SECTION 237223.23 - PACKAGED, OUTDOOR, HEAT WHEEL ENERGY RECOVERY 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

AHRI 1060 (I-P) and AHRI 1061 (SI) define rotary air-to-air heat exchangers, which are heat wheels.

* + - * 1. Section Includes:

Heat wheels in packaged, outdoor, **[sensible heat] [total energy]**-recovery units.

* + - * 1. Related Requirements:

Retain subparagraph below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Section 237343.16 "Outdoor, Semi-Custom Air-Handling Units" for outdoor, semi-custom air-handling units if they also include coils, other than electric coils for frost control, in addition to heat wheels.

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

Include packaged, outdoor, heat-wheel, energy-recovery-unit rated capacities, operating characteristics, furnished specialties, and accessories.

Fans:

Certified fan-performance curves with system operating conditions indicated.

Certified fan-sound power ratings.

Fan construction and accessories.

Motor ratings, electrical characteristics, and motor accessories.

* + - * 1. Shop Drawings: For packaged, outdoor, heat-wheel, energy-recovery units.

Include plans, elevations, sections, details, and **[mounting] [attachment]** details.

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

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. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space. Retain option for roof-mounted units.

* + - * 1. Coordination Drawings: Floor plans, **[roof plans, ]**elevations, and other details, drawn to scale and coordinated with each other, using input from installers of items involved.

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 packaged, outdoor, heat-wheel, energy-recovery 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 certification is based and their installation requirements.

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

* + - * 1. Field quality-control reports.
			1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For packaged, outdoor, heat-wheel, energy-recovery equipment to include in maintenance manuals.
			2. MAINTENANCE MATERIAL SUBMITTALS
				1. Furnish extra materials that match products installed. Package with protective covering for storage and identify with labels describing contents.

Filters: **[One] <Insert number>** set(s) of each type of filter specified.

Fan Belts: **[One] <Insert number>** set(s) of belts for each belt-driven fan in energy-recovery units.

Wheel Belts: **[One] <Insert number>** set(s) of belts for each heat wheel.

* + - 1. COORDINATION
				1. Coordinate sizes and locations of building openings and duct connections with actual equipment provided.
			2. WARRANTY

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

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace components of packaged, outdoor, heat-wheel, energy-recovery units that fail in materials or workmanship within specified warranty period.

Verify available warranties and warranty periods for units and components with manufacturers listed in Part 2 articles.

Warranty Period for Packaged Energy-Recovery Units: **[One] [Three] <Insert number>** years from date of Substantial Completion.

Warranty Period for Energy-Recovery Wheel: **[Five] <Insert number>** years from date of Substantial Completion.

**<Insert components requiring extended warranty>**.

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. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

"ASHRAE Compliance" paragraph below may be required to comply with Project requirements or authorities having jurisdiction. Sustainable design may require compliance with requirements in ASHRAE 62.1-2016, including requirements for controls, surfaces in contact with the airstream, particulate and gaseous filtration, humidification and dehumidification, drain pan construction and connection, cleaning, and equipment access. Verify, with manufacturers, the availability of units with components and features that comply with these requirements.

* + - * 1. ASHRAE Compliance:

Applicable requirements in ASHRAE 62.1.

Capacity ratings for heat-wheel, energy-recovery equipment: Comply with ASHRAE 84.

"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.

Retain "UL Compliance" paragraph below if electric frost-control coils are retained in Section Text.

* + - * 1. UL Compliance:

Packaged Heat-Recovery Ventilators: Comply with requirements in **[UL 1815] [or] [UL 1812]**.

Electric Coils: Comply with requirements in UL 1995.

Coordinate options retained in first paragraph below with authorities having jurisdiction and with manufacturers' availability. Manufacturers generally comply with one or the other standard.

* + - * 1. Comply with **[ASTM E84] [or] [UL 723]**.

