SECTION 238223 - UNIT VENTILATORS

This Section includes requirements for the LEED Rating System. However, equipment specified in this Section may not qualify for LEED Rating System prerequisites and credits. Verify, with manufacturers, that the requirements for prerequisites and credits can be met. To achieve prerequisites and obtain credits, HVAC system design alternatives that do not include unit ventilators may be required.

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section includes unit ventilators and accessories with the following heating and cooling features:

Some manufacturers can provide both heating and reheat coils in same unit; however, for most applications, retain heating or reheat coil.

**[Hydronic] [Steam] [Electric]** heating coil.

**[Hydronic] [Steam] [Electric]** reheat coil.

**[Hydronic] [Direct-expansion refrigerant]** cooling coil.

* + - 1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product

Include rated capacities, operating characteristics, and furnished specialties and accessories for each unit type and configuration.

* + - * 1. Shop Drawings:

Include plans, elevations, sections, and details.

Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Detail anchorages and attachments to structure and to supported equipment.

Include diagrams for power, signal, and control wiring.

Retain "Samples for Initial Selection" and "Samples for Verification" paragraphs below for two-stage Samples.

* + - * 1. Samples for Initial Selection: For units with factory-applied color finishes.
				2. Samples for Verification: For each type of unit ventilator**[ and auxiliary shelves]** and cabinets indicated.

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

Revise subparagraphs below for ceiling-mounted unit ventilators.

Suspended ceiling components.

Structural members to which equipment will be attached.

Method of attaching hangers to building structure.

Size and location of initial access modules for acoustical tile.

Size and location of access panels in hard ceilings to provide access to concealed units.

Items penetrating finished ceiling, including the following:

Lighting fixtures.

Air outlets and inlets.

Speakers.

Sprinklers.

Access panels.

**<Insert item>**.

Perimeter moldings.

Retain "Seismic Qualification Certificates" paragraph below if required by seismic criteria applicable to Project. Coordinate with Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment." See ASCE/SEI 7 for certification requirements for equipment and components.

* + - * 1. Seismic Qualification Certificates: For unit ventilators, accessories, and components, from manufacturer.

Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
				2. Sample Warranty: For special warranty.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For unit ventilators to include in emergency, operation, and maintenance manuals.

Include the following:

Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

* + - 1. MAINTENANCE MATERIAL SUBMITTALS
				1. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

Unit Ventilator Filters: Furnish **<Insert number>** spare filter(s) for each filter installed.

Retain "Spare Cooling Chassis" subparagraph below only for integral cooling chassis unit ventilators.

Spare Cooling Chassis: Furnish **<Insert number>** spare integral cooling chassis for each size unit installed.

* + - 1. QUALITY ASSURANCE
				1. Comply with NFPA 70.

"ASHRAE Compliance" paragraph below may be required to comply with Project requirements or authorities having jurisdiction. LEED Prerequisite IEQ 1 requires compliance with requirements in ASHRAE 62.1, including requirements for controls, surfaces in contact with the airstream, particulate and gaseous filtration, humidification and dehumidification, drain pan construction and connection, finned-tube coil selection and cleaning, and equipment access. Verify, with manufacturers, availability of units with components and features that comply with these requirements.

* + - * 1. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

"ASHRAE/IES 90.1 Compliance" paragraph below may be required to comply with Project requirements or authorities having jurisdiction. LEED Prerequisite EA 2 requires minimum efficiency equal to requirements in ASHRAE/IES 90.1.

* + - * 1. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
			1. COORDINATION

Delete this article if unit ventilators are wall or floor mounted.

Revise first paragraph below to delete or add types of construction that penetrate or are supported by ceilings.

* + - * 1. Coordinate layout and installation of unit ventilators and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

Retain paragraph below for units with outdoor air.

* + - * 1. Coordinate size and location of wall sleeves for outdoor-air intake.
			1. WARRANTY

Delete this article if remote or integral condensing unit is not required.

When warranties are required, verify with Director’s Representative's that special warranties stated in this article are not less than remedies available to Director’s Representative under prevailing local laws.

Warranties vary among manufacturers from covering the whole unit for up to four years, to only the compressor for five to 10 years, or only the condenser coil for five years. Extended special warranties are limited to units in the 1- to 5-ton (3.5- to 17.6-kW) range, and then are usually restricted to residential applications.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.

Failures include, but are not limited to, the following:

Compressor failure.

Condenser coil leak.

Verify available warranties and warranty periods for units and components.

