

SECTION 23 82 00

HEATING & COOLING TERMINAL UNITS

PART 1 – DESIGN DIRECTIVES

1.1 DESIGN CRITERIA

- A. All fan coil units shall be sized to meet design heating/ cooling load while operating at medium speed, providing unit meets Dartmouth's sound criteria. Otherwise the design of the unit shall operate at low speed to meet Dartmouth's sound criteria. Units are to meet acoustical levels as listed in Section 23 05 00 – BASIC MECHANICAL REQUIREMENTS, Paragraph 1.16 - ACOUSTICS.
- B. Fan Coil Units water coil to be sized for minimum water temperature delta T of 10 degrees^o F for cooling.
- C. Fan coil units shall meet AHRI 440 requirements. Coil selections on documents to include number of rows for each coil type.
- D. All heating terminal units are to be designed to meet heating load using Low Temperature Hot Water at 120 Deg F (EWT).
- E. Metal Ceiling Suspension System coordinated with Division 9.
- F. All terminal units to be provided with Direct Digital Control (DDC) Building Automation System, connected to campus integrated control system and recommended Sequence of Operations. Refer to Section 23 09 23 - AUTOMATIC TEMPERATURE CONTROLS.
- G. All terminal units to be UL Listed.

1.2 DESCRIPTION OF TERMINAL UNITS

- A. Fan Coil units.
- B. Low Sound Fan Coil Units.
- C. Valance units.
- D. Finned tube radiation.
- E. Wall Panel Radiators.
- F. Ceiling Heating Radiant Panels.
- G. Convectors.
- H. Unit heaters.
- I. Cabinet heaters.
- J. Chilled beams.

1.3 QUALITY ASSURANCE

- A. Comply with the latest applicable ARI, UL, ASHRAE, & I=B=R standards.

1.4 SUBMITTALS

- A. Submittals shall be project specific clearly indicating the size, model, capacity, and electrical data for the units proposed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Handle terminal units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged terminal units or components; replace with new.
- B. Store terminal units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 – PRODUCTS

2.1 FAN COIL UNITS

- A. All vertical cabinet fan coil units shall have a minimum 12" wide valve pocket on the side opposite the drain connections. The discharge grille shall be linear extruded aluminum.
- B. Ceiling recessed units shall be equipped with flanged duct connectors for both the supply and return sides. The pre-finished bottom panel shall be designed to provide access to the entire unit and be exposed in the occupied space.
- C. Ceiling exposed units shall be pre-finished on all six sides. Pipe appurtenances shall be located on the exterior of the unit. The bottom panel shall swing down to allow access to the filter and motors.
- D. Fan speed controlled through building automation controls. Fan motors shall be ECM type.
- E. Provide positive draining drain pans constructed of stainless steel and CPVC P-trap and drain line. Provide water sensor in pan when using condensate pump. Add MERV rated filter, steel or aluminum construction. Insulate with polystyrene, elastomeric, or polyurethane insulation. Exposed cabinet parts shall be factory finished, owner / architect shall chose from manufacturer's offering of standard colors.
- F. Provide units with anti-microbial internal insulation.
- H. Filters: Minimum efficiency report value (MERV) rating MERV 13, other MERV ratings can be discussed during Basis of Design development for the project. MERV ratings according to ASHRAE 52.2. Filter shall be 1" thick throwaway.
- I. Manufacturer: Subject to compliance with requirements, heating/cooling and acoustical performance, provide fan-coil units of one of the following:
 - 1. Airtherm Mfg. Co.
 - 2. York/JCI
 - 3. Daikin
 - 4. Whalen Company
 - 5. Kampmann
 - 6. Williams
 - 7. Trane

2.2 LOW SOUND FAN COIL UNITS

- A. Manufacturer: Subject to compliance with requirements, heating/cooling and acoustical performance, provide fan-coil units of one of the following:
 - 1. Aermec
 - 2. Multiaqua
 - 3. Kampmann

