SECTION 237313.13 - INDOOR, BASIC AIR-HANDLING UNITS

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

This Section may include provisions for LEED 2009, LEED v4, ASHRAE 189.1, IgCC, and Green Globes. Note that some sustainable design requirements are either mandatory or optional requirements that may be inserted in the Section Text using the hypertext links. Other requirements that are associated with sustainable design, and may be considered "best practice" or retained even if a sustainable design standard is not a project requirement, are discussed in the Evaluations.

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 factory-assembled, indoor air-handling units with limited features, including the following components and accessories:

Casings.

Fans, drives, and motors.

Coils.

Air filtration.

Dampers.

* + - 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 air-handling unit.

Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

Include unit dimensions and weight.

Include cabinet material, metal thickness, finishes, insulation, and accessories.

Fans:

Include certified fan-performance curves with system operating conditions indicated.

Include certified fan-sound power ratings.

Include fan construction and accessories.

Include motor ratings, electrical characteristics, and motor accessories.

Include certified coil-performance ratings with system operating conditions indicated.

Include filters with performance characteristics.

Retain subparagraph below if items are furnished as parts of air-handling units.

Include dampers, including housings, linkages, and operators.

* + - * 1. Shop Drawings: For each type and configuration of indoor, basic, air-handling unit.

Include plans, elevations, sections, and **[mounting] [attachment]** 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 fabrication and assembly of indoor, basic air-handling units, as well as procedures and diagrams.

Include diagrams for power, signal, and control wiring.

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: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

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

* + - * 1. Seismic Qualification Data: Certificates for indoor, basic air-handling units, 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.

Restraint of internal components.

* + - * 1. Source quality-control reports.
        2. Startup service reports.

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 manufacturer's warranty.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.
      2. 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.

Filters: **[One] <Insert number>** set(s) for each air-handling unit.

Gaskets: **[One] <Insert number>** set(s) for each access door.

Fan Belts: **[One] <Insert number>** set(s) for each air-handling unit fan.

* + - 1. WARRANTY

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

* + - * 1. Warranty: Manufacturer agrees to repair or replace components of indoor, basic, air-handling units that fail in materials or workmanship within specified warranty period.

Warranty Period: Manufacturer's standard, but not less than **[one] <Insert number>** year(s) from date of Substantial Completion.

1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. PERFORMANCE REQUIREMENTS
         1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70 “Standard for Electrical Safety in the Workplace”, by a qualified testing agency, and marked for intended location and application.
         2. NFPA Compliance: Comply with NFPA 90A “Standard for the Installation of Air-Conditioning and Ventilating Systems” for design, fabrication, and installation of air-handling units and components.

"ASHRAE 62.1 Compliance" paragraph below may be required to comply with Project requirements or authorities having jurisdiction. Sustainable design may require 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, the availability of units with components and features that comply with these requirements.

* + - * 1. ASHRAE 62.1 Compliance: Applicable requirements in ASHRAE 62.1 “Ventilation and Acceptable Indoor Air Quality”, 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. Sustainable design may require minimum efficiency equal to requirements in ASHRAE/IES 90.1.

* + - * 1. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1 “Energy Standard for Buildings Except Low-Rise Residential Buildings”, Section 6 - "Heating, Ventilating, and Air-Conditioning."

Not all basic air-handling unit manufacturers publish deflection rates indicated in "Structural Performance" paragraph below. Retain and revise after consulting manufacturers.

* + - * 1. Structural Performance: Casing panels shall be self-supporting and capable of withstanding positive/negative **[4-inch wg] <Insert value>** of internal static pressure, without exceeding a midpoint deflection of **[0.005 inches/inch] <Insert value>** of panel span.

Retain "Seismic Performance" paragraph below with "Seismic Qualification Data" paragraph in "Informational Submittals" Article for projects requiring seismic design. Delete paragraph if performance requirements are indicated on Drawings. Model building codes and ASCE/SEI 7 establish criteria for buildings subject to earthquake motions. Coordinate requirements with structural engineer.

* + - * 1. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to **[ASCE/SEI 7 “Minimum Design Loads and Associated Criteria for Buildings and Other Structures”] <Insert requirement>**.

Retain first subparagraph below to define the term "withstand" as it applies to this Project. Definition varies with type of building and occupancy and is critical to valid certification. Option is used for essential facilities where equipment must operate immediately after an earthquake.

The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified**[ and the unit will be fully operational after the seismic event]**."

For life-safety components required to function after an earthquake (such as fire-sprinkler systems, components that contain hazardous content, and storage racks in structures open to the public), the Component Importance Factor is 1.5. For other components, the Component Importance Factor is 1.0 unless the structure is in Seismic Use Group III and component is necessary for continued operation of facility or failure of component could impair continued operation of facility, in which case the Component Importance Factor is 1.5.

Component Importance Factor: **[1.5] [1.0]**.

See ASCE/SEI 7, Coefficients for Architectural Component Table and Seismic Coefficients for Mechanical and Electrical Components Table for requirements to be inserted in subparagraph below.

**<Insert requirements for Component Amplification Factor and Component Response Modification Factor>**.

* + - 1. CAPACITIES AND CHARACTERISTICS

If Project has more than one type or configuration of air-handling unit, delete this article and schedule air-handling units on Drawings.

* + - * 1. Supply Fan:

A few, but not all, manufacturers offer Type SWSI, airfoil unhoused centrifugal fans. Coordinate retained option in "Type" subparagraph below with manufacturers.

Type: **[DWDI, forward-curved centrifugal fan] [SWSI, airfoil unhoused centrifugal plenum fan] <Insert fan type>**.