Warranty Period: **[Four] [Five] [10] <Insert number>** years from date of Substantial Completion.

Warranty Period (Compressor Only): **[Five] [10] <Insert number>** years from date of Substantial Completion.

Warranty Period (Condenser Coil Only): **[Five] <Insert number>** years from date of Substantial Completion.

1. PRODUCTS

See Editing Instruction No. 1 in the Evaluations for cautions about named manufacturers and products. For an explanation of options and Contractor's product selection procedures.

* + - 1. SYSTEM DESCRIPTION
				1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
				2. Factory-packaged and -tested units rated according to AHRI 840, ASHRAE 33, and UL 1995.
			2. MANUFACTURERS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Carrier Corporation.

Daikin Applied.

Engineered Air.

Nesbitt Aire, Inc.

Trane.

Approved equivalent.

Many additional features are available for this product. Some are mutually exclusive. Include all features for unit ventilators that are required for Project, and identify additional features for specific units in a Unit Ventilator Schedule on Drawings.

* + - 1. MANUFACTURED UNITS
				1. Description: Unit ventilators consisting of finished cabinet, filter, cooling coil, drain pan, supply-air fan and motor in **[blow-] [or] [draw-]**through configuration, and hydronic cooling coil.

Unit Ventilator Coil Configurations: **[Row] [Face]** split.

Number of Heating Coils: **[One]** with two-pipe system.

Number of Cooling Coils: **[One] [Three]** with **[two][four]**-pipe system.

* + - 1. CABINETS

Closed-cell insulation with foil or matt facing is provided by some manufacturers to reduce the possibility of fibers from glass-fiber insulation being introduced into the conditioned space. Retain "Insulation" or "Coil Section Insulation" paragraph below for coil section insulation.

* + - * 1. Insulation: Minimum **[1/2-inch-] [1-inch-] <Insert dimension>** thick, **[coated glass fiber] [foil-covered, closed-cell foam] [matte-finish, closed-cell foam]** complying with ASTM C1071 and attached with adhesive complying with ASTM C916.

Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.

"Airstream Surfaces" subparagraph below may be required to comply with Project requirements or authorities having jurisdiction. Retain subparagraph to comply with LEED Prerequisite IEQ 1.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.

"Airstream Surfaces" subparagraph below may be required to comply with Project requirements or authorities having jurisdiction. Retain subparagraph to comply with LEED Prerequisite IEQ 1.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

"Main and Auxiliary Drain Pans" paragraph below may be required to comply with Project requirements or authorities having jurisdiction. LEED Prerequisite IEQ 1 requires compliance with ASHRAE 62.1. Removable drain pans in paragraph are an extra feature with some manufacturers.

* + - * 1. Main and Auxiliary Drain Pans: **[Plastic] [Insulated galvanized steel with plastic liner]**, formed as required by ASHRAE 62.1.**[ Drain pans shall be removable.]**
				2. Cabinet Frame and Access Panels: Welded-steel frame with removable panels fastened with hex-head tamperproof fasteners**[ and key-operated control and valve access doors]**.

Steel components exposed to moisture shall be **[hot-dip galvanized after fabrication] [baked-enamel finished] [powder-coat finished]**.

Retain one of two "Cabinet Finish" paragraphs below to suit Project. Coordinate custom-color requirements with sample submittal requirements. Coordinate field painting with painting Sections.

* + - * 1. Cabinet Finish: Baked-on primer ready for field painting.
				2. Cabinet Finish: **[Baked enamel] [Powder coat]**, in manufacturer's **[standard] [custom]** color as selected by Director’s Representative.
				3. Indoor-Supply-Air Grille: **[Steel] [Aluminum]**, **[double deflection, adjustable] [adjustable linear bar]**.

Note limitations of configurations when retaining an option in "Return-Air Inlet" paragraph below.

* + - * 1. Return-Air Inlet: **[Front toe space] [Back inlet with top inlet grille]**.

Retain "End Panels" paragraph below if unit ventilators are freestanding.

* + - * 1. End Panels: Matching material and finish of unit ventilator.
				2. Outdoor-Air Wall Box: Minimum 0.1265-inch- thick, aluminum, rain-resistant louver and box with integral eliminators and bird screen.

Louver Configuration: **[Horizontal] [Vertical]**, rain-resistant louver.

Louver Material: **[Aluminum] [Steel]**.

Bird Screen: 1/2-inch mesh screen on interior side of louver.

Decorative Grille: On outside of intake.

