU-6 shall be shut down and the building area connected to AHU-1A & 1B during unoccupied periods.

9. POINTS: See attached points list.

E. EXHAUST FANS

1. Exhaust fan EF-4 shall be interlocked with AHU-4 and shall operate continuously whenever AHU-4 is in the occupied operating mode. A two position motorized damper in the discharge duct from EF-4 shall be open whenever fan is energized.

2. Exhaust fan EF-5 shall be interlocked with AHU-3 and shall operate continuously whenever AHU-3 is in the occupied operating mode. A two position motorized damper in the discharge duct from EF-5 shall be open whenever fan is energized.

3. Exhaust fan EF-6: A space temperature sensor (also controlling UH-3 & UH-4) shall open the two position outdoor air and exhaust air dampers and energize EF-6 whenever space temperature rises above its setpoint (80F adj).

ADD PARAGRAPH

F. VARIABLE AIR VOLUME BOX WITH DUCT HEATING COIL OPERATED AT CONSTANT VOLUME FOR MAKE-UP AIR

1. VAV box controller shall modulate duct heating coil valve open whenever space temperature falls below setpoint.

2. Points: See attached points list.

G. VARIABLE AIR VOLUME BOX WITH DUCT HEATING COIL AND FIN TUBE RADIATION

1. VAV box controller shall modulate VAV box dampers between minimum and maximum CFM, as scheduled on the drawings, heating coil valve, and fin tube radiation valve in sequence to maintain space temperature setpoint as follows:

2. When space temperature is less than setpoint, modulate VAV box damper closed to minimum position. If space temperature continues to fall below setpoint, modulate associated VAV box duct heating coil valve and fin tube radiation valve open.

3. When space temperature exceeds setpoint, modulate VAV box duct heating coil and fin tube radiation valves closed, then modulate VAV box damper open to maintain space temperature at the occupied setpoint.

4. Points: See attached points list.

H. HEATING HOT WATER PUMPS (HWP-1 & HWP-2)

1. HWP-1 & HWP-2 shall operate in parallel. One pump shall be energized at 65F (adj.) and the second pump at 20F (adj.). The failure of the lead pump shall automatically energize the lag pump and alarm the DDC system. The lead pump shall be alternated on an annual basis (adj.).

2. The failure of the lead pump to operate shall automatically energize the lag pump and alarm the DDC system. The lead pump shall be alternated on an annual basis (adj.).

I. CHILLED WATER SYSTEM (ADD PARAGRAPH) →

1. Chiller

   a. The air cooled chiller shall be enabled whenever OA is 50°F or higher (adj.).

   b. Integrate building ATC system into control package provided by chiller manufacturer for chiller.

   c. Chilled water discharge setpoint shall be reset from 45°F to 50°F (adj.) as outside air temperature varies from 90°F to 65°F (adj.). Override discharge setpoint to obtain colder supply water if any of the served AHU's can not cool down to their discharge air temperature setpoint and whenever AHU-1A & AHU-1B are in the dehumidification cyle.

2. Chilled Water Pumps (CHWP-1 CHWP-2)

   a. CHWP-1 & CHWP-2 operate individually, with the second pump serving as back-up. The lead pump shall be operating before the chiller is energized. The failure of the lead pump shall automatically energize the lag pump and alarm the DDC system. The lead pump shall be alternated on an annual basis (adj.).

J. FIN TUBE RADIATION

1. Room temperature sensors shall open or close 2 position valve serving fin tube or convector in that space to maintain space at the occupied and unoccupied setpoint.

2. Points: Two analog input points and one digital output for each room temperature sensor:

   a. Space temperature input

   b. Space setpoint dial input

**Add** Paragraph 3.5.H. as follows:

ADDENDUM 1/30/02 AT

H. HEATING HOT WATER SYSTEM

1. The three existing boilers shall operate from their existing operating and safety controls.

2. Provide relays in the control circuits of each boiler to disable the boilers at outdoor temperatures above 60F (adj.).

3. New boiler injection pumps (BP-1, BP-2 & BP-3) shall be energized whenever associated existing boiler is firing.

4. HWP-1 & HWP-2 shall operate in parallel. One pump shall be energized at 65°F (adj.) and the second pump at 20°F (adj.). The failure of the lead pump shall automatically energize the lag pump and alarm the DDC system. The lead pump shall be alternated on an annual basis (adj.).

5. Hot water supply temperature shall be reset from outdoor air temperature to provide 200°F water at 0°F outdoor air and 140°F at 60°F outdoor air.

6. Points: See attached points list.

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**Add** Paragraphs 3.5.L, M & N as follows:

L. STEAM HUMIDIFICATION SYSTEM

1. Existing steam boiler shall operate from its existing operating and safety controls,

2. Connect new boiler feed pump BFP-1 to operate from

ADDENDUM 1
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existing water level control on boiler.

