

SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS - REVISED

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Dedicated outdoor air-handling units.

B. Related Requirements:

1. Section 284621.11 "Addressable Fire-Alarm Systems."

1.2 DEFINITIONS:

- A. ECM: Electronically commutated motor.
- B. IS COP: Integrated Seasonal Coefficient of Performance.
- C. ISMRE: Integrated Seasonal Moisture Removal Efficiency.
- D. MRC: Moisture Removal Capacity.

1.3 ACTION SUBMITTALS

A. Product Data: For each dedicated outdoor-air unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include heat exchangers with performance characteristics.
9. Include dampers, including housings, linkages, and operators.

B. Shop Drawings: For each dedicated outdoor-air unit.

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.
- C. Delegated Design Submittal: For dedicated outdoor-air-unit supports indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
1. Include design calculations for selecting vibration isolators seismic restraints and wind restraints, and for designing vibration isolation bases.
 2. Wind- and Seismic-Restraint Details: Detail fabrication and attachment of wind and seismic restraints and snubbers. Show anchorage details and indicate quantity, diameter, and depth of penetration of anchors.
 3. Detail mounting, securing, and flashing of roof curb to roof structure. Indicate coordinating requirements with roof membrane system.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor/roof plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.
- B. Sample Warranty: For manufacturer's warranty.
- C. Seismic Qualification Data: Certificates, for dedicated outdoor-air units, accessories, and components, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
 4. Restraint of internal components.
- D. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculations.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of wind force and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Source quality-control reports.
- F. Startup service reports.

- G. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For dedicated outdoor-air units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Filters: One set(s) for each unit.
 2. Gaskets: One set(s) for each access door.

1.7 WARRANTY

- A. Warranty: Manufacturer agrees to replace components of dedicated outdoor-air units that fail in materials or workmanship within specified warranty period. **Warranty shall include parts and labor.**
 1. Warranty Period for Dedicated Outdoor-Air-Handling Units: **Five** years from date of Substantial Completion.
 2. Warranty Period for Compressors: Five years from date of Substantial Completion.
 3. Warranty Period for Heat Exchangers: Five years from date of Substantial Completion.
 4. Warranty Period for Rotary Heat Exchangers: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an "NRTL" (nationally recognized testing laboratory), and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of units and components.
- C. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- D. ASHRAE 15 and ASHRAE 34 Compliance: For refrigeration system safety.
- E. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. ASHRAE 84 Compliance: Comply with capacity ratings for heat-wheel energy-recovery equipment.

- G. UL Compliance:
- H. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation, seismic restraints and wind restraints.
- I. Seismic Performance: Units shall withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7. See Section 230548 "Vibration and Seismic Controls for HVAC."
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."
 - 2. Component Importance Factor: 1.0.
- J. Wind-Restraint Performance:
 - 1. See Section 230548 "Vibration and Seismic Controls for HVAC for requirements.

2.2 DEDICATED OUTDOOR-AIR UNITS

- A. **Manufacturer:** This specification is based on Trane Horizon. Cost associated with dimensional, performance, warranty, or other deviations from the specified equipment, including engineering costs to evaluate such deviations, shall be paid for by the contractor. Subject to compliance with requirements, acceptable manufacturers are:
 - 1. Trane Horizon.
 - 2. Bid Alternate 1: Daikin.
- B. Source Limitations: Obtain dedicated outdoor-air units from single manufacturer.
- C. Unit Casing:
 - 1. 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.
 - 2. Configuration: Horizontal unit with bottom discharge for roof curb mounting on concrete curb installation.
 - 3. Double-Wall Configuration:
 - a. Outside Casing Wall: Stainless steel, minimum 16 gauge thick with corrosion-resistant coating, with pitched roof panels and knockouts with grommet seals for electrical and piping connections and lifting lugs.
 - b. Inside Casing Wall:
 - 1) Inside Casing, Burner Section: Stainless steel, solid.
 - 2) Inside Casing, All Other Sections: Stainless steel, solid.
 - 3) Antimicrobial Coating: Applied during the manufacturing process. Coating is to be EPA approved.
 - c. Floor Plate: Reinforced metal surface; reinforced to limit deflection when walked on by service personnel. Insulation is provided below metal walking surface.
 - d. Roof: Standing seam or membrane; sloped to drain water.