Finish: **[Anodized aluminum] [Baked enamel]**, color as selected by Director’s Representative from manufacturer's **[standard] [custom]** colors.

* + - 1. COILS
				1. Test and rate unit ventilator coils according to ASHRAE 33.
				2. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.
				3. Steam Coils: Copper**[ distributing]** tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 75 psig.

Some manufacturers limit air-to-air heat pumps to electric supplemental heating coils.

* + - * 1. Electric-Resistance Heating Coils: Nickel-chromium heating wire or tubular elements in coil fins, free of expansion noise and hum, with fuses in terminal box for overcurrent protection and continuous limit controls for high-temperature protection. Terminate elements in stainless-steel machine-staked terminals secured with stainless-steel hardware.

Retain "Indoor Refrigerant Coils" paragraph below for integral or remote condensing units.

* + - * 1. Indoor Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and brazed joints at fittings. Comply with AHRI 210/240, and leak test to minimum 450 psig for a minimum 300-psig working pressure. Include thermal expansion valve.
			1. INDOOR FAN
				1. Fan and Motor Board: Removable.

Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.

Fan Shaft and Bearings: Hollow-steel shaft with permanently lubricated, resiliently mounted bearings.

Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project. Permanently lubricated ball bearings are available for motors up through 5 hp.

Motor: Permanently lubricated, multispeed, resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

Wiring Termination: Connect motor to chassis wiring with plug connection.

* + - 1. DAMPERS
				1. Mixing Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with **[electric] [pneumatic]** actuator.
				2. Outdoor-Air Dampers: Galvanized-steel blades with edge and end seals and nylon bearings; with **[electric] [pneumatic]** actuator.

Face and bypass dampers in "Face and Bypass Dampers" paragraph below are optional.

* + - * 1. Face and Bypass Dampers: Galvanized-steel damper blades with edge and end seals and nylon bearings; with factory-mounted [electric] [pneumatic] actuator.

Retain paragraph below to comply with LEED Prerequisite EA 2.

* + - * 1. Comply with ASHRAE/IES 90.1.
			1. ACCESSORIES

Verify availability of additional features for unit ventilators specified.

* + - * 1. Exhaust Shutter: **[Barometric] [Motorized, modulating]** type designed to limit room pressure to maximum 0.10-inch wg with **[steel] [aluminum] [fabric]** damper blades, including edge and end seals, in galvanized-steel frame with **[outdoor] [and] [interior]** wall grille.
				2. Subbase: Sheet metal floor-mounting base with leveling screws and black enamel finish.
				3. Insulated false back with gasket seals on wall and outdoor-air plenum.

Insulation: Minimum **[1/2-inch-] [1-inch-] <Insert dimension>** thick, **[coated glass fiber] [foil-covered, closed-cell foam] [matte-finish, closed-cell foam]** complying with ASTM C1071 and attached with adhesive complying with ASTM C916.

Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.

"Airstream Surfaces" subparagraph below may be required to comply with Project requirements or authorities having jurisdiction. Retain subparagraph to comply with LEED Prerequisite IEQ 1.

Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

* + - * 1. Return-air plenum, 6 inches thick, designed to take return air from top inlet grilles in cabinets on both sides of unit ventilator with gasket seals on wall and outdoor-air plenum extension.

Retain first paragraph below for concealed unit ventilators.

* + - * 1. Duct flanges for supply-, return-, and outdoor-air connections.
				2. Radiation Grille: **[Steel] [Aluminum]**, **[linear-bar] [stamped]** grille with finish to match discharge-air grille.

Verify available filters with unit ventilator manufacturer.

For further information on air filters and air filter ratings, see Section 234100 "Particulate Air Filtration."

* + - * 1. Filters:

Retain "Minimum Efficiency Reporting Value and Average Arrestance" subparagraph below if requiring MERV 1, 2, 3, or 4 in the "Material" subparagraphs below. Retain "Minimum Efficiency Reporting Value" subparagraph if requiring MERV 5 and higher in "Material" subparagraphs below.

Minimum Efficiency Reporting Value and Average Arrestance: According to ASHRAE 52.2.

Minimum Efficiency Reporting Value: According to ASHRAE 52.2.