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: Packaged, outdoor, heat wheel energy-recovery units shall withstand the effects of earthquake motions determined in accordance with **[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. Retain option 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 packaged, outdoor, heat-wheel, energy-recovery unit, delete this article and schedule the units on Drawings.

* + - * 1. Type: Heat-wheel **[sensible heat] [total energy]**-recovery unit.
				2. Exhaust Air:

Airflow: **<Insert cfm>**.

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

Summer:

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

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

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

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

Winter:

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

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

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

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

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

Fan Motor Electrical Characteristics:

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

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

Hertz: 60.

* + - * 1. Supply Air:

Airflow: **<Insert cfm>**.

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

Summer:

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

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

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

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

Winter:

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

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

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

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

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

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

Fan Motor Electrical Characteristics:

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

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

Hertz: 60.

* + - * 1. Wheel Drive:

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

Motor Electrical Characteristics:

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

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

Hertz: 60.

* + - * 1. Effectiveness: <**Insert percentage**> percent.
				2. Electric Frost-Control Coils:

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

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

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

Power Input: **<Insert number>** Kw.

Volts: **[208] [230] [480] <Insert number>** V.

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

Hertz: 60.

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

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

Provide Silicon-Controlled Rectifier (SCR) to modulate electric coil.

* + - * 1. Filters:

Type: **[Cleanable wire mesh] [and] [Pleated]**.

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

Depth: **<Insert inches>**.

Filter Quantity: **<Insert number>**, Dimensions (Wide by High) **<Insert inches by inches>**.

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 less than 5. Filters with MERV 5 or lower ratings will not comply with LEED 2009 IEQ Prerequisite 1 and LEED v4 requirements.

Minimum Efficiency Reporting Value and Average Arrestance:

MERV Rating: **[MERV 4] <Insert value>** 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 IEQ Prerequisite 1 and LEED v4 EQ Prerequisite "Minimum Indoor Air Quality Performance" require compliance with ASHRAE 62.1 (2007 and 2010 versions, respectively), which require a MERV rating of 6 or higher for service to occupied spaces. LEED 2009 IEQ Credit 5 and LEED v4 IEQ Credit, "Enhanced Indoor Air Quality Strategies," require MERV 13 or higher. Insert values appropriate to Project sustainability goals.

Minimum Efficiency Reporting Value:

Confirm available filter MERV ratings in "MERV Rating" subparagraph below with the unit manufacturers. Not all manufacturers offer all the options shown.

MERV Rating: **[MERV 6] [MERV 8] [MERV 11] [MERV 13] <Insert value>** in accordance with ASHRAE 52.2.

* + - 1. PACKAGED, OUTDOOR, HEAT-WHEEL, ENERGY-RECOVERY UNITS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Greenheck Fan Corporation.

Loren Cook Company.

Ruskin Rooftop Systems.

Spinnaker Industries.

Systemair USA.

Thybar Corporation.

YORK; brand of Johnson Controls International plc, Building Solutions North America.

Approved equivalent.

* + - * 1. Source Limitations: Obtain packaged, outdoor, heat-wheel, energy-recovery units from single manufacturer.
				2. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1.

Housing construction can vary, depending on manufacturer and unit size; consult manufacturers. Some manufacturers offer single-wall insulated casings, some offer double-wall insulated casings, and some offer single and double-wall casings as an option.

* + - * 1. Housing: Manufacturer's standard construction with corrosion-protection coating and exterior finish, **[gasketed] [hinged access doors] [or] [removable panels]** with neoprene gaskets for inspection and access to internal parts, minimum **[1 inch] [2 inches] <Insert thickness>** thick, **<Insert R-value>**, **<Insert thickness and density>** thermal insulation, knockouts for electrical connections, exterior drain connection, and lifting lugs.
				2. Heat Wheel:

Casing:

Manufacturer's standard construction with standard factory finish.

Slide-in, slide-out cassette style.

Retain first subparagraph below to include purge. Not all manufacturers offer purge. Coordinate with manufacturers.