- B. Fan speed controlled through building automation controls. Fan motors shall be ECM type.
- C. Units to be installed concealed, ducted and floor mounted in wood cabinetry or concealed in storage/mechanical rooms, or above ceilings for protection. Cabinet types are not acceptable.
 - 1. Wall mounted cabinets installation to be reviewed with Dartmouth College engineering prior to design and selection. This type of installation may be used only due to space limitations and when other options are not available.
- D. Provide units with anti-microbial internal insulation. Coil section insulation to be foil-covered, closed cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
- E. Drain pans: Polymer fully insulated. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- F. Hydronic Coils: Copper tube, mechanically bonded aluminum fins rated for a minimum working pressure of 115 psig and maximum 20°F above design operating temperature. Include manual air vent and drain.
- G. Filters: Minimum efficiency report value (MERV) rating MERV 13, other MERV ratings can be discussed during Basis of Design for the project. MERV ratings according to ASHRAE 52.2. Filter shall be 1" thick throwaway.
- H. Thermoplastic ABS (acrylonitrile butadiene styrene) fans with an impeller equipped with inspectionable airfoil and scroll fins and brushless inverter motors for low sound emissions.

2.3 VALANCE UNITS

- A. The heat transfer element shall be an aluminum plate fin on copper tubes. Plastic slides shall be attached to the fins at 3' spacing and be held in place by the element support structure.
- B. The longitudinal support for the valance unit, including drain pan, ceiling baffle, and heat transfer element, shall be provided by the element support structure. The support structure shall consist of two aluminum channels enclosing the heat transfer element, cross brace as required, and shall run the length of the valance resting on the valance support brackets. Valance units shall only be installed full length wall to wall.
- C. The valance condensate pan shall be pre-finished 0.032 aluminum. The drain pan shall be lined with closed cell insulation having a solid waterproof surface facing the heat transfer element.
- D. The interior drain connection shall be an integral part of the valance pan, affixed to the drain pan with a mechanical seal, and be caulked with a silicone sealant. The drain shall include a length of flexible tubing for connection to the drain risers.
- E. Control valves & thermostats shall be specified in Automatic Temperature Controls section.
- F. Subject to compliance with requirements, provide valance units manufactured by Sigma; or equal.

2.4 FINNED TUBE RADIATION

- A. Commercial radiation shall be a minimum 18 gauge cold-rolled steel full backplate, minimum 16 gauge front. Brace and reinforce front minimum of 4'-0" o.c. without visible fasteners. Elements shall be copper tube and aluminum fins, with tube mechanically expanded into fin. Exposed parts shall be factory finished baked enamel, color to be selected from manufacturer's offering of

standard colors. Include all accessories as required to install a complete system including end caps, access panels, etc.

- B. Subject to compliance with requirements, provide products manufactured by one of the following:
1. Sterling Radiator; Div. of Reed National Corp.
 2. Vulcan Radiator Co.

2.5 STEEL PANEL RADIATORS

- A. Elements shall be constructed of cold rolled low carbon steel, fully welded and consisting of header pipes at each end, connected by flat oval water tubes. Elements shall run from wall to wall with space left for piping risers. Radiators must be manufactured to the nearest 3" increment or smaller. Headers shall be square tube with 0.109" wall thickness and have a key operated air vent at highest point. Radiators shall be pre-finished, color to be selected from manufacturer's offering of standard colors. Panel shall be rated for 1.5 times working pressure of the system.
- B. Units to be selected for system pressure requirements.
- C. Subject to compliance with requirements, provide products manufactured by one of the following:
1. Runtal Radiator
 2. Panel Radiator Inc.
 3. Buderus
 4. Myson
 5. Rittling