Retain one or more of three "Material" subparagraphs below. Indicate filter type in Unit Ventilators Schedule on Drawings if all units are not filtered identically. LEED 2009 IEQ Prerequisite 1 and LEED v4 EQ Prerequisite, "Minimum Indoor Air Quality Performance," require compliance with ASHRAE 62.1 (2007 and 2010 versions respectively), which requires a MERV rating of 6 or higher for service to occupied spaces. LEED 2009 IEQ Credit 5 and LEED v4 IEQ Credit, "Enhanced Indoor Air Quality Strategies," require MERV 13 or higher. Insert values appropriate to Project sustainability goals.

Material: Washable foam, **[MERV 3] <Insert value>**.

Material: Glass fiber treated with adhesive, **[MERV 5] <Insert value>**.

Material: Pleated cotton-polyester media, **[MERV 7] <Insert value>**.

* + - * 1. Energy Recovery Wheel:

Casing: Steel with manufacturer's standard paint coating and with the following:

Integral purge section.

Casing seals on periphery of rotor, on duct divider, and on purge section.

Support rotor on grease-lubricated ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.

Rotor: Corrugated-aluminum, segmented wheel strengthened with radial spokes, and having nontoxic, noncorrosive silica-gel desiccant coating. Construct media for passing maximum 800-micrometer solids and maximum 0.04 percent cross contamination by volume of exhaust air. Drive rotor with belt around outside of rotor.

Defrost Coils: Electric defrost coil in the exhaust airstream.

Drive: Fractional horsepower motor and gear reducer, with speed changed by adjustable variable frequency controller.

Inlet and Discharge Fans: Forward curved, centrifugal; resiliently mounted with flexible duct connections.

Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

Motor and Drive: Permanently lubricated, direct driven. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

Filters: 1-inch- thick, disposable type, mounted in galvanized-steel frame upstream of energy recovery wheel in both supply and exhaust airstreams.

Electrical: Single electrical connection from attached unit ventilator.

* + - 1. FACTORY HYDRONIC PIPING PACKAGE
				1. Piping: **[ASTM B88, Type L] [ASTM B88, Type M]** copper tube with wrought-copper fittings and brazed joints. Label piping to indicate service, inlet, and outlet. Crossover piping, **[NPS 1-1/2] [NPS 2] <Insert pipe size>** with shutoff valves.
				2. Control Valves: **[Electric] [Pneumatic]** actuators compatible with terminal controller and building controls.

Retain one or more of four subparagraphs below.

**[Two][Three]**-way, **[two-position] [modulating]** control valve for dual-temperature-water coil.

**[Two][Three]**-way, **[two-position] [modulating]** control valve for chilled-water coil.

**[Two][Three]**-way, **[two-position] [modulating]** control valve for hot-water heating coil.

**[Two][Three]**-way, **[two-position] [modulating]** control valve for hot-water reheat coil.

* + - * 1. Hose Kits: Minimum 400-psig working pressure and operating temperatures from 33 to 211 deg F. Tag hose kits to equipment designations.

Length: **[24 inches] [36 inches] <Insert dimension>**.

Minimum Diameter: Equal to unit ventilator connection size.

* + - * 1. Isolation Valves, Strainers, Unions, and Balance Valves:

Two-Piece Ball Valves: Bronze body with stainless-steel ball and stem and galvanized-steel lever handle for each supply and return connection. If balancing device is combination shutoff type with memory stop, isolation valve may be omitted on the return.

Calibrated-Orifice Balancing Valves: Bronze body, ball type; 125-psig working pressure, 250 deg F maximum operating temperature; with calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, threaded ends, and a memory stop to retain set position.

Automatic Flow-Control Valve: Brass or ferrous-metal body; 300-psig working pressure at 250 deg F; with removable, corrosion-resistant, tamperproof, self-cleaning piston spring; factory set to maintain constant indicated flow with plus or minus 10 percent over differential pressure range of 2 to 80 psig.

Y-Pattern Hydronic Strainers: Cast-iron body (ASTM A126, Class B); 125-psig working pressure; with threaded connections, bolted cover, perforated stainless-steel basket, and bottom drain connection. Include minimum NPS 1/2 hose-end, full-port, ball-type blowdown valve in drain connection.

Wrought-Copper Unions: ASME B16.22.

* + - 1. INTEGRAL COOLING CHASSIS
				1. Description: Assembly mounted within unit ventilator, factory assembled and tested; consisting of compressors, condenser coils, fans, motors, and refrigerant receivers; removable for maintenance, with plug and receptacle connections for control and power wiring. Construct, test, and rate condensing units according to AHRI 210/240 and ASHRAE 15.
				2. Casing: Galvanized steel with removable panels for access to controls and refrigerant piping.
				3. Exterior Louver: Extruded aluminum.
				4. Compressor: Hermetic, **[scroll] [reciprocating]** type; internally isolated for vibration with factory-installed safety devices as follows:

Anti recycle timer.