Provide unit with integral purge section, limiting carryover of exhaust air to between **<Insert number>** percent at **<Insert inch wg>** and **<Insert number>** percent at <Insert inch wg> differential pressure.

Provide casing seals on periphery of rotor and on duct divider and purge section.

Support vertical rotors on grease-lubricated ball bearings having extended grease fittings**[ or permanently lubricated bearings]** with minimum **[L-50] <Insert bearing life>** of **[200,000] <Insert number>** hours. Support horizontal rotors on tapered roller bearing.

Retain one of three "Rotor" subparagraphs below. Not all manufacturers offer each combination of materials and coatings. Not all manufacturers offer a molecular sieve desiccant coating; those that do offer it have only four-angstrom type. Consult manufacturers.

Rotor: Aluminum or polymer segmented wheel, strengthened with radial spokes.

Rotor: Aluminum or polymer segmented wheel, strengthened with radial spokes, with nontoxic, noncorrosive, silica-gel coating.

Rotor: Aluminum, metallic, or polymer segmented wheel, strengthened with radial spokes impregnated with nonmigrating, water-selective, four-angstrom, molecular-sieve desiccant coating.

Drive: Electric motor **[, with speed changed by variable-frequency motor controller]** and self-adjusting multilink belt around outside of rotor.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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."

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.

Consult manufacturer to verify the fan wheel options in "Supply and Exhaust Fans" paragraph below.

* + - * 1. Supply and Exhaust Fans: Centrifugal, **[forward-curved] [backward-inclined] <Insert fan type>** fan with **[spring isolators] [restrained, spring isolators]** of **[1-inch] <Insert value>** static deflection.

Some manufacturers offer only direct-driven or belt-driven motors and drives in certain size ranges. Coordinate with manufacturers. Because only a limited number of manufacturers offer electronically commutated motors (ECMs), this option is not included in the Section Text.

Motor and Drive: **[Direct driven] [Belt driven, with adjustable sheaves; motor mounted on adjustable base] [, with speed changed by variable-frequency motor controller]**.

Default motor characteristics are specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

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."

Motor Sizes: Minimum size as indicated. If size is not indicated, provide motor large enough so driven load will not require motor to operate in service factor range above 1.0.

Retain first "Filters" paragraph below to require that filters be provided in accordance with Section 234100 "Particulate Air Filtration."

* + - * 1. Filters:

Particulate air filtration is specified in Section 234100 "Particulate Air Filtration."

Retain "Filters" paragraph below to require that filters be provided by packaged, outdoor, heat-wheel energy-recovery manufacturer. Confirm availability with manufacturers.

* + - * 1. Filters:

Description: **[Cleanable wire mesh at outside air intake] [and] [pleated]**, factory-fabricated, self-supported, disposable air filters with holding frames.

UL Compliance: Comply with UL 900.

Media: Interlaced glass fibers sprayed with nonflammable adhesive**[ and antimicrobial coating]**.

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

Filter-Mounting Frames: Arranged with access doors or panels on one or both sides of unit. Design unit with filters removable from one side, or lift out from access plenum.

Retain "Electric Coils" paragraph below if electric frost control is retained in "Controls" Article below.

* + - * 1. Electric Coils:

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

Access: Fabricate coil section to allow removal and replacement of coil, and to allow in-place access for service.

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 heater.

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

**[Magnetic] <Insert type>** contactor.

Solid-state, stepless SCR controller.

Time-delay relay.

Airflow proving switch.

* + - * 1. Wiring: Fabricate units with space within housing for electrical conduits. Wire motors and controls, so only external connections are required during installation.

Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.

Include **[fused] [nonfused]** disconnect switches.

* + - 1. CONTROLS

Retain this article to require controls to be an integral part of packaged, outdoor, heat-wheel energy-recovery units. Delete if controls are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Control Panel: Solid-state, programmable, microprocessor-based control unit for **[wall mounting] <Insert mounting location>. [Integrate to BACnet, LonWorks, or Modbus, as specified in Section 230923 "Direct Digital Control (DDC) System for HVAC".]**
				2. Starting relay, factory mounted and wired, and manual motor starter for field wiring.