Coordinate "Class" designation in first subparagraph below with fan performance requirements and fan class availability of manufacturers.

**[Class I] [Class II]**: AMCA 99-2408 “Operating Limits for Centrifugal Fans”.

For basic air-handling units, most manufacturers offer v-belt drive with forward-curved fans and direct drive with unhoused centrifugal fans. Coordinate retained option in "Drive" subparagraph below with manufacturers.

Drive: **[V-belt] [Direct]**.

The majority of manufacturers offer one fan; coordinate with manufacturers if indicating more than one.

Number of Fan Wheels: **[One] <Insert number>**.

Fan Diameter: **<Insert number>** inches.

Airflow: **<Insert number>** cfm.

Total Static Pressure: **<Insert number>** inches wg.

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

Speed: **<Insert rpm>**.

Maximum Outlet Velocity: **<Insert number>** fpm.

Motor:

Size: **<Insert horsepower>**.

Speed: **<Insert rpm>**.

Volts: **[208] [230] [460] <Insert value>** V.

Phase: **[Three] <Insert number>**.

Hertz: **[60] <Insert number>** Hz.

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

Minimum Circuit Ampacity: **<Insert value>** A.

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

Fan Discharge Sound Power, dB:

1st Octave: **<Insert value>**.

2nd Octave: **<Insert value>**.

3rd Octave: **<Insert value>**.

4th Octave: **<Insert value>**.

5th Octave: **<Insert value>**.

6th Octave: **<Insert value>**.

7th Octave: **<Insert value>**.

8th Octave: **<Insert value>**.

* + - * 1. **[Return ]**Fan:

Type: **[DWDI, forward-curved centrifugal fan] [SWSI, airfoil unhoused centrifugal plenum fan] <Insert fan type>**.

**[Class I] [Class II]**: AMCA 99-2408 “Operating Limits for Centrifugal Fans.

Drive: **[V-belt] [Direct]**.

The majority of manufacturers offer one fan; coordinate with manufacturers if indicating more than one.

Number of Fan Wheels: **[One] <Insert number>**.

Fan Diameter: **<Insert number>** inches.

Airflow: **<Insert number>** cfm.

Total Static Pressure: **<Insert number>** inches wg.

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

Speed: **<Insert rpm>**.

Maximum Outlet Velocity: **<Insert number>** fpm.

Motor:

Size: **<Insert value>** hp.

Speed: **<Insert rpm>**.

Volts: **[208] [230] <Insert value>** V.

Phase: **[Three] <Insert number>**.

Hertz: **[60] <Insert number>** Hz.

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

Minimum Circuit Ampacity: **<Insert value>** A.

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

Fan Inlet Sound Power, dB:

1st Octave: **<Insert value>**.

2nd Octave: **<Insert value>**.

3rd Octave: **<Insert value>**.

4th Octave: **<Insert value>**.

5th Octave: **<Insert value>**.

6th Octave: **<Insert value>**.

7th Octave: **<Insert value>**.

8th Octave: **<Insert value>**.

* + - * 1. Preheat Coil:

Heat-Transfer Rate: **<Insert number>** Btu/h.

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

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

Face Area: **<Insert number>** sq. ft..

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

Maximum Air-Side, Static-Pressure Drop: **<Insert number>** inches wg.

Fin Spacing: Maximum **<Insert number>** fins per inch.

Minimum Number of Rows: **<Insert number>**.

Water:

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

Maximum Water Pressure Drop: **<Insert number>** feet of head.

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

Leaving-Water Temperature: **<Insert number>** deg F.

Tube Velocity: **<Insert number>** fpm.

Steam:

Steam Flow: **<Insert number>** lb/h.

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

Outer-Tube Diameter: **<Insert number>** inches.

* + - * 1. Heating Coil:

Heat-Transfer Rate: **<Insert number>** Btu/h.

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

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

Face Area: **<Insert number>** sq. ft..

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

Maximum Air-Side, Static-Pressure Drop: **<Insert number>** inches wg.

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

Fin Spacing: Maximum **<Insert number>** fins per inch.

Water:

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

Maximum Water Pressure Drop: **<Insert number>** feet of head.

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

Leaving-Water Temperature: **<Insert number>** deg F.

Tube Velocity: **<Insert number>** fpm.

Steam:

Steam Flow: **<Insert number>** lb/h.

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

* + - * 1. Electric Heating Coil:

Heat-Transfer Rate: **<Insert number>** Btu/h.

Input: **<Insert kilowatts>**.

Volts: **[120] [208] [230] <Insert value>** V.

Phase: **[Single] [Three]**.

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

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

* + - * 1. Cooling Coil:

Sensible Heat-Transfer Rate: **<Insert number>** Btu/h.

Total Heat-Transfer Rate: **<Insert number>** Btu/h.

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

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

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

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

Face Area: **<Insert number>** sq. ft..

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

Maximum Air-Side, Static-Pressure Drop: **<Insert number>** inches wg.

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

Fin Spacing: Maximum **<Insert number>** fins per inch.

Water:

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

Maximum Water Pressure Drop: **<Insert number>** feet of head.

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

Leaving-Water Temperature: **<Insert number>** deg F.

Tube Velocity: **<Insert number>** fpm.

Refrigerant:

Refrigerant Type: **<Insert refrigerant type>**.

* + - * 1. Filters:

Type: **<Insert type>**.

Face Dimensions, each: **<Insert number>** inches by inches.

Depth: **<Insert number>** inches.

Number of Filters in Filter Bank: **<Insert number>** wide by **<Insert number>** high.

Access Location: **[Side] <Insert location>**.

