SECTION 237423.16 - PACKAGED, INDIRECT-FIRED, OUTDOOR, HEATING-ONLY MAKEUP-AIR UNITS

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

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 outdoor, indirect, gas-fired, heating-only, makeup air units, including the following components:

Casings.

Outdoor-air intake hood.

Roof curbs.

Fans, drives, and motors.

Air filtration.

Dampers.

Indirect, gas-fired burners.

Unit control panel.

Controls.

Accessories.

* + - 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 outdoor, indirect, gas-fired, heating-only, makeup air 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.

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 filters with performance characteristics.

Include direct, gas-fired burners with performance characteristics.

Include dampers, including housings, linkages, and operators.

* + - * 1. Shop Drawings: For each outdoor, indirect, gas-fired heating and ventilating 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 gas-fired heating and ventilating 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 use 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.
        2. Sample Warranty: For manufacturer's warranty.

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 outdoor, indirect, gas-fired, makeup air 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.

Retain "Product Certificates" paragraph below if required by wind design criteria applicable to Project.

* + - * 1. Product Certificates: Submit certification that specified equipment will withstand wind forces identified in "Performance Requirements" Article and in Section 230548 "Vibration and Seismic Controls for HVAC."

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

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

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

* + - * 1. 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.
      1. CLOSEOUT SUBMITTALS
         1. Operation and Maintenance Data: For indirect, gas-fired, makeup air 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 unit.

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

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

* + - 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 indirect, gas-fired heating and ventilating units that fail in materials or workmanship within specified warranty period.

Verify available warranties and warranty periods for units and components. Warranty periods vary among manufacturers and unit sizes.

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

Warranty Period for Heat Exchangers: Not less than **[five] <Insert number>** years 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.

* + - 1. PERFORMANCE REQUIREMENTS
         1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
         2. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of 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, 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, Section 6 - "Heating, Ventilating, and Air-Conditioning."

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: Indoor, indirect gas-fired, heating and ventilating units shall withstand the effects of earthquake motions determined according to **[ASCE/SEI 7] <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 heating and ventilating unit, delete this article and schedule units on Drawings.

* + - * 1. Fan:

Discharge Configuration: **[Horizontal] [Vertical]**.

Airflow in CFM: **<Insert quantity>**.

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

Maximum RPM: **<Insert number>**.

Minimum Size: **<Insert inches>**.

Altitude: **<Insert feet>**.

* + - * 1. Fan Motor:

Horsepower: **<Insert value>**.

RPM: **<Insert value>**.

Service Factor: **<Insert value>**.

Speed: **[Single] [Two]**.

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

Volts: **[120] [240] [277] [480] <Insert value>** V.

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

Hertz: 60.

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

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

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

* + - * 1. Indirect-Fired Gas Burner:

Minimum Combustion Efficiency: **<Insert percentage>**.

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

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

Retain "Airflow" subparagraph below if different than fan.

Airflow: **<Insert cfm>**.

Gas Input: **<Insert MBh>**.

Burner Output: **<Insert MBh>**.

Number of Stages: **<Insert value>**.

Minimum Inlet Pressure: **<Insert inches wg>**.

Maximum Inlet Pressure: **<Insert inches wg>**.

Gas Piping Connection Size: **<Insert NPS>**.

Vent Diameter: **<Insert inches>**.

* + - * 1. Filters:

Type: **<Insert type>**.

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

Depth: **<Insert 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 fpm>**.

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

Recommended Final Resistance: **<Insert 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.

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.

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

CES Group.

Greenheck Fan Corporation.

Sterling HVAC Products; a Mestek company.

Titan Air.

Trane Inc.

Weather-Rite, a brand of Specified Air Solutions.

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.

Casing Joints: Sheet metal screws or pop rivets, factory sealed with water-resistant sealant.

Makeup Air Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.

* + - * 1. Configuration: Horizontal unit with **[top] [horizontal] [bottom]** discharge for **[roof-mounting] [concrete-base]** installation.
        2. Double-Wall Construction:

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

Inside Casing Wall:

Inside Casing, Burner Section: **[Galvanized steel] <Insert material>**, solid, minimum **[14-gauge] <Insert number>** thick steel.

Inside Casing, All Other Sections: **[Galvanized steel] <Insert material> [solid] [perforated]** steel.