Retain fourth option in "Frost Control" paragraph below if retaining one of two variable-speed exhaust air temperature control options in "Variable-Speed Control" paragraphs below or if this type of control is described in Section 230923 "Direct Digital Control (DDC) System for HVAC" control sequences.

* + - * 1. Frost Control: **[None] [Timed exhaust-only operation] [Electric preheat] [Variable rotor speed] [Low-temperature thermostat deenergizes supply air fan] <Insert frost control type>**.
				2. Motion (Occupancy) Sensor: Passive infrared sensor for **[wall] [ceiling]** mounting, with adjustable time-off delay of up to 30 minutes to energize unit.
				3. Carbon Dioxide Sensor: Adjustable control from 600 to 2000 ppm for **[wall] [duct]** mounting, with digital display and direct digital control (DDC) system interface to energize unit.

Retain "Economizer Control, Stop Wheel" or "Economizer Control, Airflow Bypass" paragraph below if unit operation is affected by economizer control.

* + - * 1. Economizer Control, Stop Wheel: Stop wheel rotation or modulate wheel rotation speed when conditions are favorable for economizer operation.
				2. Economizer Control, Airflow Bypass: Heat-wheel airflow bypass. See Section 230923 "Direct Digital Control (DDC) System for HVAC" for control sequence.
				3. **[Dry-bulb temperature] [Enthalpy]** sensor.
				4. Rotation sensor and alarm.
				5. Dirty filter switch.
				6. Low-Voltage Transformer: Integral transformer to provide control voltage to unit from primary incoming electrical service.
				7. Electric Coil Controls:

Retain subparagraph below for electric frost-control coils.

Factory-mounted sensor in outside-air intake with sensor adjustment located in control panel to control electric coil and maintain minimum entering temperature, to avoid frost formation.

Retain one of two "Variable-Frequency Motor Controller" paragraphs below. The 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 selected options with electrical engineer and manufacturers.

* + - * 1. Variable-Frequency Motor Controller: Comply with Section 262923 "Variable-Frequency Motor Controllers."
				2. Variable-Frequency Motor Controller: Serving wheel rotation motor.

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 derivative (PID) control interface.

DDC System for HVAC Protocols for Network Communications: **[ASHRAE 135] <Insert protocol type>**.

Line Conditioning:

Input line conditioning.

Output filtering.

EMI/RFI filtering.

Retain one of three "Variable-Speed Control" paragraphs below if unit includes variable-speed control. Delete if controls are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."

* + - * 1. Variable-Speed Control: Factory mounted and wired, permitting input of field-connected, 4- to 20-mA or 1- to 10-V control signal.
				2. Variable-Speed Control: Factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing.
				3. Variable-Speed Control: Factory mounted and wired, with exhaust- and outdoor-air sensors, automatic changeover thermostat, and set-point adjuster, to vary rotor speed and maintain**[ exhaust temperature above freezing and]** air differential temperature above set point. Increase rotor speed to maximum when exhaust-air temperature is less than outdoor-air temperature.

Insert additional variable-frequency motor controller features below after confirming availability from manufacturers.

**<Insert features>**.

Insert additional control features desired after confirming availability from manufacturers.

* + - * 1. **<Insert additional control features>**.
			1. SOURCE QUALITY CONTROL
				1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended application.

Retain "AHRI Compliance" paragraph below if AHRI-certified capacity ratings are required for a project.

* + - * 1. AHRI Compliance: Capacity ratings for air-to-air energy-recovery equipment certified as complying with AHRI 1060 (IP).
				2. Fan Performance Rating: Comply with AMCA 211, and label fans with AMCA-certified rating seal. Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210 and ASHRAE 51.
				3. Fan Sound Rating: Comply with AMCA 301 or AHRI 260 (IP).
				4. UL Compliance:

Packaged Heat-Recovery Ventilators: Comply with requirements in UL 1812.