Maximum or Rated Face Velocity: **<Insert number>** fpm.

Initial Resistance: **<Insert number>** inches wg.

Recommended Final Resistance: **<Insert number>** inches wg.

Retain "Minimum Efficiency Reporting Value and Average Arrestance" subparagraph below if requiring MERV 1, 2, 3, or 4.

Minimum Efficiency Reporting Value and Average Arrestance:

MERV Rating and Corresponding Average Arrestance: **[MERV 1] [MERV 2] [MERV 3] [MERV 4]**, and corresponding average arrestance according to ASHRAE 52.2 “Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size”.

Retain "Minimum Efficiency Reporting Value" subparagraph below if inserting requirements for MERV 5 and higher. LEED 2009 Prerequisite IEQ 1 and LEED v4 Prerequisite EQ "Minimum Indoor Air Quality Performance," require compliance with ASHRAE 62.1 (2007 and 2010 versions, respectively), which require a MERV rating of 6 or higher for service to occupied spaces. LEED 2009 IEQ Credit 5 and LEED v4 EQ Credit, "Enhanced Indoor Air Quality Strategies," require MERV 13 or higher. Insert values appropriate to Project sustainability goals.

Minimum Efficiency Reporting Value:

MERV Rating: **[MERV 6] [MERV 13] <Insert value>**, according to ASHRAE 52.2 “Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size”.

* + - 1. MANUFACTURERS
         1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

Airtherm; a Mestek company.

Buffalo Air Handling.

Carrier Corporation.

Daikin Applied.

Dunham-Bush, Inc.

ENVIRO-TEC; by Johnson Controls, Inc.

Titus, a division of Air System Components; Johnson Controls, Inc.

Trane.

YORK; a Johnson Controls company.

Approved equivalent.

* + - 1. UNIT CASINGS
         1. General Fabrication Requirements for Casings;

Forming: Form walls, roofs, and floors with at least two breaks at each joint.

Joints: Sheet metal screws or pop rivets.

Sealing: Seal all joints with water-resistant sealant. Hermetically seal at each corner and around entire perimeter.

Base Rail:

Material: **[Galvanized steel] <Insert material>**.

Height: **[4 inches] <Insert dimension>**.

Retain "Single-Wall Construction" or "Double-Wall Construction" paragraph below.

* + - * 1. Single-Wall Construction

Material: **[Galvanized steel] <Insert material>** with **[manufacturer's standard finish] <Insert special coating>**.

Floor Plate: **[Galvanized steel] <Insert material>, [treadplate, ]minimum [18 gauge] <Insert value>** thick.

Insulation and Adhesive:

Materials: **[ASTM C1071, Type I or Type II glass-fiber blanket or board insulation, neoprene coated or foil faced] <Insert insulation type>**.

Insulation R-Value: Minimum **<Insert value>**.

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

Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface [**of all complete unit**] [**, downstream from, and including, the cooling coil section**].

Liner Adhesive: Comply with ASTM C916 “Standard Specification for Adhesives for Duct Thermal Insulation”, Type I.

Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, or mechanical attachment, to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in cabinet.

* + - * 1. Double-Wall Construction:

In "Outside Casing Wall" subparagraph below, not all options are available from all manufacturers; consult manufacturers.

Outside Casing Wall: [**Galvanized steel**] <**Insert material**>, minimum [**18 gauge**] <**Insert value**> thick, with [**manufacturer's standard finish**] <**Insert special coating**>.

Inside Casing Wall: [**G90 galvanized steel**] <**Insert material**>, [**solid**] [**perforated**], minimum [**18 gauge**] <**Insert value**> thick.

Floor Plate: [**G90 galvanized steel**] <**Insert material**>, [**treadplate,**]minimum [**18 gauge**] <**Insert value**> thick.

Casing Insulation:

In "Materials" subparagraph below, not all manufacturers offer each option; consult manufacturers.

Materials: [**Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071 “Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material)”**] [**or**] [**injected polyurethane foam insulation**].

Casing Panel R-Value: Minimum <**Insert value**>.

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

Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

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

* + - * 1. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1 “Ventilation and Acceptable Indoor Air Quality”.
        2. Static-Pressure Classifications:

For Unit Sections Upstream of Fans: Minus [**2-inch wg**] [**3-inch wg**] <**Insert value**>.

For Unit Sections Downstream and Including Fans: [**2-inch wg**] [**3-inch wg**] [**4-inch wg**] <**Insert value**>.

* + - * 1. Panels and Doors:

Panels:

Fabrication: Formed and reinforced with same materials and insulation thickness as casing.

Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.

Gasket: Neoprene, applied around entire perimeters of panel frames.

Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least **[18 inches] [24 inches] <Insert dimension>** wide by full height of unit casing up to a maximum height of **[60 inches] [72 inches] <Insert dimension>**.

Doors:

Fabrication: Formed and reinforced with same materials and insulation thickness as casing.

Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type 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.

Gasket: Neoprene, applied around entire perimeters of frame.

Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least **[18 inches] <Insert dimension>** wide by full height of unit casing up to a maximum height of **[60 inches] <Insert dimension>**.

ASHRAE 62.1, Section "Access for Inspection, Cleaning, and Maintenance," sets requirements for equipment access.

Locations and Applications:

Verify that the sections listed below are large enough for access panels and doors.

Fan Section: **[Doors] [Panels]**.

Coil Section: Panels.

Access Section: **[Doors] [Panels]**.

Access Sections Immediately Upstream and Downstream of Coil Sections: **[Doors] [Panels]**.

Damper Section: **[Doors] [Panels]**.

Filter Section: **[Doors] [Panels]** large enough to allow periodic removal and installation of filters.

