

## **SECTION 233600 - AIR TERMINAL UNITS**

### PART 1 - GENERAL

#### 1.1 SUMMARY

##### A. Section Includes:

1. Single-duct air terminal units.

#### 1.2 ACTION SUBMITTALS

##### A. Product Data: For each type of air terminal unit.

##### 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.

##### C. Delegated-Design Submittal:

1. Materials, fabrication, assembly, and spacing of hangers and supports.
2. Include design calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports.

#### 1.3 INFORMATIONAL SUBMITTALS

##### A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

##### B. Field quality-control reports.

#### 1.4 CLOSEOUT SUBMITTALS

##### A. Operation and maintenance data.

## PART 2 - PRODUCTS

### 2.1 SINGLE-DUCT AIR TERMINAL UNITS

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Nailor Industries Inc.
  - 2. Price Industries.
  - 3. Titus.
- B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.
- C. Refer to the drawings for sizes, performance, and the Basis of Design for standard features, options, and accessories.

### 2.2 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Air Terminal Unit Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

### 2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test assembled air terminal units according to AHRI 880.
  - 1. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and AHRI certification seal.

## PART 3 - EXECUTION

### 3.1 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Ch. 5, "Hangers and Supports" and with Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes and for slabs more than 4 inches thick.

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4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes and for slabs less than 4 inches thick.
  5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hangers Exposed to View: Threaded rod and angle or channel supports.
- D. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.2 TERMINAL UNIT INSTALLATION

- A. Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."
- B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.
- C. Install wall-mounted thermostats.
- D. Comply with requirements in Section 233113 "Metal Ducts" for connecting ducts to air terminal units.
- E. Make connections to air terminal units with flexible connectors complying with requirements in Section 233300 "Air Duct Accessories."
- F. Label each air terminal unit with plan number, nominal airflow, and maximum and minimum factory-set airflows. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for equipment labels and warning signs and labels.

### 3.3 FIELD QUALITY CONTROL

- A. 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. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Air terminal unit will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.4 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 237413 - PACKAGED, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS**

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. This Section includes packaged, outdoor, central-station air-handling units (rooftop units) with the following components and accessories:
  - 1. Direct-expansion cooling.
  - 2. Gas furnace.
  - 3. Economizer outdoor- and return-air damper section.
  - 4. Power exhaust section
  - 5. Energy recovery wheel
  - 6. Integral, space temperature controls.
  - 7. Roof curbs.

#### 1.2 DEFINITIONS

- A. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.
- B. Supply-Air Fan: The fan providing supply-air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.
- C. VVT: Variable-air volume and temperature.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Refer to schedules on mechanical drawings for equipment basis of design performance requirements.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.
- 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. Wiring Diagrams: Power, signal, and control wiring.

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1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control test reports.
- B. Warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.7 QUALITY ASSURANCE

A. ARI Compliance:

- 1. Comply with ARI 203/110 and ARI 303/110 for testing and rating energy efficiencies for RTUs.
- 2. Comply with ARI 270 for testing and rating sound performance for RTUs.

B. ASHRAE Compliance:

- 1. Comply with ASHRAE 15 for refrigerant system safety.
- 2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.
- 3. Comply with 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."

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Comply with UL 1995.

F. 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.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of RTUs that fail in materials or workmanship within specified warranty period.

- 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

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## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Trane.
  - 2. AAON.
  - 3. Daikin.
  - 4. YORK; a Johnson Controls company.

### 2.2 CASING

- A. General Fabrication Requirements for Casings: Formed and reinforced double-wall insulated panels, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
- B. Exterior Casing Material: Galvanized steel with factory-painted finish, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
  - 1. Unit casing shall be constructed of zinc coated, heavy gauge, galvanized steel. Exterior surfaces shall be cleaned, phosphatized, and finished with a weather-resistant baked enamel finish. Unit's surface shall be tested 1000 hours in a salt spray test in compliance with ASTM B117. Unit shall have a 2 inch thick Antimicrobial Insulation. All insulation edges shall be either captured or sealed. The unit's base pan shall have no penetrations within the perimeter of the curb other than the raised downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up.
- C. Condensate Drain Pans: Formed sections of stainless-steel sheet, a minimum of 2 inches deep, and complying with ASHRAE 62.1.
  - 1. Double-Wall Construction: Fill space between walls with foam insulation and seal moisture tight.
  - 2. Drain Connections: Threaded nipple on both sides of drain pan.
  - 3. Pan-Top Surface Coating: Corrosion-resistant compound.
- D. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