3. Provide relays in the control circuits of each boiler to disable the boilers at outdoor temperatures above 60F (adj.).

4. Points: See attached points list.

M. COMPUTER ROOM SYSTEM

1. Computer room system CRAC-1 with remote drycooler and glycol pump shall be controlled by its integral temperature and humidity controls. System shall be manually started and stopped and shall run continuously.

2. Provide control wiring as required to connect CRAC-1 unit with remote drycooler, pump(s), flow switches etc as furnished by the equipment manufacturer.

3. Points: See attached points list.

N. DOMESTIC HOT WATER SYSTEM

1. Existing domestic hot water boiler and recirculating pump shall operate from its existing operating and safety controls.

2. Points: See attached points list.

c. Fin tube valve output.

K. UNIT HEATERS & CABINET HEATERS

1. Unit heaters shall be controlled by two position electric valves controlled by electric space thermostats.

2. Provide strap on aquastat set at 110°F (adj.) to prevent fan operation when hot water is not available or valve is closed.

ADD PARAGRAPHS PER ADDENDUM 1

END OF SECTION

ADD PARAGRAPH
ADDENDUM 2 1/29/02 AT

Add **Paragraph 3.5.O. as follows:**

O. PACKAGED ROOFTOP AIR CONDITIONING UNIT AC-T1

1. Packaged rooftop air conditioning unit AC-T1 shall be controlled by its integral temperature controls.
2. Provide control wiring, relays, etc as required to connect remote space programmable sensor and to interlock exhaust fan EF-T1. EF-T1 shall run whenever AC-T1 in operating in the occupied mode.

3 ATC POINTS LISTS ADDED PER ADDENDUM 2 1/29/02 AT

**MAINE DOT**

# ATC POINTS LIST

| | POINT | TYPE I/O | AHU-1A&1B D | AHU-1A&1B A | AHU-2 D | AHU-2 A | AHU-3 D | AHU-3 A | AHU-4 D | AHU-4 A | AHU-5 D | AHU-5 A | AHU-6 D | AHU-6 A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **DDC INPUTS** | | | | | | | | | | | | | |
| 1 | OA Temp | I | | 1 | | 1 | | | | | | | | |
| 2 | OA RH | I | | 1 | | 1 | | | | | | | | |
| 3 | Mixed Air Temp | I | | 2 | | | | 1 | | 1 | | 1 | | 1 |
| 4 | ERU SA Temp | I | | | | | | | | | | | | |
| 5 | Supply Fan Flow Status | I | 2 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| 6 | Return Fan Flow Status | I | 2 | | | | 1 | | 1 | | 1 | | 1 | |
| 7 | Exhaust Fan Flow Status | I | 2 | | 3 | | | | | | | | | |
| 8 | Discharge Air Temp Limit | I | | | | 1 | | | | | | | | |
| 9 | Discharge Air Temp | I | | 2 | | 1 | | 1 | | 1 | | 1 | | 1 |
| 10 | Return Air Temp | I | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 |
| 11 | Return Air RH | I | | 1 | | 1 | | 1 | | 1 | | 1 | | 1 |
| 12 | Space CO2 | I | | | | | | | | | | | | |
| 13 | Traq Damper | I | | 2 | | | | | | | | | | |
| 14 | Hood switch | I | | | | | | | | | | | | |
| 15 | Space zone sensor | I | | 98 | | 1 | | 1 | | 1 | | 1 | | 1 |
| 16 | Zone setpoint dial | I | | 98 | | 1 | | 1 | | 1 | | 1 | | 1 |
| 17 | Unocc. Override Button | I | 4 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| 18 | VAV CFM | I | | 98 | | | | | | | | | | |
| 19 | Boiler Temperature | I | | | | | | | | | | | | |
| 20 | Heating Loop S.W.T. | I | | | | | | | | | | | | |
| 21 | Heating Loop R.W.T. | I | | | | | | | | | | | | |
| 22 | DHW Aquastat | I | | | | | | | | | | | | |
| 23 | Pump proof of flow | I | | | | | | | | | | | | |
| | **DDC OUTPUTS** | | | | | | | | | | | | | |
| 24 | System Start/Stop | O | 2 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| 25 | Mixing Box Dampers | O | | 2 | | | | 1 | | 1 | | 1 | | 1 |
| 26 | Econ. Exhaust Dampers | O | | 2 | | | | 1 | | 1 | | 1 | | 1 |
| 27 | Supply Fan VFD | O | | 2 | | | | | | | | | | |
| 28 | Exhaust Fan VFD | O | | 2 | | | | | | | | | | |
| 29 | Exhaust Fan Start/Stop | O | 1 | | 1 | | 1 | | 1 | | 1 | | | |
| 30 | Alarm output | O | 1 | | 1 | | 1 | | 1 | | 1 | | 1 | |
| 31 | Heating Coil valve | O | | 2 | | 1 | | 1 | | | | 1 | | 1 |
| 32 | Face & bypass dampers | O | | | | | | | | | | | | 1 |
| 33 | DX stage | O | | | | | | | | | | | | 1 |
| 34 | Chilled Water Coil valve | O | | | | 1 | | 1 | | 1 | | 1 | | 1 |
| 35 | Humidifier Valve | O | | 2 | | 1 | | 1 | | 1 | | 1 | | |
| 36 | VAV damper position | O | | 98 | | | | | | | | | | |
| 37 | Traq Damper | O | | 2 | | | | | | | | | | |
| 38 | VAV Coil Valve | O | | 60 | | | | | | | | | | |
| 39 | Pump start/stop | O | | | | | | | | | | | | |
| 40 | Spare | O | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **AHU TOTAL** | | 15 | 477 | 9 | 12 | 7 | 12 | 7 | 11 | 7 | 12 | 6 | 3 |
| | **TOTAL** | | 44 | | Digital | | 515 | | Analog | | | | | |