- e. Casing Insulation:
 - 1) Materials: Polyurethane foam insulation.
 - 2) Casing Panel R-Value: Minimum R-6.7.
 - 3) Insulation Thickness: 2 inches.
 - 4) Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.
- 4. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.
- 5. Static-Pressure Classifications:
 - a. For Unit Sections Upstream of Fans: Minus 2 inches wg.
 - b. For Unit Sections Downstream and Including Fans: 2 inches wg.
- 6. Panels and Doors:
 - a. Panels:
 - 1) Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - 2) Fasteners: Two or more camlock-type fasteners for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
 - 3) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 4) Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.
 - b. Doors:
 - 1) Fabrication: Formed and reinforced double-wall and insulated panels of same materials and thicknesses as casing.
 - 2) Hinges: A minimum of two ball-bearing hinges or stainless steel piano hinge and two wedge-lever latches, operable from inside and outside. Arrange doors to be opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.
 - 3) Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 4) Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components.
 - c. Locations and Applications for DOAU-1:
 - 1) Fan Section: Panels.
 - 2) Access Section: Doors.
 - 3) Gas-Fired Burner Section: Panels.
 - 4) Damper Section: Panels.
 - 5) Filter Section: Panels large enough to allow periodic removal and installation of filters.
 - 6) Relief Section: Doors.
 - d. Locations and Applications for DOAU-2 and DOAU-3:

- 1) Fan Section: Doors.
 - 2) Access Section: Doors.
 - 3) Gas-Fired Burner Section: Doors.
 - 4) Damper Section: Doors.
 - 5) Filter Section: Doors large enough to allow periodic removal and installation of filters.
 - 6) Relief Section: Doors.
 - 7)
7. Condensate Drain Pans:
- a. Location: Each refrigerant coil.
 - b. Construction:
 - 1) Single-wall, stainless steel sheet.
 - c. Size: Large enough to collect condensate from cooling coils, including coil piping connections, coil headers, and return bends.
 - d. Drain Connection:
 - 1) Located on one end of pan, at lowest point of pan.
 - 2) Terminated with threaded nipple.
 - 3) Minimum Connection Size: As shown on plans.
 - e. Slope: Minimum 0.125-inch/ft. slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and from humidifiers and to direct water toward drain connection.
 - f. Length: Extend drain pan downstream from leaving face for distance to comply with ASHRAE 62.1.
 - g. Width: Entire width of water-producing device.
 - h. Depth: A minimum of 2 inches deep.
 - i. Provide units having stacked coils with intermediate drain pan to collect condensate from top coil.
- D. Fans, Drives, And Motors:
1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 2. Supply-Air Fans and Relief-Air Fans: Centrifugal; galvanized or painted steel; mounted on solid-steel shaft.
 - a. Shafts: With field-adjustable alignment.
 - 1) Turned, ground, and polished hot-rolled steel with keyway.
 - b. Shaft Bearings:
 - 1) Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 100,000 hours in accordance with ABMA 9.

- c. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.
 - 1) Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - d. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.
 - e. Backward-Inclined, Centrifugal Fan Wheels: Construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; aluminum hub riveted to backplate and fastened to shaft with setscrews.
 - f. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; aluminum hub swaged to backplate and fastened to shaft with setscrews.
 - g. Mounting: For internal vibration isolation and seismic control. Factory mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.
 - h. Shaft Lubrication Lines: Extended to a location outside the casing.
 - i. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, s-steel sheet.
 - 1) Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.
3. Drive, Direct: Factory-mounted direct drive.
4. Condenser-Coil Fan: Variable-speed propeller, mounted on shaft of permanently lubricated multispeed motors.
5. Motors:
- a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
 - b. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - c. Enclosure Type: Open, dripproof.
 - d. Enclosure Materials: Cast iron.
 - e. Efficiency: Premium efficient as defined in NEMA MG 1.
 - f. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - g. Mount unit-mounted disconnect switches on exterior of unit.
6. Comply with Section 262923 "Variable-Frequency Motor Controllers."
- E. Coils:
- 1. General Requirements for Coils:

- a. Comply with AHRI 410.
 - b. Fabricate coils section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - c. Coils are not to act as structural component of unit.
2. Supply-Air Refrigerant Coils:
- a. Tubes: Copper.
 - b. Fins:
 - 1) Material: Aluminum.
 - 2) Fin Spacing: Maximum 14 fins per inch.
 - c. Fin and Tube Joints: Mechanical bond.
 - d. Headers: Seamless-copper headers with brazed connections.
 - e. Frames: Galvanized steel.
 - f. Coatings: Corrosion-resistant coating.
 - g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - 1) Working Pressure: Minimum 300 psig.
3. Hot-Gas Reheat Refrigerant Coils:
- a. Tubes: Copper.
 - b. Fins:
 - 1) Material: Aluminum.
 - 2) Fin Spacing: Maximum 14 fins per inch.
 - c. Fin and Tube Joints: Mechanical bond.
 - d. Headers: Seamless-copper headers with brazed connections.
 - e. Frames: Galvanized steel.
 - f. Coatings: Corrosion-resistant coating.
 - g. Ratings: Designed, tested, and rated in accordance with ASHRAE 33 and AHRI 410.
 - 1) Working Pressure: Minimum 300 psig.
 - h. Suction-discharge bypass valve.
4. Condenser Refrigerant Coils:
- a. Tube Material: Copper.
 - b. Fin Material: Aluminum.
 - c. Fin and Tube Joint: Mechanical bond.
 - d. Coating: Corrosion-resistant.
- F. Refrigeration Circuit Components:

1. Compressors: Hermetic, variable-speed scroll compressors, mounted on integral vibration isolators; with internal overcurrent and high-temperature protection, internal pressure relief, and crankcase heater.
2. Refrigerant: R-454B.
3. Refrigeration Specialties:
 - a. Expansion valve with replaceable thermostatic element.
 - b. Refrigerant filter/dryer.
 - c. Manual-reset high-pressure safety switch.
 - d. Automatic-reset low-pressure safety switch.
 - e. Minimum off-time relay.
 - f. Automatic-reset compressor motor thermal overload.
 - g. Thermostat for coil freeze-up protection during low-ambient-temperature operation or loss of air.
 - h. Brass service valves installed in discharge and liquid lines.
 - i. Low-ambient kit high-pressure sensor.
 - j. Single compressor with evaporator and condenser coil within the refrigerant section to provide initial pre-cooling and to reheat for humidity control.
 - k. Modulating hot-gas reheat solenoid valve with a replaceable magnetic coil.
 - l. Heat-pipe heat exchanger, wrapped around the evaporator coil to pre-cool the air entering the evaporator coil and reheat the air leaving the evaporator coil to control humidity.
 - m. Hot-gas bypass refrigerant control for capacity control with continuous dehumidification for single-speed compressor.

G. Air Filtration:

1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
2. Panel Filters:
 - a. Description: Pleated factory-fabricated, self-supported disposable air filters with holding frames.
 - b. Filter Unit Class: UL 900.
 - c. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
 - d. Filter-Media Frame: High wet-strength beverage board with perforated metal retainer, or metal grid, on outlet side.
3. Mounting Frames:
 - a. Panel filters arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or from access plenum.
 - b. Cartridge filters arranged for flat orientation, removable from access plenum.
 - c. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks with space for prefilter.

H. Rotary Heat Exchanger:

1. Casing:

- a. Stainless steel, stainless steel, or aluminum with manufacturer's standard factory-painted finish.
 - b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
 - c. Casing seals on periphery of rotor and on duct divider and purge section.
 - d. Support vertical rotor on grease-lubricated ball bearings having extended grease fittings or permanently lubricated bearings. Support horizontal rotors on tapered roller bearings.
2. Rotor - Aluminum, Metallic, or Polymer: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, molecular-sieve desiccant coating.
 3. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable-frequency controller. Provide permanently lubricated wheel bearings.
 4. Controls:
 - a. Starting relay, factory mounted and wired, and manual motor starter for field wiring.
 - b. Variable-frequency controller, factory mounted and wired, permitting input of 4-20 mA or 1-10 V control signal.
 - c. Control energy recovery to permit air economizer operation.
 - 1) Bypass dampers to assist energy recovery control.
 - d. Pilot-Light Indicator: Display rotor rotation and speed.
 - e. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
 - f. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 percent at 4-inch wg differential pressure.
 - g. Defrost cycle.
 - h.
- I. Indirect-Fired Gas Furnace Heating:
1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
 2. CSA Approval: Designed and certified by and bearing label of CSA.
 3. Burners:
 - a. Heat-Exchanger Material: Stainless steel.
 - b. Fuel: Natural gas.
 - c. Ignition: Electronically controlled electric spark with flame sensor.
 - d. Gas Control Valve: Electronic modulating.
 - e. 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.
 4. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
 5. Heat-Exchanger Drain Pan: Stainless steel.
 6. Safety Controls:
 - a. Gas Manifold: Safety switches and controls complying with ANSI standards.