Mixing Section: **[Doors] [Panels]**.

* + - * 1. Condensate Drain Pans:

Location: Each type of cooling coil.

Construction:

Single-wall, **[galvanized-steel or noncorrosive polymer] [stainless-steel]** sheet.

Drain Connection:

Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on **[one end] [both ends]** of pan.

Minimum Connection Size: **[NPS 1] [NPS 2] <Insert pipe size>**.

Retain last option in "Slope" subparagraph below to comply with LEED 2009 Prerequisite IEQ 1 or LEED v4 Prerequisite EQ "Minimum Indoor Air Quality Performance" if required by Project requirements or authorities having jurisdiction.

Slope: Minimum **[0.125 in./ft.] <Insert dimension>** slope**[, to comply with ASHRAE 62.1 “Ventilation and Acceptable Indoor Air Quality”,]** 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.

Retain last option in "Length" subparagraph below to comply with LEED 2009 Prerequisite IEQ 1 or LEED v4 Prerequisite EQ "Minimum Indoor Air Quality Performance" if required by Project requirements or authorities having jurisdiction.

Length: Extend drain pan downstream from leaving face **[for distance to comply with ASHRAE 62.1 “Ventilation and Acceptable Indoor Air Quality”] <Insert distance>**.

Width: Entire width of water producing device.

Depth: A minimum of **[2 inches] <Insert dimension>** deep.

* + - 1. FAN, DRIVE, AND MOTOR SECTION
         1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
         2. Fans: Centrifugal, rated according to AMCA 210 “Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating”; galvanized steel; mounted on solid-steel shaft.

Shafts: With field-adjustable alignment.

Turned, ground, and polished hot-rolled steel with keyway.

Shaft Bearings:

Heavy-duty, self-aligning, pillow-block type with an **[L-50] <Insert bearing life rating>** rated life of minimum **[100,000] <Insert number>** hours according to ABMA 9 “Load Ratings and Fatigue Life for Ball Bearings”.

Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.

Retain "Forward-Curved, Centrifugal Fan Wheels" or "Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels)" subparagraph below if these fan wheels are retained as options in "Capacities and Characteristics" Article.

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; **[steel] [aluminum]** hub swaged to backplate and fastened to shaft with setscrews.

Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

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] <Insert dimension>**.

Shaft Lubrication Lines: Extended to a location outside the casing.

In "Flexible Connector" subparagraph below, select metal compatible with casing material option selected.

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, galvanized-steel sheet.

Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181 “Standard for Safety Factory-Made Air Ducts and Air Connectors”, Class 1.

* + - * 1. Drive, Direct: Factory-mounted, direct drive.
        2. Drive, Belt: Factory-mounted, V-belt drive, with adjustable alignment and belt tensioning, and with **[1.5] [1.25]** service factor based on fan motor.

Pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at the factory.

Belts: Oil resistant, non-sparking and nonstatic; in matched sets for multiple-belt drives.

Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; **[0.146-inch-] <Insert dimension>** thick, **[3/4-inch] <Insert dimension>** diamond-mesh wire screen, welded to steel angle frame; prime coated.

* + - * 1. Motors:

Retain first subparagraph below if motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." If different characteristics are required, insert subparagraphs to suit Project.

Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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.

Verify enclosure types with manufacturer of specified equipment.

Enclosure Type: **[Open, dripproof] [Totally enclosed, fan cooled] <Insert type>**.

Retain "Enclosure Materials," "Motor Bearings," "Unusual Service Conditions," "Efficiency," and "NEMA Design" subparagraphs below if options are available from equipment manufacturers and are different from default requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment." Consider each subparagraph and retain only those that vary from default requirements.

Enclosure Materials: **[Cast iron] <Insert material>**.

Motor Bearings: **<Insert requirements>**.

Unusual Service Conditions:

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

Altitude: **<Insert feet>** above sea level.

High humidity.

**<Insert conditions>**.

Efficiency: Premium efficient as defined in NEMA MG 1 “Motors and Generators”.

NEMA Design: **<Insert designation>**.

5-hp limit in "Motor Pulleys" subparagraph below is standard with many manufacturers but is a designer's choice.

Motor Pulleys: Adjustable pitch for use with **[5] <Insert number>**-hp motors and smaller; fixed pitch for use with motors larger than **[5] <Insert number>** hp. Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.

Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

* + - * 1. Motors:

First paragraph below is an example of variable-frequency controllers. Retain features and attributes to suit Project, and verify their availability with manufacturers.

Retain one of two "Variable-Frequency Motor Controller" paragraphs below. First paragraph coordinates with electrical variable-frequency motor-control specification. Second paragraph describes basic features of variable-frequency motor controllers and can be used when the variable-frequency motor controller is not on a schedule on Drawings or is different from that specified in variable-frequency motor-controller specification. Coordinate either option with electrical engineer and manufacturers.

* + - * 1. Variable-Frequency Motor Controller: Comply with Section 262923 "Variable-Frequency Motor Controllers."
        2. Variable-Frequency Motor Controller: Serving **[each fan individually] [all fans combined]** in fan array.

Manufactured Units: Pulse-width modulated; **[constant torque] [and] [variable torque]** **<Insert application>** for **[Design A and Design B] [inverter-duty]** motors.

Output Rating: Three phase; 10 to **[60 Hz, with voltage proportional to frequency throughout voltage range] [66 Hz, with torque constant as speed changes]**; maximum voltage equals input voltage.

Unit Operating Requirements:

Internal Adjustability:

Minimum Speed: 5 to 25 percent of maximum rpm.

Maximum Speed: 80 to 100 percent of maximum rpm.