| LEGEND | | | |
|---|---|---|---|
| A | Analog | SWT | Supply Water Temperature |
| D | Digital | RWT | Return Water Temperature |
| I | Input | VFD | Variable Frequency Drive |
| O | Output | | |

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# ATC POINTS LIST

| | POINT | TYPE I/O | CHW SYS D | CHW SYS A | HW SYS D | HW SYS A | DOM HW D | DOM HW A | STM HUM D | STM HUM A | CRAC-1 D | CRAC-1 A |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **DDC INPUTS** | | | | | | | | | | | |
| 1 | OA Temp | I | | 1 | | 1 | | | | 1 | | |
| 2 | OA RH | I | | | | | | | | | | |
| 3 | Mixed Air Temp | I | | | | | | | | | | |
| 4 | ERU SA Temp | I | | | | | | | | | | |
| 5 | Supply Fan Flow Status | I | | | | | | | | | 1 | |
| 6 | Return Fan Flow Status | I | | | | | | | | | | |
| 7 | Exhaust Fan Flow Status | I | | | | | | | | | | |
| 8 | Discharge Air Temp Limit | I | | | | | | | | | | |
| 9 | Discharge Air Temp | I | | | | | | | | | | |
| 10 | Space Temp | I | | | | | | | | | | 1 |
| 11 | Space RH | I | | | | | | | | | | 1 |
| 12 | Space CO2 | I | | | | | | | | | | |
| 13 | Damper prove open | I | | | | | | | | | | |
| 14 | AHU-1A&1B Dehum. | I | 1 | | | | | | | | | |
| 15 | AHU Disch. Temp | I | | 7 | | | | | | | | |
| 16 | CHW SWT | I | | 1 | | | | | | | | |
| 17 | CHW RWT | I | | 1 | | | | | | | | |
| 18 | VAV CFM | I | | | | | | | | | | |
| 19 | Boiler Flame Failure | I | | | 3 | | 1 | | 1 | | | |
| 20 | Heating Loop S.W.T. | I | | | | 1 | | | | | | |
| 21 | Heating Loop R.W.T. | I | | | | 1 | | | | | | |
| 22 | DHW Aquastat | I | | | | | | 1 | | | | |
| 23 | Pump proof of flow | I | | | 5 | | | | | | | |
| | **DDC OUTPUTS** | | | | | | | | | | | |
| 24 | System Start/Stop | O | | | | | | | | | | |
| 25 | Mixing Box Dampers | O | | | | | | | | | | |
| 26 | Econ. Exhaust Dampers | O | | | | | | | | | | |
| 27 | Supply Fan VFD | O | | | | | | | | | | |
| 28 | Exhaust Fan VFD | O | | | | | | | | | | |
| 29 | Exhaust Fan Start/Stop | O | | | | | | | | | | |
| 30 | Alarm output | O | 1 | | 1 | | 1 | | 1 | | 1 | |
| 31 | Heating Coil valve | O | | | | | | | | | | |
| 32 | Face & bypass dampers | O | | | | | | | | | | |
| 33 | DX stage | O | | | | | | | | | | |
| 34 | Chilled Water Coil valve | O | | | | | | | | | | |
| 35 | Humidifier Valve | O | | | | | | | | | | |
| 36 | VAV damper position | O | | | | | | | | | | |
| 37 | Chilled Water Temp | O | | 1 | | | | | | | | |
| 38 | Heating HW Temp | O | | | | 1 | | | | | | |
| 39 | Pump start/stop | O | 2 | | | | | | | | | |
| 40 | Spare | O | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| | **EQUIP TOTAL** | | 5 | 12 | 10 | 5 | 3 | 2 | 3 | 2 | 3 | 3 |
| | **TOTAL** | | 21 | | Digital | | 22 | | Analog | | | |