### 2.3 FANS

- A. Direct-Driven Supply-Air Fans: Supply Fan motor shall be direct drive type with factory installed Variable Frequency Drive. All motors shall be thermally protected. All indoor fan motors meet the U.S. Energy Policy Act of 2005 (EPACT).
- B. Condenser-Coil Fan: Propeller, mounted on shaft of permanently lubricated motor.

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- C. Fan Motor: Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

## 2.4 COILS

- A. Supply-Air Refrigerant Coil:
  - 1. Aluminum-plate fin and seamless copper tube in steel casing with equalizing-type vertical distributor.
  - 2. Coil Split: Interlaced.
  - 3. Condensate Drain Pan: Stainless steel formed with pitch and drain connections complying with ASHRAE 62.1.

## 2.5 REFRIGERANT CIRCUIT COMPONENTS

- A. Number of Refrigerant Circuits: Two.
- B. Compressor: Hermetic, scroll, mounted on vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
- C. Refrigeration Specialties:
  - 1. Refrigerant: R-410A.
  - 2. Expansion valve with replaceable thermostatic element.
  - 3. Refrigerant filter/dryer.
  - 4. Manual-reset high-pressure safety switch.
  - 5. Automatic-reset low-pressure safety switch.
  - 6. Minimum off-time relay.
  - 7. Automatic-reset compressor motor thermal overload.
  - 8. Brass service valves installed in compressor suction and liquid lines.

## 2.6 ENERGY RECOVERY WHEEL

- A. Energy recovery wheel performance shall be AHRI 1060 certified and bear the AHRI certified label.
- B. The rotor media shall be light weight and must be made of aluminum. Paper or fibrous media are not acceptable.
- C. All surfaces must be coated with a nonmigrating adsorbent layer of desiccant prior to being formed into the media structure to ensure that all surfaces are coated and that adequate latent capacity is provided.
- D. The desiccant must be a 3A molecular sieve designed for the adsorption of water vapor. The media shall be cleanable by vacuuming the media surface, without degrading the latent recovery. Dry particles up to 800 microns shall pass freely through the media.

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## 2.7 AIR FILTRATION

- A. Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
  - 1. Minimum MERV 13.

## 2.8 GAS FURNACE

- A. Description: Factory assembled, piped, and wired; complying with ANSI Z21.47 and NFPA 54.
  - 1. CSA Approval: Designed and certified by and bearing label of CSA.
- B. Burners: Stainless steel.
  - 1. Fuel: Natural gas.
  - 2. Ignition: Electronically controlled electric spark or hot-surface igniter with flame sensor.
- C. Heat-Exchanger and Drain Pan: Stainless steel.
- D. Power Vent: Integral, motorized centrifugal fan interlocked with gas valve.
- E. Safety Controls:
  - 1. Gas Control Valve: Modulating.
  - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

## 2.9 DAMPERS

- A. Outdoor-Air Damper: Linked damper blades, for 0 to 25 percent outdoor air, with motorized damper filter.
- B. Outdoor- and Return-Air Mixing Dampers: Parallel- or opposed-blade galvanized-steel dampers mechanically fastened to cadmium plated for galvanized-steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
  - 1. Damper Motor: Modulating with adjustable minimum position.
  - 2. Relief-Air Damper: Gravity actuated or motorized, as required by ASHRAE/IESNA 90.1, with bird screen and hood.