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

Casing Insulation:

Materials: **[Glass-fiber blanket or board insulation, Type I or Type II ASTM C1071] <Insert insulation type>**.

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 roof of unit.

"Airstream Surfaces" subparagraph below may be required to comply with Project requirements or authorities having jurisdiction and is required for sustainable design systems.

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

* + - * 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 unit's internal components.

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 panel frames.

Size: Large enough to allow unobstructed access for inspection and maintenance of unit's internal components.

Locations and Applications:

Verify that the sections listed below are large enough for panels and doors. Verify applicability with listed manufacturers.

Fan Section: **[Inspection and access panels] [Doors] [Doors and inspection and access panels]**.

Access Section: Doors.

Gas-Fired Burner Section: **[Inspection and access panels] [Doors]**.

Damper Section: **[Inspection and access panels] [Doors]**.

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

Mixing Section: Doors.

Retain "Service Light" subparagraph below to add service lights. Not all manufacturers offer this option; consult manufacturers.

Service Light: 100-W vaporproof fixture with switched junction box located **[outside]** [inside] adjacent to door.

Locations: **[Each section accessed with door] [Fan section] <Insert location>**.

* + - 1. OUTDOOR-AIR INTAKE HOOD
         1. Type: Manufacturer's standard hood or louver.
         2. Materials: Match cabinet.

Retain "Bird Screen" or "Filter" paragraph below.

* + - * 1. Bird Screen: Comply with requirements in ASHRAE 62.1.
        2. Filter: Aluminum, 1 inch cleanable.
        3. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.
      1. ROOF CURBS

Retain one of first two paragraphs below. Retain first for curbs with vibration isolation and seismic or wind restraints; retain second for curbs provided by makeup air unit manufacturer without vibration isolation and seismic or wind restraints. Not all manufacturers offer this option; consult manufacturers.

* + - * 1. Roof curbs with vibration isolators and wind or seismic restraints are specified in Section 230548 "Vibration and Seismic Controls for HVAC."
        2. Materials: Galvanized steel with corrosion-protection coating, watertight gaskets, and factory-installed wood nailer; complying with NRCA standards.

Curb Insulation and Adhesive: Comply with NFPA 90A or NFPA 90B.

Materials: ASTM C 1071, Type I or Type II.

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

Application: Factory applied with adhesive and mechanical fasteners to the internal surface of curb.

Liner Adhesive: Comply with ASTM C 916, Type I.

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

Liner materials applied in this location shall have air-stream surface coated with a temperature-resistant coating or faced with a plain or coated fibrous mat or fabric depending on service air velocity.

Liner Adhesive: Comply with ASTM C 916, Type I.

* + - * 1. Curb Height: **[14 inches] [24 inches] [36 inches] <Insert dimension>**.
        2. Wind and Seismic Restraints: Metal brackets compatible with the curb and casing, painted to match unit, used to anchor unit to the curb, and designed for loads at Project site. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for wind-load requirements.
      1. FANS, DRIVES, AND MOTORS
         1. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
         2. Fans: Centrifugal, rated according to AMCA 210; galvanized steel; mounted on solid-steel shaft.

Shafts: With field-adjustable alignment.

Shaft Bearings: Heavy-duty**[, self-aligning, permanently lubricated ball bearings][, pillow-block bearings]** with an **[L50] <Insert bearing life rating>** rated life of **[100,000] <Insert number>** hours according to ABMA 9.

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

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, Class 1.

* + - * 1. Drives: 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 paragraphs 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: Maximum sizes 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: **[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.

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.

* + - 1. AIR FILTRATION
         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.

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

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

* + - * 1. Cleanable Filters:

Cleanable metal mesh.

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" or "Outdoor- and Return-Air Dampers" paragraphs below. Retain "Dampers" paragraph 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. at 1-inch wg. 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 rated in accordance with AMCA 500D.

Retain "Damper Operators" or "Electronic Damper Operators" paragraph below. Retain first paragraph if damper operators are specified in Section 230923.12 "Control Dampers." Retain second 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 "Power Requirements (Two-Position Spring Return)," "Power Requirements (Modulating)," and "Proportional Signal" subparagraphs 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. INDIRECT-FIRED GAS BURNER
         1. Description: Factory assembled, piped, and wired; and complying with ANSI Z21.47 and with NFPA 54.
         2. CSA Approval: Designed and certified by and bearing label of CSA.
         3. Burners: **[Aluminized steel with stainless-steel inserts] [Stainless steel]**.