**LEGEND**

| | |
|---|---|
| A | Analog |
| D | Digital |
| I | Input |
| O | Output |

| | |
|---|---|
| SWT | Supply Water Temperature |
| RWT | Return Water Temperature |
| VFD | Variable Frequency Drive |

**MAINE DOT**

# ATC POINTS LIST

| | POINT | TYPE I/O | ERU-1 SYS D | ERU-1 SYS A | ERU-2 SYS D | ERU-2 SYS A |
|---|---|---|---|---|---|---|
| | **DDC INPUTS** | | | | | |
| 1 | OA Temp | I | | | | |
| 2 | OA RH | I | | | | |
| 3 | Mixed Air Temp | I | | | | |
| 4 | ERU SA Temp | I | | 1 | | 1 |
| 5 | Supply Fan Flow Status | I | 1 | | 1 | |
| 6 | Return Fan Flow Status | I | | | | |
| 7 | Exhaust Fan Flow Status | I | | | | |
| 8 | Discharge Air Temp Limit | I | | | | |
| 9 | Discharge Air Temp | I | | 1 | | 3 |
| 10 | Return Air Temp | I | | | | |
| 11 | Return Air RH | I | | | | |
| 12 | Space CO2 | I | | | | |
| 13 | Damper prove open | I | | | | |
| 14 | Hood switch | I | | | | |
| 15 | Space zone sensor | I | | | | |
| 16 | Zone setpoint dial | I | | | | |
| 17 | Unocc. Override Button | I | | | | |
| 18 | VAV CFM | I | | | | |
| 19 | Boiler Temperature | I | | | | |
| 20 | Heating Loop S.W.T. | I | | | | |
| 21 | Heating Loop R.W.T. | I | | | | |
| 22 | Enthalpy Control | I | 1 | | 1 | |
| 23 | Mixing Box Dampers | I | | | | 3 |
| | **DDC OUTPUTS** | | | | | |
| 24 | System Start/Stop | O | 1 | | 1 | |
| 25 | Mixing Box Dampers | O | | | | |
| 26 | Econ. Exhaust Dampers | O | | | | |
| 27 | Supply Fan VFD | O | | | | 1 |
| 28 | Exhaust Fan VFD | O | | | | |
| 29 | Exhaust Fan Start/Stop | O | | | | |
| 30 | Alarm output | O | 1 | | 1 | |
| 31 | Heating Coil valve | O | | | | |
| 32 | Face & bypass dampers | O | | | | |
| 33 | DX stage | O | | | | |
| 34 | Chilled Water Coil valve | O | | | | |
| 35 | Humidifier Valve | O | | | | |
| 36 | VAV damper position | O | | | | |
| 37 | Zone valve | O | | | | |
| 38 | VAV Coil Valve | O | | | | |
| 39 | Pump start/stop | O | | | | |
| 40 | Spare | O | 1 | 1 | 1 | 1 |
| | **EQUIP TOTAL** | | 5 | 3 | 5 | 9 |
| | **TOTAL** | | 10 | Digital | 3 | Analog |

| LEGEND | | | |
|---|---|---|---|
| A | Analog | SWT | Supply Water Temperature |
| D | Digital | RWT | Return Water Temperature |
| I | Input | VFD | Variable Frequency Drive |
| O | Output | | |

SECTION 15990

TESTING, ADJUSTING, AND BALANCING AIR AND WATER SYSTEMS

(FILED SUB-BID)

PART 1 GENERAL

1.1 QUALITY ASSURANCE

A. The Publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by the basic designation only.

B. Associated Air Balance Council (AABC):

1. 71679 National Standards for Field Measurements and Instrumentation, Total System Balance, Air Distribution - Hydronic Systems, Air Pollution, Sound, Vibration, 1979 Edition; 2nd Edition.

C. National Environmental Balancing Bureau (NEBB):

1. 1974 Procedural Standards for Testing - Balancing - Adjusting of Environmental Systems; 2nd Edition.

1.2 ACCEPTABLE TESTING AND BALANCING CONTRACTORS

A. The Contractor, as part of this contract, shall obtain the services of a qualified testing, adjusting, and balancing (TAB) organization to perform the testing and balancing work as herein specified. Prior to commencing work under this section of the specifications, the testing organization shall have been approved by the Architect.

B. The criteria for determining qualifications shall be membership in the AABC, or certification by the NEBB, or acceptable performance on past projects, in the experience of the architect. The agency shall also have an engineer, registered in the State of the project site, employed in the firm.

C. Architect Selection: If the Contractor fails to submit the name of an acceptable agency, the Architect may select a firm to accomplish the work, and the selection shall be binding upon the Contractor at no additional cost to the Owner.

