

## SECTION 233600 - AIR TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Modulating, single-duct air terminal units.
  2. Case Liner

#### 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of air terminal unit.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for air terminal units.
  2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For air terminal units.
1. Include plans, elevations, sections, and mounting details.
  2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Include diagrams for power, signal, and control wiring.
  4. Hangers and supports, including methods for duct and building attachment and vibration isolation.

#### 1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals.
1. In addition to items specified in front end specs include the following:
    - a. Instructions for resetting minimum and maximum air volumes.
    - b. Instructions for adjusting software set points.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a Qualified Electrical Testing Laboratory, and marked for intended location and application.
- B. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, "Section 6 - Heating, Ventilating, and Air Conditioning."

### 2.2 MODULATING, SINGLE-DUCT AIR TERMINAL UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Price
  - 2. Titus
  - 3. Anemostat
  - 4. Metalaire
  - 5. Nailor
  - 6. Krueger
  - 7. Trane
  - 8. Tuttle & Bailey
- B. Description: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Casing: Minimum 20-gauge- thick galvanized steel.
  - 1. Casing Liner: Comply with requirements in "Casing Liner" Article below for "Casing Liner, Fibrous Glass" Paragraph with "Solid Metal Liner" Subparagraph.
  - 2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
  - 3. Air Outlet: S-slip and drive connections.
  - 4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.
- D. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
  - 1. Maximum Damper Leakage: AHRI 880 rated, 1.5 percent of nominal airflow at 6-inch wg inlet static pressure.
- E. Velocity Sensors: Multipoint array with velocity inlet sensors.
- F. Hydronic Heating Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch. Include manual air vent and drain valve. Provide hydronic heating coils for air terminal units scheduled on Drawings.

G. Electronic Controls:

1. Electronic Damper Actuator: 24 V, fail in last position.
2. Electronic Thermostat: Wall-mounted electronic type with temperature set-point display in Fahrenheit and Celsius.
3. Electronic Air Volume Controller: Pressure-independent analog electronic controller, factory calibrated and field adjustable to minimum and maximum air volumes; provides consistent airflow to the space in response to electronic thermostat signal while compensating for inlet static-pressure variations of up to 4 inches wg; includes a multipoint velocity sensor at air inlet.

H. Direct Digital Controls:

1. Terminal Unit Controller: Pressure-independent, VAV controller and integrated actuator, and electronic airflow transducer with multipoint velocity sensor at air inlet, factory calibrated to minimum and maximum air volumes.
  - a. Occupied and unoccupied operating mode.
  - b. Remote reset of airflow or temperature set points.
  - c. Adjusting and monitoring with portable terminal.
  - d. Communication with temperature-control system specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
2. Room Sensor: Wall mounted with temperature set-point adjustment and access for connection of portable operator terminal.

I. Control Sequence: See Drawings for control sequences.

2.3 CASING LINER

- A. Casing Liner, Fibrous Glass: Fibrous-glass duct liner, complying with ASTM C1071, NFPA 90A or NFPA 90B, and with NAIMA AH124.
1. Minimum Thickness: 1 inch.
    - a. Maximum Thermal Conductivity:
      - 1) Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F at 75 deg F mean temperature.
  2. Solid Metal Liner: Solid galvanized sheet metal encapsulating matted insulation face from airstream.
  3. Water-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C916.

2.4 SOURCE QUALITY CONTROL

- A. AHRI 880: Test and rate assembled air terminal units in accordance with AHRI 880.
- B. Water Coils: Factory pressure test to 300 psig in accordance with AHRI 410 and ASHRAE 33.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Comply with Section 230529 "Hangers and Supports for HVAC Piping and Equipment" and Section 233113 "Metal Ducts" for hangers and supports.
- B. Install air terminal units according to NFPA 90A.
- C. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- D. Install wall-mounted thermostats.

### 3.2 PIPING CONNECTIONS

- A. Where installing piping adjacent to air terminal unit, allow space for service and maintenance.
- B. Hot-Water Piping: Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties," and connect heating coils to supply piping with shutoff valve, strainer, control valve, and union or flange; and to return piping with balancing valve and union or flange.

### 3.3 DUCTWORK CONNECTIONS

- A. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.