High-pressure cutout.

Low-pressure cutout or loss-of-charge switch.

Internal thermal-overload protection.

Current- and voltage-sensitive safety devices.

Retain "Energy Efficiency" paragraph below if applying for LEED certification or if required by Project requirements or authorities having jurisdiction. LEED Prerequisite EA 2 requires minimum efficiency equal to requirements in ASHRAE/IES 90.1.

* + - * 1. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IES 90.1, "Energy Standard for Buildings except Low-Rise Residential Buildings."
				2. Refrigerant Piping Materials:

Drawn-Temper Copper Tube: **[ASTM B88, Type L]**.

Annealed-Temper Copper Tube: **[ASTM B88, Type L] [ASTM B88, Type K]**.

Wrought-Copper Fittings: ASME B16.22.

* + - * 1. Refrigerant: R-407C or R-410A.
				2. Low ambient controls to permit operation down to 45 deg F.
				3. Crankcase heater.
				4. Charging and service fittings.
				5. Filter dryer.
				6. Air-to-Air Heat Pump: Pilot-operated, sliding-type reversing valve with replaceable magnetic coil, and controls for air-to-air heat pump operation with supplemental heat.
				7. HGBP, constant-pressure expansion valve and controls to maintain continuous refrigeration system operation at 10 percent of full load.
				8. Condenser: Copper-tube, aluminum-fin coil, with liquid subcooler.
				9. Direct-Driven Condenser Fan: Forward curved, double width, centrifugal; thermoplastic or painted-steel wheels and galvanized-steel fan scrolls.

Motor characteristics such as NEMA designation, temperature rating, service factor, enclosure type, and efficiency are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, add subparagraphs below to suit Project.

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

* + - 1. BASIC UNIT CONTROLS

Retain first paragraph below and delete "Basic Unit Controls" paragraph below if controls are part of overall temperature-control system.

* + - * 1. Control devices and operational sequences are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."
				2. Basic Unit Controls:

Control voltage transformer.

Verify control features with manufacturer.

**[Wall-mounting] [Unit-mounted]** thermostat with the following features.

Heat-cool-off switch.

Fan on-auto switch.

Retain first subparagraph below if multispeed motors are specified.

Fan-speed switch.

**[Manual] [Automatic]** changeover.

Adjustable deadband.

**[Concealed] [Exposed]** set point.

**[Concealed] [Exposed]** indication.

**[Degree F]** indication.

**[Wall-mounting] [Unit-mounted]** humidistat.

**[Concealed] [Exposed]** set point.

**[Concealed] [Exposed]** indication.

**[Wall-mounting] [Unit-mounted]** temperature sensor.

Unoccupied-period-override push button.

Data entry and access port.

Input data includes room temperature, and humidity set points and occupied and unoccupied periods.

Output data includes room temperature and humidity, supply-air temperature, entering-water temperature, operating mode, and status.

Retain "(DDC )Terminal Controller" paragraph below and coordinate with "Basic Unit Controls" paragraph above or with control devices specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. **[DDC ]**Terminal Controller:

Safety Controls Operation: Freezestat shall stop fan and close outdoor-air damper if air less than 38 deg F enters coils.

Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.

Unoccupied-Period-Override Operation: **[Two] <Insert number>** hours.

Dual-Temperature Coil Operation:

Occupied Periods: When chilled water is available, **[open] [modulate]** control valve if room temperature exceeds thermostat set point. When hot water is available, **[open] [modulate]** control valve if room temperature falls below thermostat set point.

Unoccupied Periods: When chilled water is available, close control valve. When hot water is available, **[open] [modulate]** control valve if room temperature falls below thermostat setback temperature.

Hydronic Cooling-Coil Operation:

Occupied Periods: **[Open] [Modulate]** control valve to provide cooling if room temperature exceeds thermostat set point.

Unoccupied Periods: Close control valve.

Refrigerant coil may be cooling or heating with air-to-air heat pump.

Refrigerant-Coil Operation:

Occupied Periods: Start compressor to maintain room temperature.

Unoccupied Periods: **[Stop compressor cooling] [Cycle compressor for heating to maintain setback temperature]**.

**[Supplemental ]**Heating-Coil Operation:

Occupied Periods: **[Open control valve] [Modulate control valve] [Energize electric-resistance coil]** to provide heating if room temperature falls below thermostat set point.