- b. Vent Flow Verification: Differential pressure switch to verify open vent.
- c. High Limit: Thermal switch or fuse to stop burner.
- d. Purge-period timer shall automatically delay burner ignition and bypass low-limit control.
- e. Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.
- f. Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.
- g. Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

J. Dampers:

- 1. Outdoor-Air Dampers: Low-leakage, double-skin, airfoil-blade, stainless-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in parallel-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single stainless-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1 inch wg and 8 cfm/sq. ft. at 4 inches wg.
- 2. Electronic Damper Operators:
 - a. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - b. Electronic damper position indicator shall have visual scale indicating percentage of travel and 2 to 10 V dc feedback signal.
 - c. Operator Motors:
 - 1) Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230500 "Common Work Results for HVAC."
 - 2) Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - 3) Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
 - d. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
 - e. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf.
 - f. Size dampers for running torque calculated as follows:
 - 1) Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - 2) Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
 - 3) Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - 4) Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
 - 5) Dampers with 2 to 3 Inches wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.

- 6) Dampers with 3 to 4 Inches wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.
 - g. Coupling: V-bolt and V-shaped, toothed cradle.
 - h. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - i. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 - j. Power Requirements (Two-Position Spring Return): 24 V dc.
 - k. Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.
 - l. Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2 to 10 V dc position feedback signal.
 - m. Temperature Rating: Minus 22 to plus 122 deg F.
 - n. Run Time: 12 seconds open, 5 seconds closed.

K. Electrical Power Connections:

1. Single-Point Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
2. Enclosure: NEMA 250, Type 4X, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key.
3. Wiring: Numbered and color-coded to match wiring diagram.
4. Wiring Location: Install factory wiring outside an enclosure in a raceway.
5. Power Interface: Field power interface to be NEMA KS 1, heavy-duty, nonfused disconnect switch.
6. Factory Wiring: Branch power circuit to each motor and to controls with one of the following disconnecting means:
 - a. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection in accordance with IEC 60947-4-1.
 - b. NEMA KS 1, heavy-duty, nonfusible switch.
 - c. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
7. Factory-Mounted, Overcurrent-Protection Service: For each motor.
8. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
9. Controls: Factory wire unit-mounted controls where indicated.
 - a. Convenience Outlets: One 20 A duplex GFCI receptacle per location with junction box located on outside casing wall.
 - 1) Locations: Fan section.
10. Control Relays: Auxiliary and adjustable time-delay relays.

L. Controls:

1. Air Handling Unit shall be provided with Refrigerant Safety control only, all other controls shall be by Section 230900 "Building Automation and Temperature Control System"
2. Interface via terminal strip with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.

M. Roof Curbs:

1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC." Roof curbs with vibration isolators and wind restraints are specified in Section 230548.13 "Vibration Controls for HVAC."
2. Curb shall be provided with an integral walkable platform and railings. Refer to details for locations and requirements.
3. Materials: Galvanized steel with corrosion-resistant coating, watertight gaskets, and factory-installed wood nailer; complying with National Roofing Contractors Association manuals for the specific type of roofing applicable to the Project.
 - a. Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.
 - 1) Materials: ASTM C1071, Type I or II.
 - 2) Thickness: 2 inches.
 - b. Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.
 - 1) Liner Adhesive: Comply with ASTM C916, Type I.
 - 2) 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.
 - 3) Liner materials applied in this location shall have airstream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric, depending on service air velocity.
4. Curb Dimensions: Height of 48 inches.
5. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, 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.

N. Intake And Relief Openings:

1. Type: Manufacturer's standard hood or louver, including moisture eliminator, at all unit intake and relief openings.
2. Materials: Match material and finish of casing exterior.
3. Bird Screen: Comply with requirements in ASHRAE 62.1.
4. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

2.3 MATERIALS

- A. Steel:
 - 1. ASTM A36/A36M for carbon structural steel.
 - 2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
 - 1. Manufacturer's standard grade for casing.
 - 2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.
- E. Corrosion-Resistant Coating: Coat coils with a corrosion-resistant coating capable of withstanding a 10,000-hour salt-spray test in accordance with ASTM B117.
 - 1. Standards:
 - a. ASTM B117 for salt spray.
 - b. ASTM D2794 for minimum impact resistance of 100 in-lb.
 - c. ASTM D3359 for cross-hatch adhesion of 5B.
 - 2. Coating shall not be applied at the project location.