1.3 GENERAL SCOPE OF SERVICES

A. Air system Balancing of existing air systems: After repairs to existing ductwork and controls are complete, measure airflow from existing supply diffusers, return and exhaust grills, AHU fans, Outside Air/Return Air percentage, Exhaust fans. Adjust balancing dampers, fan speed, etc. as

required to obtain air flows quantities indicated on the drawings in each room. Balance water systems as required so all new and existing equipment is served by adequate hot water flows.

B. Air and Water Systems Testing and Balancing of new systems: Upon completion of the installation and field testing, performance test and adjust the supply, return, outside air, and exhaust air systems, and heating water systems to provide the air volume and water flow quantities indicated and sound levels required. Accomplish all work in accordance with the agenda, procedures specified herein, AABC 71679, and standards of the NEBB. Correct air and water systems performance deficiencies disclosed by the test before balancing the systems.

1.4 SUBMITTALS

A. Submit in accordance with Section 15010 - General Requirements.

B. AGENDA: An agenda shall be submitted and approved by the Architect/Engineer at least one month prior to the start of testing and balancing work or project close out, which ever comes first. The agenda will be used by the engineer to help assure that the balancing contractor has complete and up to date information on the systems and equipment to be balanced. The final report shall not be accepted until the Agenda is received, reviewed, and approved by the architect/engineer. The submitted Agenda shall include the following:

1. Procedures: Provide specific test procedures to be used for measuring air quantities at fans, pumps, and terminals. Specify type of instrument to be used, method of instrument application (by sketch), and factors for:

   a. Air and water terminal configuration.

   b. Pressure measurements

   c. Flow direction (supply or exhaust).

   d. Velocity corrections.

   e. Effective area applicable to each size an type of air terminal. Area and Application Factors will not be required where air flow hoods or installed air measuring systems are employed to determine terminal capacity.

   f. Applicable density corrections (unless applicable data are covered elsewhere).

2. Preliminary Report: Review plans and specifications prior to installation of any of the specified systems. Submit a written report to the Architect indicating any deficiencies in the system

that would preclude the proper adjusting, balancing, and testing of the systems.

3. General description of each air and water system with its associated equipment, and operation cycles for heating, ventilation, and cooling. Where different cycles are used for day and night, they shall be described independently.

4. A complete listing of all air and water flow and air terminal measurements to be performed, with design air and water flows and pressures listed.

5. Specific test procedures and parameters for determining specified quantities; e.g., flow drafts, sound levels, etc., from the actual field measurements to establish compliance with contract requirements.

6. Samples of forms showing applications of procedures and calculations to typical systems.

C. BALANCING REPORT: The balancing report shall be submitted and approved by the Architect/Engineer at the completion of testing and balancing work. The submitted balancing report shall include the following:

1. Procedure Reporting: Include test procedures as approved in from the agenda specified above. Document specific approved test procedures used for measuring air and water quantities at fans, pumps, and terminals. Specify type of instruments used, and published accuracy each instrument.

2. Air and Water Flow Reports: An orderly listing of pumps, fans, and terminals measured shall be prepared, including the following:

   a. Equipment specifications as installed.

   b. Design air or water flow requirements.

   c. Design pressure ratings for fans and pumps.

   d. Actual operating air or water flows measured.

   e. Actual operating static pressures for fans and pumps.

   f. Adjustment Requirements: Report shall indicate what adjustments were made, including damper and valve positions, sheave adjustments, etc. to obtain design flows.

   g. If any specified flows or pressures are not obtainable, report shall indicate why.

1.5 TEST DURATION

A. Operating tests of heating and cooling coils, fans and other equipment shall be of not less than 4 hours duration, after stabilized operating conditions have been established. Capacities shall be based on temperatures and air and water quantities measured during such tests.

1.6 COORDINATION

A. The balancing contractor shall coordinate with the ATC contractor to set minimum and maximum flows on mixing box dampers, economizer exhaust fan, VAV boxes, and ERU fans.

B. The balancing contractor shall coordinate with the commissioning agent to ensure proper system function.

1.7 INSTRUMENTATION

A. Method of application of instrumentation shall be in accordance with the approved agenda. Furnish all personnel, instruments, and equipment for tests specified herein.

B. Accuracy of Instruments: Instruments used for measurements shall be accurate. Provide calibration histories for each instrument in the balancing reports. Calibrate each test instrument by an approved laboratory or by the manufacturer. The engineer has the right to request instrument recalibration, or the use of other instruments and test methodology, where accuracy of readings is questionable.

C. Application of Instruments: Comply with manufacturer's certified instructions.

D. Permanently-Installed Instruments: Do not install permanently - installed equipment used for the tests, e.g., gages, thermometers, etc., until just prior to the tests to avoid damage and changes in calibration.