Acceleration: **[0.1 to 999.9] <Insert range>** seconds.

Deceleration: **[0.1 to 999.9] <Insert range>** seconds.

Current Limit: 30 to minimum of 150 percent of maximum rating.

Self-Protection and Reliability Features:

Surge suppression.

Loss of input signal protection.

Under- and overvoltage trips.

Variable-frequency motor controller and motor-overload/overtemperature protection.

Critical frequency rejection.

Loss-of-phase protection.

Reverse-phase protection.

Motor-overtemperature fault.

Bidirectional autospeed search.

Torque boost.

Motor temperature compensation at slow speeds.

Panel-mounted operator station.

Historical logging information and displays.

Digital indicating devices.

Control Signal Interface: Electric.

Proportional Integral Directive (PID) control interface.

DDC system for HVAC Protocols for Network Communications: **[ASHRAE 135 “A Data Communication Protocol for Building Automation and Control Networks”] <Insert protocol type>**.

Line Conditioning:

Input line conditioning.

Output filtering.

EMI/RFI filtering.

Insert additional features below after confirming availability from manufacturers.

**<Insert features>**.

* + - 1. COIL SECTION
         1. General Requirements for Coil Section:

Comply with AHRI 410 “Forced-Circulation Air-Cooling and Air-Heating Coils”.

Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).

Coils shall not act as structural component of unit.

* + - * 1. Preheat Coils:

Retain "Electrical Coils," "Hot-Water Coils," or "Steam Coils" subparagraph below for preheat coil type. Not all manufacturers offer electrical coils for preheat; consult manufacturers.

Electrical Coils: Comply with UL 1995 “Standard for Safety Heating and Cooling Equipment”.

Casing Assembly: **[Slip-in] [Flanged]** type with galvanized-steel frame.

Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

Control Panel: **[Unit] [Remote]** mounted with disconnecting means and overcurrent protection.

**[Magnetic] [Mercury]** contactor.

Solid-state, stepless pulse controller.

Toggle switches, one per step.

Step controller.

Time-delay relay.

Pilot lights, one per step.

Airflow proving switch.

In "Hot-Water Coils" subparagraph below, coordinate type with manufacturers.

Hot-Water Coils: **[Continuous circuit] [Self-draining] [Cleanable]**.

Piping Connections: **[Threaded] [Flanged], [same end] [opposite ends]** of coil.

Tube Material: **[Copper] <Insert material>**.

Fin Type: Plate.

Fin Material: **[Aluminum] [Copper] <Insert material>**.

Fin Thickness: **<Insert number>** inches.

Fin and Tube Joint: **[Mechanical bond] [Silver brazed]**.

Headers:

Cast iron with**[ cleaning plugs and]** drain and air vent tappings **[ extended to exterior of unit]**.

Seamless copper tube with brazed joints, prime coated.

Fabricated steel, with brazed joints, prime coated.

Provide insulated cover to conceal exposed outside casings of headers.

Frames: Channel frame, minimum 0.052-inch- thick galvanized steel.

Pressure and temperature ratings in first subparagraph below are standard for most copper tube coils. Other materials have different ratings.

Coil Working-Pressure Ratings: **[200 psig, 325 deg F] <Insert value and temperature>**.

Coating: **[None] [Corrosion-resistant coating]**.

In "Steam Coils" subparagraph below, coordinate type with manufacturers.

Steam Coils: **[Distributed] [Single tube]**.

Steam Outer-Tube Diameter: **<Insert number>** inches.

Piping Connections: **[Threaded] [Flanged]**, **[same end] [opposite ends]** of coil.

Tube Material: **[Copper] <Insert material>**.

Fin Type: Plate.

Fin Material: **[Aluminum] [Copper] <Insert material>**.

Fin Thickness: **<Insert number>** inches.

Fin and Tube Joint: **[Mechanical bond] [Silver brazed]**.

Headers:

Cast iron with**[ cleaning plugs and]** drain and air vent tappings **[ extended to exterior of unit]**.

Seamless copper tube with brazed joints, prime coated.

Fabricated steel, with brazed joints, prime coated.

Provide insulated cover to conceal exposed outside casings of headers.

Frames: Channel frame, minimum 0.052-inch- thick galvanized steel.

Pressure and temperature ratings in first subparagraph below are standard for most copper tube coils. Other materials have different ratings.

Coil Working-Pressure Ratings: **[200 psig, 325 deg F] <Insert value and temperature>**.

Coating: **[None] [Corrosion-resistant coating]**.

* + - * 1. Heating Coils:

Retain "Electrical Coils," "Hot-Water Coils," or "Steam Coils" subparagraph below for heating coil type.

Electrical Coils: Comply with UL 1995 “Standard for Safety Heating and Cooling Equipment”.

Casing Assembly: **[Slip-in] [Flanged]** type with galvanized-steel frame.

Open Heating Elements: Resistance wire of 80 percent nickel and 20 percent chromium supported and insulated by floating ceramic bushings recessed into casing openings, fastened to supporting brackets, and mounted in galvanized-steel frame.

Overtemperature Protection: Disk-type, automatically resetting, thermal-cutout, safety device; serviceable through terminal box without removing heater from coil section.

Secondary Protection: Load-carrying, manually resetting or manually replaceable, thermal cutouts; factory wired in series with each heater stage.

Control Panel: **[Unit] [Remote]** mounted with disconnecting means and overcurrent protection.

**[Magnetic] [Mercury]** contactor.

Solid-state, stepless pulse controller.

Toggle switches, one per step.

Step controller.

Time-delay relay.

Pilot lights, one per step.

Airflow proving switch.