Rated Minimum Turndown Ratio: **[30 to 1] <Insert ratio>**.

Fuel: **[Natural] [Propane]** gas.

Ignition: Electronically controlled electric spark with flame sensor.

Gas Control Valve: **[Single stage] [Two stage] [Modulating]**.

Gas Train: Regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, **[hydraulic] [electronic]**-modulating temperature control valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff all in one body.

High-altitude feature in "High-Altitude (Model) (Kit)" subparagraph below is available from some manufacturers; consult manufacturers

High-Altitude **[Model] [Kit]**: For Project elevations more than 2000 feet above sea level.

Retain "Venting, Gravity" or "Venting, Power" paragraph below.

* + - * 1. Venting, Gravity: Gravity vented.
        2. Venting, Power: Power vented, with integral, motorized centrifugal fan interlocked with gas valve.
        3. Heat Exchanger: **[Aluminized] [Stainless]** steel.
        4. Heat-Exchanger Drain Pan: Stainless steel.
        5. Safety Controls:

Director’s Representative 's insurance underwriter may require gas train by FM Global or another insurer. Verify with Director’s Representative.

Gas Manifold: Safety switches and controls complying with ANSI standards **[and] [FM Global] <Insert insurer>**.

Vent Flow Verification: **[Differential pressure switch to verify open vent] [Flame rollout switch]**.

High Limit: Thermal switch or fuse to stop burner.

Purge-period timer shall automatically delay burner ignition and bypass low-limit control.

Airflow proving switch feature in "Airflow Proving Switch" subparagraph below is provided by some manufacturers.

Airflow Proving Switch: Differential pressure switch senses correct airflow before energizing pilot.

Automatic-Reset, High-Limit Control Device: Stops burner and closes main gas valve if high-limit temperature is exceeded.

Safety Lockout Switch: Locks out ignition sequence if burner fails to light after three tries. Controls are reset manually by turning the unit off and on.

Control Transformer: 24 V ac.

* + - 1. UNIT CONTROL PANEL
         1. Factory-wired, fuse-protected control transformer, connection for power supply and field-wired unit to remote control panel.
         2. Control Panel: **[Surface-mounted] [Recessed, with trim ring,]** remote panel, with engraved plastic cover and the following lights and switches:

**[On-off] [On-off-auto]** fan switch.

Heat-vent-off switch.

Supply-fan operation indicating light.

Heating operation indicating light.

Thermostat.

Damper position potentiometer.

Dirty-filter indicating light operated by unit-mounted differential pressure switch.

Safety-lockout indicating light.

Enclosure: NEMA 250, **[Type 1] [Type 3R] [Type 4] [Explosion proof]**.

* + - 1. CONTROLS

Retain first paragraph below to specify temperature controls in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC." Delete first paragraph and retain remainder of this article to require controls integral to the heating and ventilating unit to be provided by heating and ventilating unit manufacturer.

* + - * 1. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC" for control equipment and sequence of operation.
        2. Control Devices:

Remote Thermostat: Adjustable room thermostat with temperature readout.

Remote Setback Thermostat: Adjustable room thermostat without temperature readout.

Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

Fire-Protection Thermostats: Fixed or adjustable settings to operate at not less than 75 deg F above normal maximum operating temperature.

Retain "Timers, Seven Day" or "Timers, Solid State" subparagraph below. Programmable time control is best option for applications requiring more than one timed program.

Timers, Seven Day:

Programming-switch timer with synchronous-timing motor and seven-day dial.

Continuously charged, nickel-cadmium-battery-driven, eight-hour, power-failure carryover.

Multiple-switch trippers.

Minimum of two and maximum of eight signals per day with two normally open and two normally closed output contacts.

Timers, Solid State:

Programmable time control with four separate programs.

24-hour battery carryover; individual on-off-auto switches for each program.

365-day calendar with 20 programmable holidays.

Choice of fail-safe operation for each program.

System fault alarm.