E. Accuracy of All Thermometers: Plus or minus one graduation at the temperatures to be measured. Graduations shall conform with the following schedule:

| Medium to be Measured | Design Temperature Differential (°F) | Maximum Graduation (°F) |
|---|---|---|
| Air | 10° or less | 0.5 |
| Air | over 10° | 1.0 |
| Water | 10° or less | 0.1 |
| Water | 10 – 20° | 0.5 |
| Water | over 20° | 1.0 |

PART 2 PRODUCTS

NOT USED

PART 3 EXECUTION

3.1 AIR SYSTEM BALANCING PROCEDURES

A. Adjust all air handling systems to provide the required design air quantity to or through, each component. Obtain measurements and make adjustments in accordance with procedures specified by AABC or SMACNA. Conduct adjusting and balancing of systems while operating equipment at capacities approximating maximum seasonal operation.

B. Fan Adjustment: Total air system quantities, generally, shall be varied by adjustment of fan speeds. Where applicable, where fan capacity as designed is less than total flow requirements of individual terminals of system served (due to diversity), full flow in each branch may be simulated by the temporary restriction of flow to portions of the system. In such a case, delineate specific procedures in the agenda and balancing reports.

1. For systems with direct drive fans (without adjustable belt drives), solid state speed controller shall be used to adjust fan speed. Note adjustments made in the balancing report and clearly mark speed controller at balanced setting.

2. When the fan capacity as provided is less than or exceeds the specified design air flows, adjust the fan speed to obtain the specified design air flows as follows:

a. Adjust variable pitch sheaves. For motors 10 hp or greater, provide and install fixed pitch sheave after correct size has been determined during balancing, and turn over adjustable pitch sheave to owner.

b. When factory supplied sheaves or pulleys are not suitable to meet the air flows specified, the balancing contractor shall determine correct pulley and sheave sizes based on operating point observed, then supply and install correct pulleys and sheaves, then rebalance the fan system until specified performance is obtained, at no additional cost to owner. The balancing contractor shall carry the cost of one set of replacement sheaves for each belt driven fan.

c. If motor power or maximum fan speed limitations prevent satisfactory fan performance, the systems shall be balanced to meet the motor nameplate or maximum fan speed rating, and the balancing report shall clearly indicate the system limitations.

3. When no other adjustment mechanism is available, damper restrictions of a system's total flow may be used, only if system pressure is less than 1/2 inch w.g. and sound level criteria is met.

C. Cooling Coil Bypass

1. Balance DX coil bypass for air handling units equipped with dehumidification coils (AHU-1) to provide scheduled airflow through the DX dehumidification coil.
Bypass CFM = Total CFM - DX coil CFM.

2. Use measuring damper (Halton PRA) where provided and duct traverse where measuring damper is not available. Report setting of balancing damper and pressure loss through bypass.

D. Velocity Traverse: Make air velocity traverses using a pitot tube or hot wire anemometer of each main supply, return, outside air, and exhaust duct to measure air flow therein.

1. At a minimum, provide a velocity traverse and duct size measurement, converted to CFM, at each of the following locations:

   a. Supply Air from each AHU at maximum conditions.

   b. Return Air main branches into each AHU at minimum OA and maximum OA into each AHU.

   c. Outside Air at minimum OA and maximum OA into each AHU.

   d. Exhaust Air, at minimum OA and maximum OA into each AHU.

2. Pitot-tube traverse of main branch duct may be omitted if the duct serves only a single room or space and its design volume is less than 2000 CFM. In lieu of Pitot-tube traverse, determine air flow in the duct by totaling volume of individual terminals served, measured as described herein.

3. Test holes shall be in a straight duct, as far as possible downstream from elbows, bends, take-offs, and other turbulence generating devices, to optimize reliability of flow measurements. Where long runs of straight duct do not exist or are inaccessible, traverse shall be performed using enough points to obtain a reasonable average velocity. Note in report where traverse conditions may compromise the results. Poor traverse locations do not relieve contractor of responsibility for making and reporting traverse measurements. Plug each test hole with plastic plug and provide 25 extra (spare) plugs to owner when balancing is complete.

**Delete** entirely and replace with:
ADDENDUM 2 1/29/02 AT

1. Each AHU with a return fan shall be set up and balanced initially while operating with 100% outdoor air. The AHU shall then be operated with minimum outdoor air and the total supply air measured. Adjust return air damper blank off plates or return air damper maximum position as required to obtain the same total supply air quantity at minimum outdoor air as at 100% outdoor air.

E. Air Terminal Balancing

1. Measurements of flow rates by means of velocity meters or air flow hoods applied to individual terminals, with or without cones or other adapters, shall be used only for balancing. Measurement of air quantities at each type of air terminal (inlet and outlet) shall be determined by the method approved for balancing agenda.

2. Use flow adjusting (volume control) devices to balance air quantities only. Proportion flow between various terminals comprising system only to the extent that their adjustments do not create objectionable air motion or sound.