Unoccupied Periods: Start fan and **[open control valve] [modulate control valve] [energize electric-resistance coil]** if room temperature falls below setback temperature.

Switch refrigerant-reversing valve to operate supplemental coil for heating when outdoor temperature is below **[25 deg F] <Insert temperature>**.

Reheat-Coil Operation:

Retain "Humidity Control for Occupied Periods" and "Humidity Control for Unoccupied Periods" subparagraphs below if reheat coil provides reheating only.

Humidity Control for Occupied Periods: Humidistat **[opens control valve] [modulates control valve] [energizes electric-resistance coil]** to provide heating. As room temperature rises above set point, cooling-coil valve **[opens] [modulates]** to maintain room temperature.

Humidity Control for Unoccupied Periods: **[Close control valve] [De-energize]**.

Retain first "Outdoor-Air Damper Operation" subparagraph below for fixed outdoor-air intake; retain second subparagraph for economizer cycle. Energy recovery wheel is provided with fixed outdoor-air damper described in first subparagraph.

Outdoor-Air Damper Operation: Open to **[25] <Insert number>** percent fixed minimum intake during occupied periods, and close during unoccupied periods.

Outdoor-Air Damper Operation: Open to **[25] <Insert number>** percent fixed minimum intake, and maximum 100 percent of the fan capacity to comply with ASHRAE Cycle II during occupied periods, and close during unoccupied periods. Microprocessor controller shall permit air-side economizer operation when outdoor air is less than **[60 deg F] <Insert temperature>**.

Carbon Dioxide Sensor Operation: During occupied periods, reset minimum outdoor-air ratio down to minimum **[10] <Insert number>** percent to maintain maximum **[800-ppm] <Insert value>** concentration.

Face-and-Bypass Damper Operation: Position damper to face of coils until room temperature equals thermostat set point; bypass after room-temperature set point is achieved.

Cooling Lockout: During economizer cycle operation, block out cooling.

HGBP: Open HGBP solenoid valve to maintain minimum suction pressure at compressor.

Energy Recovery Wheel Operation:

Factory-mounted and -wired, starting relay and manual motor starter for field wiring.

Occupied period is established by **[remote signal] [room occupancy sensor]**.

Energy recovery wheel and inlet and discharge fans operate during occupied periods after room temperature set point has been achieved.

Energy recovery wheel operates during occupied periods, but stops when unit ventilator controls call for cooling, and outdoor-air temperatures permit free air cooling.

Energy recovery wheel and fans stop during unoccupied periods.

Controller shall have volatile-memory backup.

* + - * 1. Building Automation System (BAS) Interface Requirements:

Interface relay for scheduled operation.

Interface relay to provide indication of fault at the central workstation.

Provide **[BACnet] [or] [LonWorks]** interface for central BAS workstation for the following functions:

Adjust set points.

Unit ventilator start, stop, and operating status.

Data inquiry to include **[outdoor-air damper position, ]**supply- and room-air temperature**[ and humidity]**.

Occupied and unoccupied schedules.

* + - * 1. Electrical Connection: Factory wire motors and controls for a single electrical connection.
			1. METAL SHELVES AND CABINETS

Retain features required for Project. Verify available features with manufacturer. Coordinate this article with Drawings.

* + - * 1. Include manufacturer's standard cabinets to match unit ventilators with required installation hardware as indicated:

Open Shelving with Reinforced Shelves:

**[Return-air plenum] [Radiation enclosure]** and aluminum bar grille with finish to match unit ventilator grille.

Through-piping enclosure with solid top.

Closed Shelving with Reinforced Shelves:

**[Return-air plenum] [Radiation enclosure]** and aluminum bar grille with finish to match unit ventilator grille.

Through-piping enclosure with solid top.

Two sliding doors with key-operated locks.

Utility compartment with access panel with key-operated lock.

Wall and corner filler sections, and end panels finished to match shelving.

* + - * 1. Painted Finish: Manufacturer's **[standard] [custom]** baked enamel, in color selected by Director’s Representative, applied to shelving before shipping.
				2. Cabinet Top: Plastic-laminate top in color and pattern selected by Director’s Representative from manufacturer's **[standard] [custom]** colors.
			1. CAPACITIES AND CHARACTERISTICS

If Project has more than one type or configuration of unit ventilator, delete this article and schedule unit ventilators on Drawings.