### 3.4 ELECTRICAL CONNECTIONS

- A. Install field power to each air terminal unit electrical power connection. Coordinate with air terminal unit manufacturer and installers.
- B. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

### 3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."

### 3.6 IDENTIFICATION

- A. Label each air terminal unit with drawing designation, nominal airflow, maximum and minimum factory-set airflows, and coil type. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Verify that inlet duct connections are as recommended by air terminal unit manufacturer to achieve proper performance.
  - 3. Verify that controls and control enclosure are accessible.
  - 4. Verify that control connections are complete.
  - 5. Verify that nameplate and identification tag are visible.
  - 6. Verify that controls respond to inputs as specified.

### 3.8 ADJUSTING

- A. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air terminal unit testing, adjusting, and balancing.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
  - 2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Air terminal unit will be considered defective if it does not pass tests and inspections.

- D. Prepare test and inspection reports.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

SECTION 238239 - UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
  - 1. Propeller unit heaters with hot-water coils.
  - 2. Cabinet unit heaters with hot-water coils.

1.3 DEFINITIONS

- A. BAS: Building automation system.
- B. CWP: Cold working pressure.
- C. PTFE: Polytetrafluoroethylene plastic.
- D. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Plans, elevations, sections, and details.
  - 2. Location and size of each field connection.
  - 3. Details of anchorages and attachments to structure and to supported equipment.
  - 4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
  - 5. Location and arrangement of piping valves and specialties.
  - 6. Location and arrangement of integral controls.
  - 7. Wiring Diagrams: Power, signal, and control wiring.
- C. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

- D. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

#### 1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

#### 1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

### PART 2 - PRODUCTS

#### 2.1 CABINET UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
- D.
  - 1. Trane.
  - 2. Vulcan
  - 3. Sterling
  - 4. Modine Manufacturing Company, Inc.



- E. Description: A factory-assembled and -tested unit complying with ARI 440.
1. Comply with UL 2021.
- F. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing to prevent erosion of glass fibers.
1. Thickness: 1 inch.
  2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F. mean temperature.
  3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.
  5. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- G. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint.
1. Vertical Unit, Exposed Front Panels: Minimum 0.0677-inch-thick, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
  2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0677-inch-thick, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
  3. Recessing Flanges: Steel, finished to match cabinet.
  4. Control Access Door: Key operated.
  5. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
  6. Extended Piping Compartment: 8-inch-wide piping end pocket.
  7. False Back: Minimum 0.0428-inch-thick steel, finished to match cabinet.
- H. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Glass Fiber Treated with Adhesive: 80 percent arrestance and 5 MERV.
- I. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch (2.5 mm) and rated for a minimum working pressure of 200 psig (1378 kPa) and a maximum entering-water temperature of 220 deg F (104 deg C). Include manual air vent and drain.
- J. Fan and Motor Board: Removable.
1. Fan: Forward curved, high static, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
  2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
  3. Wiring Terminations: Connect motor to chassis wiring with plug connection.
- K. Control devices and operational sequences are specified in Section 230923 - Instrumentation and Controls.

## 2.2 PROPELLER UNIT HEATERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Trane.
  - 2. Modine Manufacturing Company, Inc.
- C. Description: An assembly including casing, coil, fan, and motor in vertical and horizontal discharge configuration with adjustable discharge louvers.
- D. Comply with UL 2021.
- E. Comply with UL 823.
- F. Cabinet: Removable panels for maintenance access to controls.
- G. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and - tested propeller unit heater before shipping.
- H. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- I. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.
- J. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.
- K. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F. with manual air vent. Test for leaks to 350 psig (2413 kPa) underwater.
- L. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- M. Fan Motors: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 1. Motor Type: Permanently lubricated, multispeed.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Section 079200 "Joint Sealants."
- B. Install cabinet unit heaters to comply with NFPA 90A.
- C. Install propeller unit heaters level and plumb.
- D. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration Controls for HVAC Piping and Equipment."
- E. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

### 3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping" and Section 232213 "Steam and Condensate Heating Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to cabinet unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Comply with safety requirements in UL 1995.
- E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping."
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

### 3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

### 3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 23 8239