3. Equalizers: Adjust equalizing devices to provide uniform velocity across the inlets (duct side for supply air terminals) prior to measuring flow rates.

4. Balancing Between Runs (branch mains and branches): Use flow regulating devices at or in the divided - flow fittings. Minimize restriction imposed by flow regulating devices in or at terminals.

5. Final Measurements of Air Quantity: Make final measurements of air quantity, after the air terminal has been adjusted to provide the optimum patterns of diffusion.

6. Displacement Diffusers: Balance low velocity type diffusers by measuring airflow via measuring type iris damper (re: Halton PRA) where available, or using duct traverse on runout. Do not use flow hoods on face of diffusers.

7. Air Motion and Distribution: Insure that diffuser discharge arrangements and adjustments result in air flows as indicated on the drawings. Make adjustments as required, or adjustment is not possible, report which systems do not comply with indicated and/or specified flows. The Balancing Contractor, in addition to air motion measurements, shall make smoke tests wherever requested by the engineer, to demonstrate the air distribution from air terminals.

3.2 WATER SYSTEM BALANCING PROCEDURES

A. Adjustment: Adjust heating water systems to provide required quantities to or through each component.

B. Metering: Measure water quantities and pressures with calibrated meters.

1. Use venturi tubes, orifices, circuit setters, triple duty valves, or other metering fittings and pressure gages. Adjust systems to provide the approved pressure drops through the heat transfer

equipment (coils, except room units, converters, etc.), prior to capacity testing.

2. Where flow metering fittings are not installed, determine flow balance by measuring temperature differential across the heat transfer equipment, pressure differential on pumps, or use ultrasonic flow measuring equipment. Perform measurement of temperature differential with the air system, adjusted as described herein, in operation.

C. Automatic Controls: Position automatic control valves for full flow through the heat transfer equipment of the system during tests.

D. Flow through by-pass circuits at three-way valves shall be adjusted to balance that through the supply circuit, so that pressure loss through the coil equals pressure loss through the bypass.

E. Distribution: Adjust distribution by means of balancing devices and automatic flow control valves. Do not use service valves for adjustment. Where automatic flow control valves are utilized in lieu of balancing valves, record only pressure drop across the valve to confirm that pressure drop is within the pressure drop rating on the valve tag.

F. Special Procedures:

1. Where applicable, where pump capacity as designed is less than total flow requirements of individual heat transfer units of system served (due to diversity), full flow in each branch may be simulated by the temporary restriction of flow to portions of the system. In such a case, delineate specific procedures in the agenda and balancing reports.

2. When the available pump head is more than 15% above the required head to meet the design flow, trim the pump impeller to bring the head within 100 to 110 percent of the required head to meet the design flow.

3.3 CERTIFIED REPORTS

A. Submittal: Submit copies of the Agenda and Balancing Reports described herein, covering air and water system performance, air motion (FPM), as specified in Part 1.

B. Instrument Records: Include types, serial numbers, and dates calibration of all instruments.

C. Reports shall clearly identify equipment and systems not conforming to contract requirements, or obvious mal-operation or design deficiencies.

D. Certification: The reports shall be certified by an independent, Registered Professional Engineer who is versed in the field of air and

water balancing and who is not affiliated with any firm involved in the design or construction phases of the project. Certification shall include checking or adherence to agenda of calculations, procedures, and evaluation of final summaries.

3.4 AIR SYSTEM REPORT

A. General: The certified report shall include the data listed below for each air-handling system.

B. Fans (supply, return, or exhaust fan or factory fabricated packaged or central station unit).

1. Installation Data:

a. Manufacturer and Model

b. Wheel Size, sheave, pulley, and belt sizes and manufacturer.

c. Arrangement, Discharge, and Class

d. Motor H.P., Voltage, Phase, Cycles, and Full Load Amps

e. Drive Type (i.e. direct, belt, adjustable sheaves, variable frequency drive, single or two speed starter, solid state speed control for single phase motors, etc.)

f. Location and Local Identification Data.

2. Design Data (Data listed in schedules on drawings and specifications) and Measured Test Data:

a. Unit Total CFM

b. Static Pressure – inlet and discharge

c. Fan and motor R.P.M., including sheave adjustment or speed controller adjustments and correct sheave and pulley sizes as installed.

d. Motor Operating Amps.

e. Motor Operating B.H.P.

f. Check measured values against fan manufacturer's submitted fan curves and report any discrepancies exceeding 15%.