Ionization-Type Smoke Detectors:

24-V dc, nominal.

Self-restoring.

Plug-in arrangement.

Integral visual-indicating light.

Sensitivity that can be tested and adjusted in place after installation.

Integral addressable module.

Remote controllability.

Responsive to both visible and invisible products of combustion.

Self-compensating for changes in environmental conditions.

Retain "Fan Control, Interlocked" or "Fan Control, Timer" paragraph below.

* + - * 1. Fan Control, Interlocked: Fan to start automatically with exhaust fan(s) to which this heating and ventilating unit is associated for makeup air.
        2. Fan Control, Timer: Timer starts and stops indirect-fired heating and ventilating unit and exhaust fan(s).

Retain "Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units" or "Mixed Outdoor- and Return-Air Damper Control" paragraph below. Retain first paragraph for units that supply 100 percent outdoor air.

* + - * 1. Outdoor-Air Damper Control, 100 Percent Outdoor-Air Units: Outdoor-air damper shall open when supply fan starts, and close when fan stops.

Retain "Mixed Outdoor- and Return-Air Damper Control" paragraph below for units that circulate varying amounts of outdoor and return air.

* + - * 1. Mixed Outdoor- and Return-Air Damper Control: When fan is running, outdoor- and return-air dampers shall modulate to supply minimum outdoor air as follows:

Minimum **[30] <Insert number>** percent outdoor air.

Outdoor-air quantity adjusted by potentiometer on control panel.

Outdoor-air quantity to maintain minimum building static pressure.

* + - * 1. Temperature Control:

Retain one of first two subparagraphs below.

Operates gas valve to maintain discharge-air temperature with factory-mounted sensor in blower outlet.

Operates gas valve to maintain space temperature with wall-mounting, field-wired sensor**[ with temperature adjustment,] [and unit-mounted control adjustment] [and adjustment on remote-control panel]**.

Timer shall select remote setback thermostat to maintain space temperature at **[50 deg F] <Insert temperature>**.

Retain "Burner Control, Stepped" or "Burner Control, Modulating" subparagraph below.

Burner Control, Stepped: Two or four steps of control using one or two burner sections in series.

Burner Control, Modulating: 20 to 100 percent modulation of the firing rate. 10 to 100 percent with dual burner units.

Retain "Interface with DDC System for HVAC" paragraph below if controls interface with the DDC system for HVAC. Coordinate with Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display status and alarms of heating and ventilating unit.

Retain "Hardwired Points" subparagraph below if interface with the DDC system for HVAC is through hardwired points and minimal interface is required.

Hardwired Points:

Room temperature.

Discharge-air temperature.

Burner operating.

Delete "Hardwired Points" subparagraph above and retain subparagraph below if extensive interface with the DDC system for HVAC is required and is beyond what hardwired points can provide. Requirement may exclude some manufacturers.

**[ASHRAE 135.1 (BACnet)] [LonTalk] [Modbus] [Industry-accepted, open-protocol] <Insert type of interface>** communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the heating and ventilating unit from an operator workstation. Control features and monitoring points displayed locally at heating and ventilating unit control panel shall be available through the DDC system for HVAC.

* + - 1. ACCESSORIES
         1. Electric heater with integral thermostat maintains minimum 50 deg F temperature in gas burner compartment.
         2. Duplex, 115-V, ground-fault-interrupter outlet with 15-A overcurrent protection. Include transformer if required.**[ Outlet shall be energized even if the unit main disconnect is open.]**
         3. Low-ambient kit using [staged] [damper on] [variable-speed] condenser fans for operation down to **[35 deg F] <Insert temperature>**.
         4. Filter differential pressure switch with sensor tubing on either side of filter. Set for final filter pressure loss.

Retain one or both paragraphs below; if retaining both, identify guard requirements for each unit in a schedule.

* + - * 1. Coil guards of painted, galvanized-steel wire.
        2. Hail guards of galvanized steel, painted to match casing.
      1. MATERIALS
         1. Steel:

ASTM A36 for carbon structural steel.

ASTM A568 for steel sheet.

* + - * 1. Stainless Steel:

Manufacturer's standard grade for casing.

Manufacturer's standard type, ASTM A240 for bare steel exposed to airstream or moisture.