* + - * 1. Fan:

Airflow: **<Insert cfm>**.

External Static Pressure: **<Insert inches wg>**.

Fan Speed: **<Insert rpm>**.

Motor Horsepower: **<Insert horsepower>**.

Drive: **[Direct] [Belt]**.

* + - * 1. Cooling Capacity:

Total: **<Insert Btu/h>**.

Sensible: **<Insert Btu/h>**.

Entering-Air Dry-Bulb Temperature: **<Insert deg F>**.

Entering-Air Wet-Bulb Temperature: **<Insert deg F>**.

* + - * 1. Chilled-Water Coil:

Water Flow: **<Insert gpm>**.

Water-Side Pressure Loss: **<Insert feet wg>**.

Entering-Water Temperature: **<Insert deg F>**.

Air-Side Pressure Drop: **<Insert inches wg>**.

* + - * 1. Refrigerant Coil:

Suction Temperature: **<Insert deg F>**.

Air-Side Pressure Drop: **<Insert inches wg>**.

* + - * 1. Condensing Unit:

Ambient Temperature: **<Insert deg F>**.

Compressor Power Input: **<Insert kilowatts>**.

LEED Prerequisite EA 2 requires minimum efficiency equal to requirements in ASHRAE/IES 90.1. If applying for LEED certification, efficiency must be equal to or greater than minimum efficiency required by ASHRAE/IES 90.1, Table 6.8.1A, "Air Conditioners and Condensing Units," for cooling-only equipment and Table 6.8.1B, "Electrically Operated Unitary and Applied Heat Pumps - Minimum Efficiency Requirements," for heat pump applications.

Cooling Energy Efficiency **[(EER)] [(SEER)]: <Insert value>**.

Retain "Heating Coefficient of Performance" subparagraph below for heat pump applications.

Heating Coefficient of Performance: **<Insert value>**.

Voltage/Phase/Hertz: **<Insert values>**.

Full-Load Amperes: **<Insert value>**.

Maximum Circuit Amperes: **<Insert value>**.

Maximum Overcurrent Protection: **<Insert amperage>**.

* + - * 1. Heating Capacity:

Output: <**Insert Btu/h>**.

Entering-Air Temperature: **<Insert deg F>**.

Air-Temperature Rise: **<Insert deg F>**.

* + - * 1. Hot-Water Heating Coil:

Water Flow: **<Insert gpm>**.

Water-Side Pressure Loss: **<Insert feet wg>**.

Air-Side Pressure Drop: **<Insert inches wg>**.

Entering-Water Temperature: **<Insert deg F>**.

* + - * 1. Steam Heating Coil:

Inlet Steam Pressure: **<Insert psig>**.

Condensing Capacity: **<Insert lb/h>**.

Air-Side Pressure Drop: **<Insert inches wg>**.

* + - * 1. Electric-Resistance Heating Coil:

Capacity: **<Insert kilowatts>**.

Number of Steps: **<Insert number>**.

Air-Side Pressure Drop: **<Insert inches wg>**.

* + - * 1. Reheat Capacity:

Output: **<Insert Btu/h>**.

Entering-Air Temperature: **<Insert deg F>**.

Air-Temperature Rise: **<Insert deg F>**.

* + - * 1. Filters:

Retain third option in "Type" subparagraph below if applying for LEED certification. LEED Prerequisite IEQ 1 requires compliance with ASHRAE 62.1, which requires a MERV rating of 6 or higher.

Type: **[Washable foam] [Coated glass fiber] [Pleated cotton-polyester media]**.

Maximum Face Velocity: **<Insert fpm>**.

Thickness: **[1 inch] [2 inches] <Insert dimension>**.

* + - * 1. Energy Recovery Exhaust:

Airflow: **<Insert cfm>**.

Entering-Air Dry-Bulb Temperature: **<Insert deg F>**.

Entering-Air Wet-Bulb Temperature: **<Insert deg F>**.

Leaving-Air Dry-Bulb Temperature: **<Insert deg F>**.

Leaving-Air Wet-Bulb Temperature: **<Insert deg F>**.

Air-Side Pressure Drop: **<Insert inches wg>**.

Fan Motor Horsepower: **<Insert horsepower>**.

* + - * 1. Energy Recovery Outdoor Air:

Airflow: **<Insert cfm>**.

Entering-Air Dry-Bulb Temperature: **<Insert deg F>**.

Entering-Air Wet-Bulb Temperature: **<Insert deg F>**.