2.6 RADIANT METAL CEILING PANELS

- A. The radiant panel shall consist of a heat exchanger assembly, bonded directly to the back of a metal ceiling panel. The heat exchanger assembly shall consist of 2 main pieces, a "C" channel aluminum extrusion, in which a seamless precision drawn copper tube is embedded. The heat exchanger assembly shall be custom manufactured to fit the various sizes of ceiling panels used. For custom shaped ceiling panels, or panels that have integral light fixtures, sprinkler heads, and other building appliances, shape and bend the copper tubing to fit the panel according to the application design. Systems that cannot provide this feature when necessary are not acceptable. The bonding of the heat exchanger assembly shall be executed at a center certified by the Manufacturer. No "field installation" of the provide to the metal ceiling panel shall be allowed.
- B. Each cooling/heating/zone shall consist of one or more panels, which are connected in series with flexible hoses to form a hydronic loop. The hoses are to be equipped with Swagelok compression fittings quick connect/disconnect couplings. Within the control zone multiple hydronic loops may be connected to the water mains in parallel. Shark bite connections not allowed.
- C. Hydronic type, extruded aluminum, 0.115" thick, with fluted face pattern. Copper tube (1/2"), type L, shall be mechanically bonded to panel with heat conductive paste. Provide interconnecting piping between panels: Provide hangers, expansion joints, and hold-down clips as required and as recommended by manufacturer. Provide 3" unfaced fiberglass blanket insulation pre-cut for installation above panels. Color to be selected from manufacturer's offering of standard colors.
- D. The "C" profile is to encase the copper tube under an angle of no less than 210°. A consistent thermal contact between the extrusion and the copper is to be achieved.
- E. The copper drawn copper tubing shall be tested with "Eddy Current Method" and provided with documentation that certifies it is free of hairline cracks and inclusions.
- F. The heat exchanger assembly shall be factory bonded directly to the metal ceiling tile surface using a thermally activated bonding process, utilizing a permanently elast VHB (Very High Bonding) tape no more than 0.2mm thick. The aluminum extrusion shall be painted flat black on the lower side. Acoustic fleece shall be applied between the extrusions for the sound absorption. Acoustic fleece under the extrusions shall not be accepted.

- G. Subject to compliance with requirements, provide products manufactured by one of the following:
 - 1. Aerotech Mfg., Inc.
 - 2. AirTex Radiant Ceiling Systems
 - 3. Steel Ceilings, Inc.
 - 4. Barcol Air
 - 5. TWA Panel System Inc
 - 6. Linder USA Inc

2.7 PUSH-FIT HOSES

- A. Hoses shall be made of flexible stainless steel (full metal or with EDPM core), Swagelok compression quick connect/disconnect end fittings. All hoses shall have an integrated barrier to prevent oxygen from permeating through the hose. Shark bite connections not allowed.
- B. The hoses shall be tested at 348 psi and 200°F.
- C. Provide brass nipples for installation of supply and return piping to receive push-fit hoses for connections to radiant panels. The nipples shall be one piece precision-machined brass to ensure a leak-tight system. The nipple ends shall be either solder, propress or threaded.

2.8 ACOUSTIC FLEECE AND INSULATION

- A. Acoustic fleece shall be provided for all perforated metal ceiling panels.
- B. Above all radiant ceiling panels, additional 1" acoustical inlay mineral fiber insulation shall be provided. Insulation shall be bagged in an air tight black sheet, have a density of 0.3-0.5 PCF and provide a minimal NRC rating of 0.8. Shall be furnished by Creative Materials for Acoustics (CMA) or equal.

2.9 PERIMETER HEATING PANEL

- A. The linear radiant panel shall consist of a high precision extruded "C" channel for maximum heat transfer rate to a seamless precision drawn copper tube embedded within. These panels shall be able to be installed in any type of grid system or as a freely suspended unit. These units shall have precision mitered corners (any angle) and conform to architectural features in a building. The spacing between extrusions shall be adjustable, including the ability to have them adjacent with no visible space between them.
- B. Each heating zone shall consist of one or more panels which are connected in series with flexible hoses to form a hydronic loop. The hoses are to be equipped with "push-fit" quick connect/disconnect couplings. Within the control zone, multiple hydronic loops may be connected to the water mains in parallel.
- C. Materials:
 - 1. The "C" channel aluminum extrusions shall not be less than 5-1/2" wide and custom manufactured to fit the various sizes. The "C" profile is to encase the copper tube under an angle of no less than 210°. A consistent thermal contact between the extrusion and the copper is to be achieved.
- D. The copper tube shall be 0.47 OD (0.42 ID), seamless, semi-hard drawn copper tube in the shape and size required for each size panel. The copper tubing shall be tested with "Eddy Current Method" and provided with documentation that certifies it is free of hairline cracks and inclusions.