In "Hot-Water Coils" subparagraph below, coordinate type with manufacturers.

Hot-Water Coils: **[Continuous circuit] [Self-draining] [Cleaning]**.

Piping Connections: **[Threaded] [Flanged], [same end] [opposite ends]** of coil.

Tube Material: **[Copper] <Insert material>**.

Fin Type: Plate.

Fin Material: **[Aluminum] [Copper] <Insert material>**.

Fin Thickness: **<Insert number>** inches.

Fin and Tube Joint: **[Mechanical bond] [Silver brazed]**.

Headers:

Cast iron with**[ cleaning plugs and]** drain and air vent tappings **[ extended to exterior of unit]**.

Seamless copper tube with brazed joints, prime coated.

Fabricated steel, with brazed joints, prime coated.

Provide insulated cover to conceal exposed outside casings of headers.

Frames: Channel frame, minimum 0.052-inch- thick galvanized steel.

Pressure and temperature ratings in first subparagraph below are standard for most copper tube coils. Other materials have different ratings.

Coil Working-Pressure Ratings: **[200 psig, 325 deg F] <Insert value and temperature>**.

Coating: **[None] [Corrosion-resistant coating]**.

In "Steam Coils" subparagraph below, coordinate type with manufacturers.

Steam Coils: **[Distributed] [Single tube]**.

Steam Outer-Tube Diameter: **<Insert number>** inches.

Piping Connections: **[Threaded] [Flanged]**, **[same end] [opposite ends]** of coil.

Tube Material: **[Copper] <Insert material>**.

Fin Type: Plate.

Fin Material: **[Aluminum] [Copper] <Insert material>**.

Fin Thickness: **<Insert number>** inches.

Fin and Tube Joint: **[Mechanical bond] [Silver brazed]**.

Headers:

Cast iron with**[ cleaning plugs and]** drain and air vent tappings **[ extended to exterior of unit]**.

Seamless copper tube with brazed joints, prime coated.

Fabricated steel, with brazed joints, prime coated.

Provide insulated cover to conceal exposed outside casings of headers.

Frames: Channel frame, minimum 0.052-inch- thick galvanized steel.

Pressure and temperature ratings in first subparagraph below are standard for most copper tube coils. Other materials have different ratings.

Coil Working-Pressure Ratings: **[200 psig, 325 deg F] <Insert value and temperature>**.

Coating: **[None] [Corrosion-resistant coating]**.

* + - * 1. Cooling Coils:

Retain "Chilled-Water Coil" or "Refrigerant Coil" subparagraph below.

In "Chilled-Water Coil" subparagraph below, coordinate type with manufacturers.

Chilled-Water Coil: **[Continuous circuit] [Self-draining] [Cleanable]**.

Retain third option in "Piping Connections" subparagraph below for freeze protection.

Piping Connections: **[Threaded] [Flanged]**, **[same end] [opposite ends]** of coil.

Tube Material: **[Copper] <Insert material>**.

Tube Thickness: **<Insert number>** inches.

Fin Type: Plate.

Fin Material: **[Aluminum] [Copper] <Insert material>**.

Fin Thickness: **<Insert number>** inches.

Fin and Tube Joint: **[Mechanical bond] [Silver brazed]**.

Headers:

Cast iron with**[ cleaning plugs and]** drain and air vent tappings **[ extended to exterior of unit]**.

Seamless copper tube with brazed joints, prime coated.

Fabricated steel, with brazed joints, prime coated.

Provide insulated cover to conceal exposed outside casings of headers.

Frames: Channel frame, minimum 0.052-inch- thick galvanized steel.

Coatings: **[None] [Corrosion-resistant coating]**.

Pressure and temperature ratings in first subparagraph below are standard for most copper tube coils. Other materials have different ratings.

Working-Pressure Ratings: **[200 psig, 325 deg F] <Insert value and temperature>**.

Refrigerant Coil:

Tubes: **[Copper] <Insert material>**.

Fins:

Material: **[Aluminum] <Insert material>**.

Fin and Tube Joints: Mechanical bond.

Headers: **[Seamless-copper headers with brazed connections] <Insert material and connections>**.

Frames: **[Galvanized steel] <Insert material frame>**.

Coatings: **[None] [Corrosion-resistant coating]**.

Ratings: Designed, tested, and rated according to ASHRAE 33 “Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils” and AHRI 410 “Forced-Circulation Air-Cooling and Air-Heating Coils”.

Working Pressure: Minimum 300 psig

* + - 1. AIR FILTRATION SECTION

Retain one or more of three paragraphs below to require that filters be provided under other filter sections and retain appropriate side access housings to be provided by air-handling manufacturer. Retain applicable filter paragraphs to require that filters be provided by air-handling unit manufacturer. Confirm filter availability with manufacturers.

* + - * 1. Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."
        2. Panel Filters:

Description: **[Flat, non-pleated] [Pleated]** factory-fabricated, self-supported disposable air filters with holding frames.

Filter Unit Class: UL 900 “Standard for Safety Air Filter Units”.

Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.

Filter-Media Frame: **[High wet-strength beverage board] <Insert material>** with perforated metal retainer, or metal grid, on outlet side.

Retain "Adhesive, Sustainability Projects" paragraph below if required for sustainability.

* + - * 1. Adhesive, Sustainability Projects: As recommended by air-filter manufacturer and with a VOC content of 80 g/L or less.

Retain "Adhesive, LEED for Schools Projects" paragraph below if required for sustainability.

* + - * 1. Adhesive, LEED for Schools Projects: As recommended by air-filter manufacturer and that complies with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
        2. Side-Access Filter Mounting Frames:

Particulate Air Filter Frames: Match inner casing and outer casing material, and insulation thickness. **[Galvanized steel] <Insert material>** track.