Leaving-Air Dry-Bulb Temperature: **<Insert deg F>**.

Leaving-Air Wet-Bulb Temperature: **<Insert deg F>**.

Air-Side Pressure Drop: **<Insert inches wg>**.

Motor Horsepower: **<Insert horsepower>**.

* + - * 1. Energy Recovery Wheel:

Heat-Transfer Efficiency: **<Insert percent>**.

Drive Motor Horsepower: **<Insert horsepower>**.

* + - * 1. Electrical Characteristics for Single-Point Connection:

Voltage/Phase/Hertz: **<Insert values>**.

Full-Load Amperes: **<Insert value>**.

Maximum Circuit Amperes: **<Insert value>**.

Maximum Overcurrent Protection: **<Insert amperage>**.

1. EXECUTION
	* + 1. EXAMINATION
				1. Examine areas, with Installer present, to receive unit ventilators for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
				2. Examine roughing-in for piping and electrical connections to verify actual locations before unit ventilator installation.
				3. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. INSTALLATION
				1. Install unit ventilators to comply with NFPA 90A and with all manufacturer’s requirements.

Retain first paragraph below for horizontal, suspended units.

* + - * 1. Suspend horizontal unit ventilators from structure with threaded steel rods and minimum [0.25-inch static-deflection, elastomeric vibration isolation hanger] [1.0-inch static-deflection spring hangers]. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."

Verify mounting height in first paragraph below with authorities having jurisdiction to comply with requirements of the Americans with Disabilities Act.

* + - * 1. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices **[48 inches] [60 inches] <Insert dimension>** above finished floor.

Retain paragraph below for condensing units not packaged with unit ventilators.

* + - * 1. Comply with requirements in Section 236200 "Packaged Compressor and Condenser Units" for condensing units matched to refrigerant cooling coil packaged in unit ventilators.
			1. CONNECTIONS

Coordinate piping installations and specialty arrangements with schematics on Drawings and with requirements specified in piping systems. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:

Install piping adjacent to machine to allow service and maintenance.

Connect piping to unit ventilator factory hydronic piping package. Install piping package if shipped loose.

Connect condensate drain to indirect waste.

Retain first paragraph below for unit ventilators with remote condensing units.

* + - * 1. Install refrigerant piping as required by Section 232300 "Refrigerant Piping," and add refrigerant as required to compensate for length of piping.

Retain first paragraph below for ducted, unit ventilators. Coordinate duct installation requirements with Drawings and with requirements specified in Section 233113 "Metal Ducts," Section 233116 "Nonmetal Ducts," and Section 233300 "Air Duct Accessories."

* + - * 1. Connect supply-air and return-air ducts to unit ventilators with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
				2. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
				3. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
			1. FIELD QUALITY CONTROL

Retain "Testing Agency," "Manufacturer's Field Service," and "Perform the following tests and inspections" paragraphs below to identify who shall perform tests and inspections. If retaining second option in "Testing Agency" paragraph or if retaining "Manufacturer's Field Service" or "Perform the following tests and inspections" paragraph, retain "Field quality-control reports" paragraph in "Informational Submittals" Article.

Retain "Manufacturer's Field Service" paragraph below to require a factory-authorized service representative to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a Company Field Advisor per OGS Spec Section 014216 to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform the following tests and inspections" paragraph below to require Contractor to perform tests and inspections.

* + - * 1. Perform the following tests and inspections**[ with the Company Field Advisor per OGS Spec Section 014216]**:

Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

Retain first subparagraph below if units have electric heat.

Operate electric heating elements through each stage to verify proper operation and electrical connections.

Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

Retain subparagraph below if energy recovery wheel is required.

Record temperatures entering and leaving energy recovery wheel when outdoor-air temperature is a minimum of 15 deg F higher, or 20 deg F lower, than room temperature.

* + - * 1. Remove and replace malfunctioning units and retest as specified above.
				2. Prepare test and inspection reports.
			1. ADJUSTING

Retain this article if control devices are specified in this Section; delete if they are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

* + - * 1. Adjust initial temperature and humidity set points.
				2. 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] <Insert number> visits to Project during other-than-normal occupancy hours for this purpose.
			1. DEMONSTRATION

Delete this article if factory-authorized service representative is not required.

* + - * 1. **[Engage a Company Field Advisor per OGS Spec Section 014216 to train] [Train]** Director’s Representative 's Facility’s maintenance personnel to adjust, operate, and maintain unit ventilators.

END OF SECTION 238223