## 2.10 ELECTRICAL POWER CONNECTION

- A. Provide for single connection of power to unit with unit-mounted disconnect switch accessible from outside unit and control-circuit transformer with built-in overcurrent protection.
- B. Unit mounted prewired convenience outlet

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## 2.11 CONTROLS

- A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC."
- B. DDC Controller:
  - 1. Controller shall have volatile-memory backup.
  - 2. Safety Control Operation:
    - a. Smoke Detectors: Stop fan and close outdoor-air damper if smoke is detected. Provide additional contacts for alarm interface to fire alarm control panel.
    - b. Fire Alarm Control Panel Interface: Provide control interface to coordinate with operating sequence described in Section 283111 "Digital, Addressable Fire-Alarm System" and Section 283112 "Zoned (DC Loop) Fire-Alarm System."
  - 3. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
  - 4. Unoccupied Period:
    - a. Heating Setback: 10 deg F.
    - b. Cooling Setback: System off.
    - c. Override Operation: Two hours.
    - d. Night setback and morning warmup
  - 5. Supply Fan Operation:
    - a. Occupied Periods: Run fan continuously and operate to maintain system static pressure for VAV operation.
    - b. Unoccupied Periods: Cycle fan to maintain setback temperature.
  - 6. Refrigerant Circuit Operation:
    - a. Occupied Periods: Cycle or stage compressors to match compressor output to cooling load to maintain room temperature. Cycle condenser fans to maintain maximum hot-gas pressure.
    - b. Unoccupied Periods: Compressors off.
  - 7. Gas Furnace Operation:
    - a. Occupied Periods: Stage burners during morning warmup and night setback stages.
    - b. Unoccupied Periods: Cycle burner to maintain setback temperature.
  - 8. Fixed Minimum Outdoor-Air Damper Operation:
    - a. Occupied Periods: Open to 25 percent.
    - b. Unoccupied Periods: Close the outdoor-air damper.
  - 9. Economizer Outdoor-Air Damper Operation:

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- a. Occupied Periods: Open to 25 percent (adjustable) fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II. Controller shall permit air-side economizer operation when outdoor air is less than 60 deg F. Use outdoor-air enthalpy and return-air enthalpy to adjust mixing dampers. Start relief-air fan with end switch on outdoor-air damper. During economizer cycle operation, lock out cooling.
  - b. Unoccupied Periods: Close outdoor-air damper and open return-air damper.
10. VVT Relays:
- a. Provide heating- and cooling-mode changeover relays compatible with VVT terminal control system required in Section 230900 "Instrumentation and Control" and
- C. Interface Requirements for HVAC Instrumentation and Control System:
- 1. Interface relay for scheduled operation.
  - 2. Interface relay to provide indication of fault at the central workstation and diagnostic code storage.
  - 3. Provide BACnet compatible interface for central HVAC control workstation for the following:
    - a. Adjusting set points.
    - b. Monitoring supply fan start, stop, and operation.
    - c. Inquiring data to include outdoor-air damper position, supply- and room-air temperature and humidity.
    - d. Monitoring occupied and unoccupied operations.

## 2.12 ACCESSORIES

- A. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required. Outlet shall be energized even if the unit main disconnect is open.
- B. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.
- C. Hail guards of galvanized steel, painted to match casing.

## 2.13 ROOF CURBS

- A. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.
  - 1. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
    - a. Materials: ASTM C 1071, Type I or II.
    - b. Thickness: 1 inch

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2. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
  - a. Liner Adhesive: Comply with ASTM C 916, Type I.
  - b. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.
  - c. Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.
  - d. Liner Adhesive: Comply with ASTM C 916, Type I.
- B. Curb Height: 14 inches
- C. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match RTU, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Equipment Mounting:
  1. Install RTUs on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
  2. Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."
- B. Roof Curb: Install RTUs on roof curb provided by manufacturer and coordinate roof penetrations and flashing with roof construction.
- C. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- D. Install piping adjacent to RTUs to allow service and maintenance.
  1. Gas Piping: Comply with applicable requirements in Section 231123 "Facility Natural-Gas Piping." Connect gas piping to burner, full size of gas train inlet, and connect with union and shutoff valve with sufficient clearance for burner removal and service.

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### 3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Tests and Inspections:
  - 1. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.
  - 2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
  - 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. Remove and replace malfunctioning units and retest as specified above.

### 3.3 CLEANING AND ADJUSTING

- A. 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 site during other-than-normal occupancy hours for this purpose.
- B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

END OF SECTION 237413

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