Sealing: Incorporate positive-sealing device to ensure seal between gasketed material on channels to seal top and bottom of filter cartridge frames to prevent bypass of unfiltered air.

* + - 1. DAMPERS

Retain "Dampers" paragraph below if dampers are specified in Section 230923.12 "Control Dampers." Retain "Outdoor- and Return-Air Dampers" paragraph if dampers are to be provided by unit manufacturer. Not all manufacturers offer this option; consult manufacturers.

* + - * 1. Dampers: Comply with requirements in Section 230923.12 "Control Dampers."

Low-leakage dampers in "Outdoor- and Return-Air Dampers" paragraph below are available from most manufacturers and from manufacturers of temperature-control equipment. ASHRAE/IES 90.1 limits maximum damper leakage based on climate zone, number of stories, damper function (intake, exhaust/relief), and damper type (motorized, non-motorized). The most restrictive across all climate zones, number of stories, damper function, and damper type is 4 cfm/sq. ft. (20 L/s per sq. m) at 1-inch wg (250 Pa). This is the maximum leakage cited in paragraph.

* + - * 1. Outdoor- and Return-Air Dampers: Low-leakage, double-skin, airfoil-blade, **[galvanized-steel] <Insert material>** dampers with compressible jamb seals and extruded-vinyl blade edge seals in **[opposed] [parallel]**-blade arrangement with **[zinc-plated ]**steel operating rods rotating in **[sintered bronze or nylon] <Insert material>** bearings mounted in a single **[galvanized-steel]** **<Insert material>** 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-inch wg.

Retain "Damper Operators" paragraph below if damper operators are specified in Section 230923.12 "Control Dampers." Retain "Electronic Damper Operators" paragraph to require that damper operators be provided by air-handling unit manufacturer. Not all manufacturers offer this option; consult manufacturers. If retaining second paragraph, coordinate with Division 23 controls Sections for electrical service to devices.

* + - * 1. Damper Operators: Comply with requirements in Section 230923.12 "Control Dampers."
        2. Electronic Damper Operators:

Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment." Insert subparagraphs to suit Project if different characteristics are required.

Operator Motors:

Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

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.

Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

Size dampers for running torque calculated as follows:

Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.

Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.

Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.

Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.

Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

Coupling: V-bolt and V-shaped, toothed cradle.

Overload Protection: Electronic overload or digital rotation-sensing circuitry.

Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.

Coordinate first two subparagraphs and "Proportional Signal" subparagraph below with Division 23 controls Sections.

Power Requirements (Two-Position Spring Return): **[24 V dc] [120 V ac] [230 V ac]**.

Power Requirements (Modulating): Maximum 10 VA at 24 V ac or 8 W at 24 V dc.

Proportional Signal: 2 to 10 V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

Temperature Rating: **[Minus 22 to plus 122 deg F] [40 to 104 deg F]**.

Run Time: **[12 seconds open, 5 seconds closed] [30 seconds] [60 seconds] [120 seconds]**.

* + - * 1. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.
        2. Combination Filter and Mixing Section:

Cabinet support members shall hold **[2-inch-] <Insert dimension>** thick, pleated, flat, permanent or throwaway filters.

* + - 1. AIR BLENDERS
         1. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.
      2. MATERIALS
         1. Steel:

ASTM A36 “Standard Specification for Carbon Structural Steel” for carbon structural steel.

ASTM A568 “Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements” for steel sheet.

* + - * 1. Stainless Steel:

Manufacturer's standard grade for casing.

Manufacturer's standard type, ASTM A240 “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications” for bare steel exposed to airstream or moisture.

* + - * 1. Galvanized Steel: ASTM A653 “Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process”.
        2. Aluminum: ASTM B209 “Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate”.

Retain first paragraph below if corrosion-resistant coating is specified in Section 230546 "Coatings for HVAC." Retain "Corrosion-Resistant Coating" paragraph if corrosion-resistant coating options are cited in "Coil Section" Article and if corrosion-resistant coating is specified in this Section. Determine availability with air-handling unit manufacturers.

* + - * 1. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
        2. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a **[3000] <Insert time>**-hour salt-spray test according to ASTM B117 “Standard Practice for Operating Salt Spray (Fog) Apparatus”.

Standards:

ASTM B117 “Standard Practice for Operating Salt Spray (Fog) Apparatus” for salt spray.

ASTM D2794 “Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact)” for minimum impact resistance of 100 in-lb

ASTM D3359 “Standard Test Methods for Rating Adhesion by Tape Test” for cross hatch adhesion of 5B.

Application: **[Immersion] [Spray]**.

Thickness: **[1 mil] <Insert value>**.

Gloss: Minimum gloss of 60 on a 60-degree meter.

* + - 1. SOURCE QUALITY CONTROL

The majority of listed manufacturers are AHRI 430 certified, but a few are not; consult manufacturers. Note that AHRI 430 requires fan performance to be in compliance with AMCA 210.

* + - * 1. AHRI 430 Certification: Air-handling units and their components shall be factory tested according to AHRI 430 “Performance Rating of Central Station Air-Handling Unit Supply Fans” and shall be listed and labeled by AHRI.

Retain "AMCA 300 and AMCA 301, or AHRI 260 Certification" paragraph below when specifying maximum sound levels. Manufacturers typically offer one certification or the other.