2.10 CONVECTORS

- A. Minimum 16 gauge painted steel front and top panels, 18 gauge painted side panels, and 20 gauge galvanized back panels. Secure fronts in place with quick opening slide bolts or camlock fasteners. Elements shall consist of aluminum fins on copper tubes, and cast iron headers suitable for use in steam or hot water systems. Convectors shall be pre-finished, color to be selected from manufacturer's offering of standard colors.

- B. Subject to compliance with requirements, provide products manufactured by one of the following:
 - 1. Airtherm Mfg. Co,
 - 2. Vulcan
 - 3. Trane
 - 4. Sterling Radiator; Div. of Reed National Corp.

2.11 UNIT HEATERS

- A. Horizontal unit heaters shall be constructed of steel, phosphatized inside and out, and finished with baked enamel. Provide motor-mounted panel, minimum of 18gauge steel. Fabricate casing to enclose coil, louvers, and fan blades. Fans shall be constructed of aluminum, and factory balanced.
- B. Vertical unit heaters shall be constructed of steel, phosphatized inside and out, and finished with baked enamel. Design casing to enclose fan, motor, and coil, design fan orifice formed into discharge panel. Fans shall be constructed of aluminum and factory balanced. Motor and fan assembly is removable through fan outlet panel.
- C. Coils shall be constructed of plate type aluminum fins, mechanically bonded to copper tubes. Design coil for use in steam or hot water applications. Provide totally enclosed motors with built in overload protection.
- D. Subject to compliance with requirements, provide products manufactured by one of the following:
 - 1. Airtherm Mfg. Co.
 - 2. Vulcan
 - 3. Trane
 - 4. Modine Mfg. Co.
 - 5. Sterling Radiator

2.12 CABINET HEATERS

- A. Minimum 16 gauge painted steel front and top panels, 18 gauge painted side panels, and 20 gauge galvanized back panels. Secure fronts in place with quick opening slide bolts or camlock fasteners. Elements shall consist of aluminum fins on copper tubes, and cast iron headers suitable for use in steam or hot water systems. Provide 1" thick throwaway type filters. Cabinet heaters shall be pre-finished, color to be selected from manufacturer's offering of standard colors.
- B. Provide centrifugal, forward curved double width fans. Construct fan scrolls of galvanized steel. Motors shall be shaded pole motors with integral thermal over load protection. Provide two sets of filters, one for construction, and the other for turnover to the owner.
- C. Filters: Minimum efficiency report value (MERV) rating MERV 13, other MERV ratings can be discussed during Basis of Design for the project. MERV ratings according to ASHRAE 52.2. Filter shall be 1" thick throwaway.
- D. Subject to compliance with requirements, provide products manufactured by one of the following:
 - 1. Airtherm Mfg. Co.
 - 2. Vulcan
 - 3. Trane
 - 4. Daikin
 - 5. Sterling Radiator

PART 3 - EXECUTION

3.1 INSTALLATION OF TERMINAL UNITS – Refer to Dartmouth Guidelines Section 23 05 00, for system flushing, cleaning and start-up requirements.

- A. Provide two sets of MERV 13 efficient filters, one for construction, and the other for installation prior to turnover to the owner.
- B. Insulate all copper condensate drain piping outside of fan coil unit.

3.2 INSTALLATION OF VALANCE UNITS

- A. Fasten wall brackets to wall substrate. Brackets must be concealed by wall finish.
- B. Install balance of hangers as required for valance length. Provide suitable space for maintenance access to the zone valve.
- C. For valance units used for cooling, adjust the rear clips to provide positive drainage of the condensate.

3.3 INSTALLATION OF FINNED TUBE RADIATION

- A. Install end caps where units butt against walls. Install access panels centered in front of each shutoff valve, air vent & temperature control valve.

3.4 INSTALLATION OF UNIT HEATERS

- A. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible.

3.5 ADJUSTING AND CLEANING

- A. After construction is completed, including painting, clean unit exposed surfaces, vacuum clean terminal coils and inside of cabinets. Repair any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer. Install new filter units for terminals so equipped. Protect units with protective covers during balance of construction.
- B. Clean and comb coil fins.

END OF SECTION