* + - * 1. Galvanized Steel: ASTM A653.

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 roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
          3. Verify cleanliness of airflow path to include inner-casing surfaces, filters, coils, turning vanes, fan wheels, and other components.
          4. Proceed with installation only after unsatisfactory conditions have been corrected.
       2. INSTALLATION

Retain "Roof Curb" paragraph below if curbs are provided by unit manufacturer.

* + - * 1. Roof Curb: Install on roof structure or concrete base, level and secure, according to **[NRCA's "NRCA Roofing Manual: Membrane Roof Systems."] [AHRI Guideline B.]** Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 077200 "Roof Accessories." Secure units to upper curb rail, and secure curb base to roof framing or concrete base with anchor bolts. Coordinate sizes and locations of roof curbs with actual equipment.

Retain "Unit Support" paragraph below if installing unit on field-fabricated curbs or steel supports.

* + - * 1. Unit Support: Install unit level on structural **[curbs] [steel supports]**. Coordinate roof penetrations and flashing with roof construction. Secure units to structural support with anchor bolts. Coordinate sizes and locations of **[curbs] [steel supports]** with actual equipment provided.

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. Install gas-fired units in accordance with NFPA 54.
        2. Install controls and equipment shipped by manufacturer for field installation with indirect, gas-fired heating and ventilating units.
      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. Drawings indicate general arrangement of piping, fittings, and specialties.

Gas Piping: Comply with requirements in **[Section 231123 "Facility Natural-Gas Piping."] [Section 231126 "Facility Liquefied-Petroleum Gas Piping."]** Connect gas piping with shutoff valve and union, and with sufficient clearance for burner removal and service. Make final connections of gas piping to unit with corrugated, stainless-steel tubing flexible connectors complying with ANSI LC 1/CSA 6.26 equipment connections.

* + - * 1. Drain: Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for traps and accessories on piping connections to condensate drain pans under condensing heat exchangers.
        2. Where installing piping adjacent to heating and ventilating units, allow space for service and maintenance.
      1. DUCTWORK CONNECTIONS
         1. Duct Connections: Connect supply**[ and return]** ducts to indirect-fired heating and ventilating units with flexible duct connectors. Comply with requirements in Section 233300 "Air Duct Accessories" for flexible duct connectors.
      2. 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 and NECA 1.
         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 wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
      2. STARTUP SERVICE
         1. **[Engage a Company Service Advisor to perform] [Perform]** startup service.
         2. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

Inspect for visible damage to burner combustion chamber.

Inspect casing insulation for integrity, moisture content, and adhesion.

Verify that clearances have been provided for servicing.

Verify that controls are connected and operable.

Verify that filters are installed.

Purge gas line.

Inspect and adjust vibration isolators**[ and seismic restraints]**.

Verify bearing lubrication.

Inspect fan-wheel rotation for movement in correct direction without vibration and binding.

Adjust fan belts to proper alignment and tension.

* + - * 1. Start unit according to manufacturer's written instructions.

Complete startup sheets and attach copy with Contractor's startup report.

Inspect and record performance of interlocks and protective devices; verify sequences.

Operate unit for run-in period recommended by manufacturer.

Perform the following operations for both minimum and maximum firing, and adjust burner for peak efficiency:

Measure gas pressure at manifold.

Measure combustion-air temperature at inlet to combustion chamber.

Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.

Calibrate thermostats.

Adjust and inspect high-temperature limits.

Inspect dampers, if any, for proper stroke and interlock with return-air dampers.

Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

Measure and record airflow. Plot fan volumes on fan curve.

Verify operation of remote panel, including pilot-operation and failure modes. Inspect the following:

High-limit heat.

Alarms.

After startup and performance testing, change filters, verify bearing lubrication, and adjust belt tension.

Verify drain-pan performance.

Verify outdoor-air damper operation.

* + - 1. ADJUSTING
         1. Adjust initial temperature set points.
         2. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
         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 makeup air 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 two paragraphs below.

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

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 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 factory-authorized service agent.

* + - * 1. Perform tests and inspections**[ with the assistance of a Company Field Advisor per OGS Spec Section 014216]**.
        2. Units will be considered defective if they do not pass tests and inspections.
        3. 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 heating and ventilating units.

END OF SECTION 237423.16