C. Coils (Air handling unit coils)

1. Installation Data

   a. Manufacturer and type

   b. Rows, face size, fins per inch

2. Design Data (Data listed in schedules on drawings and specifications) and Measured Test Data

   a. Rated airflow and capacity (MBH)

   b. Measured airflow

   c. Bypass airflow

D. Duct Systems: Duct Air Quantities (Maximum and Minimum) - Main, Submains, Branches, Outdoor (Outside) Air, Total-Air, and Exhaust:

1. Duct size(s) and configuration (length of straight runs into and out of the traverse location.

2. Number of Pitot-tube (Pressure) Measurements

3. Sum of Velocity Measurements, excluding pressure measurements.

4. Average Velocity

5. Recorded (Test) CFM

6. Design CFM

E. VAV Boxes:

1. Terminal Identification: Unit number.

2. Type, Size, Manufacturer, and Catalog Identification.

3. Design and Recorded Minimum and Maximum Air Quantities in CFM.

4. Heating Coils

   a. Rows, face size, fins per inch

   b. Rated airflow and capacity (MBH)

   c. Discharge Air Temperature Measured at minimum airflow.

d. Discharge Air Temperature Measured at maximum airflow.

F. Individual Air Terminals:

1. Terminal Identification: Supply, return, or exhaust. Location and number designation shall be submitted indicated on a marked up plan.

2. Type, Size, Manufacturer, and Catalog Identification.

3. Design and Recorded Air Quantities in CFM.

4. Deflector Vane or Diffusion Cone Settings.

5. Applicable Factor for Application: Velocity, Area, etc. (Not required where terminal air measuring systems and flow hoods are used.)

6. Design and Recorded Velocities - F.P.M. (Indicate measuring locations: i.e. "core", "inlet", etc., as applicable). (Not required where terminal air measuring systems are used and flow hoods are used.)

7. Subtotal of all terminals from each main system (each side of classroom wings).

8. Total of all terminals from each Air Handling System.

3.5 WATER SYSTEM REPORT DATA

A. General: The certified report shall include the data listed below for each HVAC water system.

B. Pumps:

1. Installation Data:

a. Manufacturer and Model

b. Size – inlet and discharge

c. Drive and coupling type

d. Motor H.P., Voltage, Phase, and Full Load Amps.

2. Design Data:

a. GPM

b. Head

c. R.P.M.

d. B.H.P. and Amps.

3. Recorded Data:

a. Discharge Pressures: Full specified flow and no-flow (shut off head).

b. Suction Pressures: Full specified flow and no-flow (shut off).

c. Operating Head (differential pressure)

d. Operating GPM (from pump curves and sum of terminals if metering is not provided.)

e. Full-Flow Amps.

f. No-Flow (shut off) Amps.

C. Air Heating and Cooling Equipment:

1. Installation Data:

a. Manufacturer, Model, and Type.

2. Design Data:

a. Load in BTU per hour

b. GPM

c. Entering and Leaving Water Temperature

d. Entering and Leaving Air Conditions (D.B. and W.B.).

e. CFM

f. Water Pressure Drop.

3. Recorded Data:

a. Type of Equipment and Identification (location or number designation)

b. Entering and Leaving Air Conditions (D.B. and W.B.)

c. Entering and Leaving Water Temperatures

d. GPM (if metered)

e. Temperature Rise or Drop

D. VAV box coils:

1. Installation Data:

a. Manufacturer, Model, and Type.

2. Design Data:

a. Load in BTU per hour

b. GPM

c. Entering and Leaving Water Temperature

d. Entering and Leaving Air Conditions (D.B. and W.B.).

e. CFM

f. Water Pressure Drop.

3. Recorded Data:

a. Type of Equipment and Identification (location or number designation)

b. Entering and Leaving Air Conditions (D.B. and W.B.)

c. Entering and Leaving Water Temperatures

d. GPM (if metered)

e. Temperature Rise or Drop

3.6 FINAL TESTS, INSPECTION, AND ACCEPTANCE

A. Capacity and Performance Tests: Make tests to demonstrate that capacities and general performance of air and water systems comply with contract requirements.

1. Final Inspection: At the time of final inspection, the Contractor shall recheck, in the presence of the Engineer or commissioning agent, random selections of data water and air quantities and air motion recorded in the certified report.

2. Points and areas for Recheck: As selected by the Architect and/or Engineer.

3. Measurement and Test Procedures: As approved for work forming basis of certified report.

4. Selections for recheck (specific plus random): In general, selections for recheck will not exceed 10 percent of the total number tabulated in the report, except that special air systems may require a complete recheck for safety reasons.

B. Retests:

1. If random tests elicit a measured flow deviation of ten percent or more that recorded in the certified report listings, at ten percent or more of the rechecked selections, the report shall be automatically rejected.

2. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made.

C. Marking of Settings: the adjustment settings of all valves, splitters, dampers, and other adjustment devices shall be permanently marked by the Contractor, so that adjustment can be restored if disturbed at any time. Any adjustment settings found to be incorrect which are subsequently readjusted shall also be remarked in the correct position.

END OF SECTION