Electric Coils: Comply with UL 1995.

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 packaged, outdoor, heat wheel energy-recovery unit installation. Replace insulation materials and filter media that are wet, moisture damaged, or mold contaminated.
				3. Proceed with installation only after unsatisfactory conditions have been corrected.
			2. INSTALLATION OF PACKAGED, OUTDOOR, HEAT-WHEEL, ENERGY-RECOVERY UNITS
				1. Install packaged, outdoor, heat-wheel, energy-recovery units, so supply and exhaust airstreams flow in opposite directions, and rotation is away from exhaust side to purge section to supply side.

Install access doors in both supply and exhaust ducts, both upstream and downstream, for access to wheel surfaces, drive motor, and seals.

Install removable panels or access doors between supply and exhaust ducts on building side for bypass during startup.

Access doors and panels are specified in Section 233300 "Air Duct Accessories."

* + - * 1. Equipment Mounting:

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

Install deck-mounted packaged, outdoor, heat-wheel, energy-recovery units on **[4-inch] <Insert dimension>** cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

Install roof-mounted packaged, outdoor, heat-wheel, energy-recovery units on manufacturer's-recommended-height equipment roof curbs. Comply with requirements for equipment curbs specified in Section 077200 "Roof Accessories."

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."

Delete "Suspended Units" paragraph unless equipment is suspended from an outdoor structure.

* + - * 1. Suspended Units: Suspend**[ and brace]** units from outdoor structural-steel support frame, using threaded steel rods and spring hangers. 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. Install units with clearances for service and maintenance.

Sustainable design systems require filters with a minimum MERV 13 rating for air delivered to the occupied space. Units should not be used for temporary 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 equipment fans until temporary or permanent filters are in place. Replace temporary filters used during construction and testing with new, clean filters prior to final inspection.
			1. DUCTWORK CONNECTIONS
				1. Comply with requirements for ductwork in accordance with Section 233113 "Metal Ducts."
				2. Connect duct to units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."
				3. Isolation Dampers: Install isolation dampers in accordance with Section 230923.12 "Control Dampers."
			2. PIPING CONNECTIONS

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

* + - * 1. Comply with requirements for piping specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
				2. Where installing piping adjacent to unit, allow service and maintenance.
				3. Connect piping to units mounted on vibration isolators with flexible connectors.
				4. Condensate Drain Piping: See Section 232113 "Hydronic Piping" for pipe type. Install condensate drain piping from drain pans to nearest floor drain, same size as condensate drain connection.

Construct deep trap at connection to drain pan, and install cleanouts at changes in direction.

* + - 1. ELECTRICAL CONNECTIONS
				1. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
				2. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
				3. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
				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 in accordance with Section 260523 "Control-Voltage Electrical Power Cables."
			2. STARTUP SERVICE
				1. **[Engage Company Field Advisor per OGS Spec Section 014216 to perform] [Perform]** startup service.

Complete installation and startup checks in accordance with manufacturer's written instructions.

**<Insert startup steps if any>**.

* + - 1. ADJUSTING
				1. Adjust moving parts to function smoothly, and lubricate as recommended by manufacturer.
				2. Adjust initial temperature and humidity set points.
				3. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
			2. 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 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 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 the Contractor to perform tests and inspections, and retain the optional text to require Contractor to arrange for the assistance of a Company Service Advisor.

* + - * 1. Perform tests and inspections**[ with assistance of Company Field Advisor per OGS Spec Section 014216]**.
				2. Tests and Inspections:

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

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

* + - * 1. Packaged, outdoor, heat-wheel, energy-recovery equipment will be considered defective if it does not pass tests and inspections.
				2. Prepare test and inspection reports.
			1. DEMONSTRATION
				1. **[Engage Company Field Advisor per OGS Spec Section 014216 to train] [Train]** Facility’s maintenance personnel to adjust, operate, and maintain air-to-air energy-recovery units.

END OF SECTION 237223.23