* + - * 1. AMCA 300 and AMCA 301, or AHRI 260 Certification: Air-handling unit fan sound ratings shall comply with AMCA 300, "Reverberant Room Methods for Sound Testing of Fans " and AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data," or with AHRI 260, "Sound Rating of Ducted Air Moving and Conditioning Equipment."
        2. Water Coils: Factory tested to 300 psig according to AHRI 410 “Forced-Circulation Air-Cooling and Air-Heating Coils” and ASHRAE 33 “Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils”.
        3. Steam Coils: Factory tested to 300 psig, and to 200 psig underwater, according to AHRI 410 “Forced-Circulation Air-Cooling and Air-Heating Coils” and ASHRAE 33 “Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils”.
        4. Refrigerant Coils: Factory tested to minimum 450-psig internal pressure, and to minimum 300-psig internal pressure while underwater, according to AHRI 410 “Forced-Circulation Air-Cooling and Air-Heating Coils” and ASHRAE 33 “Methods of Testing Forced-Circulation Air-Cooling and Air-Heating Coils”.

1. EXECUTION
   * + 1. EXAMINATION
          1. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
          2. Examine casing insulation materials and filter media before air-handling unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.
          3. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.
          4. Proceed with installation only after unsatisfactory conditions have been corrected.
       2. INSTALLATION
          1. Equipment Mounting:

Retain first subparagraph below to require equipment to be installed on cast-in-place concrete equipment bases.

Install air-handling units on cast-in-place concrete equipment bases. Coordinate sizes and locations of concrete bases with actual equipment provided. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Retain one of two subparagraphs below. Retain first for projects in seismic areas; retain second for projects not in seismic areas. Indicate vibration isolation and seismic-control device types and minimum deflection in supported equipment schedule on Drawings.

Comply with requirements for vibration isolation and seismic-control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

Comply with requirements for vibration isolation devices specified in Section 230548.13 "Vibration Controls for HVAC."

* + - * 1. Suspended Units: Suspend**[ and brace]** units from structural-steel support frame using threaded steel rods and spring hangers. Coordinate sizes and locations of structural-steel support members with actual equipment provided. Comply with requirements for vibration isolation devices specified in **[Section 230548 "Vibration and Seismic Controls for HVAC."] [Section 230548.13 "Vibration Controls for HVAC."]**
        2. Arrange installation of units to provide access space around air-handling units for service and maintenance.

Sustainable design systems require filters with a minimum MERV 13 rating for air delivered to the occupied space. Air-handling units should not be used for temporary heating and ventilating unless expressly approved by Director’s Representative. If used during construction, see SMACNA's "IAQ Guidelines for Occupied Buildings under Construction" for procedures to protect HVAC system.

* + - * 1. 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.
        2. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."
      1. PIPING CONNECTIONS

Coordinate piping installations and specialty arrangements with 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.
        2. Where installing piping adjacent to air-handling unit, allow for service and maintenance.
        3. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
        4. Connect condensate drain pans using **[NPS 1-1/4] <Insert pipe size>**, ASTM B88 “Standard Specification for Seamless Copper Water Tube”, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
        5. Hot- and Chilled-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.
        6. Steam and Condensate Piping: Comply with applicable requirements in Section 232213 "Steam and Condensate Heating Piping" and Section 232216 "Steam and Condensate Heating Piping Specialties." Install shutoff valve at steam supply connections, float and thermostatic trap, and union or flange at each coil return connection.
        7. Refrigerant Piping: Comply with applicable requirements in Section 232300 "Refrigerant Piping." Install shutoff valve and union or flange at each supply and return connection.
      1. ELECTRICAL CONNECTIONS
         1. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
         2. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
         3. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 “Standard for Electrical Safety in the Workplace” and NECA 1 “Standard for Good Workmanship”.
         4. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

Retain one of two subparagraphs below. First subparagraph cross-references Section 260553 "Identification for Electrical Systems" and should be retained for consistent electrical identification. Second subparagraph is an abbreviated version of product specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

* + - 1. CONTROL CONNECTIONS
         1. Install control and electrical power wiring to field-mounted control devices.
         2. Connect control wiring according to Section 260523 "Control-Voltage Electrical Power Cables."
      2. STARTUP SERVICE
         1. **[Engage a Company Field Advisor per OGS Spec Section 014216 to perform] [Perform]** startup service.

Complete installation and startup checks according to manufacturer's written instructions.

Verify that shipping, blocking, and bracing are removed.

Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.

Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.

Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.

Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.

Comb coil fins for parallel orientation.

Verify that proper thermal-overload protection is installed for electric coils.

Install new, clean filters.

Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

* + - * 1. Starting procedures for air-handling units include the following:

Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm.**[ Replace fan and motor pulleys as required to achieve design conditions.]**

Measure and record motor electrical values for voltage and amperage.

Manually operate dampers from fully closed to fully open position and record fan performance.

* + - 1. ADJUSTING
         1. Adjust damper linkages for proper damper operation.
         2. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.
         3. Occupancy Adjustments: When requested within **[12] <Insert number>** months from 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.
      2. CLEANING
         1. After completing system installation and testing, adjusting, and balancing of air-handling unit and air-distribution systems, and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.
      3. FIELD QUALITY CONTROL

Retain one of first three paragraphs below.

Retain "Testing Agency" paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

Retain "Manufacturer's Field Service" paragraph below to require a Company Field Advisor 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 and retain option to require Contractor to arrange for the assistance of a Company Service Advisor.

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

Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.

Charge refrigerant coils with refrigerant and test for leaks.

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

* + - * 1. Air-handling unit and components will be considered defective if unit or components do not pass tests and inspections.
        2. Prepare test and inspection reports.
      1. DEMONSTRATION
         1. **[Engage a Company Field Advisor per OGS Spec Section 014216 to train] [Train]** Facility’s maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION 237313.13