2.4 SOURCE QUALITY CONTROL

- A. AHRI 920: Manufacturer to certify that performance ratings are in accordance with AHRI 920 if AHRI 920 certification program is not in place. Provide AHRI 920 certification if AHRI 920 certification program is in place.
- B. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.
- C. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.
- D. Damper Leakage and Air Performance:
 - 1. Damper Rating: Test and rate dampers for leakage and air performance in accordance with AMCA 510.
- E. Refrigerant Coils: Factory tested to minimum 300 psig internal pressure and to minimum 300 psig internal pressure while under water, in accordance with AHRI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Examine roof curbs and equipment supports for suitable conditions where units will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION OF DEDICATED OUTDOOR-AIR UNITS

- A. Unit Support: Install unit level on structural curbs. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of curbs with actual equipment provided.
 - 1. Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.
- C. Install filter-gauge, static-pressure taps upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum in accessible position. Provide filter gauges on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- D. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."
- E. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.
- F. Comply with requirements for gas-fired furnace installation in NFPA 54.
- G. Install separate devices furnished by manufacturer and not factory installed.
- H. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

3.3 PIPING CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Where installing piping adjacent to units, allow space for service and maintenance.
- C. Connect piping to units mounted on vibration isolators with flexible connectors.
- D. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.
- E. Gas Piping: Comply with requirements in Section 231123 "Facility Natural-Gas Piping." Provide AGA-approved flexible connectors.
 - 1. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
 - 2. Install AGA-approved flexible connectors.
- F. Duct Connections:
 - 1. Comply with requirements in Section 233113 "Metal Ducts."
 - 2. Drawings indicate the general arrangement of ducts.
 - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. 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."
 - 2. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

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 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. Inspect units for visible damage to furnace combustion chamber.
 3. Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:
 - a. Measure gas pressure at manifold.
 - b. Measure combustion-air temperature at inlet to combustion chamber.
 - c. Measure flue-gas temperature at furnace discharge.
 - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
 - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
 4. Verify operation of remote panel, including pilot-light operation and failure modes. Inspect the following:
 - a. High-limit heat exchanger.
 - b. Alarms.
 5. Inspect units for visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
 6. Start refrigeration system when outdoor-air temperature is within normal operating limits. and measure and record the following:
 - a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
 - b. Cooling coil entering-air, dry- and wet-bulb temperatures.
 - c. Condenser coil entering-air dry-bulb temperature.
 - d. Condenser coil leaving-air dry-bulb temperature.
 7. Simulate maximum cooling demand and inspect the following:
 - a. Compressor refrigerant suction and hot-gas pressures.
 - b. Short-circuiting of air through outside coil or from outside coil to outdoor-air intake.
 8. Inspect casing insulation for integrity, moisture content, and adhesion.
 9. Verify that clearances have been provided for servicing.
 10. Verify that controls are connected and operable.
 11. Verify that filters are installed.
 12. Clean coils and inspect for construction debris.
 13. Clean furnace flue and inspect for construction debris.
 14. Inspect operation of power vents.
 15. Purge gas line.
 16. Inspect and adjust vibration isolators and seismic restraints.
 17. Verify bearing lubrication.

18. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
19. Adjust fan belts to proper alignment and tension.
20. Start unit.
21. Inspect and record performance of interlocks and protective devices, including response to smoke detectors by fan controls and fire alarm.
22. Operate unit for run-in period.
23. Calibrate controls.
24. Adjust and inspect high-temperature limits.
25. Inspect outdoor-air dampers for proper stroke.
26. Verify operational sequence of controls.
27. Measure and record the following airflows. Plot fan volumes on fan curve.
 - a. Supply-air volume.
 - b. Relief-air flow.
 - c. Outdoor-air flow.

- B. After startup, change filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate, and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

3.7 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from 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.

3.8 CLEANING

- A. After completing system installation; testing, adjusting, and balancing dedicated outdoor-air unit and air-distribution systems; and completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, casings, dampers, coils, and filter housings, and install new, clean filters.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Charge refrigerant coils with refrigerant and test for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3.10 DEMONSTRATION

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

END OF SECTION 237433