SECTION 23 72 00

AIR-TO-AIR ENERGY RECOVERY EQUIPMENT

**BASED ON DFD MASTER SPECIFICATION DATED 12/4/2023**

This section has been written to cover most (but not all) situations that you will encounter. Depending on the requirements of your specific project, you may have to add material, delete items, or modify what is currently written. The Division of Facilities Development expects changes and comments from you.

# P A R T 1 - G E N E R A L

SCOPE

This section includes specifications for air-to-air energy recovery equipment. Included are the following topics:

PART 1 - GENERAL

Scope

Reference

Related Work

Quality Assurance

Submittals

Operation and Maintenance Data

Design Criteria

PART 2 - PRODUCTS

Packaged Energy Recovery Unit

Standalone Heat Exchanger

PART 3 - EXECUTION

Installation

Packaged Energy Recovery Unit

Leakage Test

Construction Verification Items

Functional Performance Testing

Agency Training

REFERENCE

Applicable provisions of Division 1 govern work under this Section.

RELATED WORK

Section 01 91 01 or 01 91 02 - Commissioning Process

Section 23 05 13 - Common Motor Requirements for HVAC Equipment

Section 23 08 00 - Commissioning of HVAC

Section 23 09 14 - Pneumatic and Electric Instrumentation and Control Devices for HVAC

Section 23 09 15 - Direct Digital Control Input/Output Point Summary Tables

Section 23 09 93 - Sequence of Operations for HVAC Controls

Section 23 41 00 - Particulate Air Filtration

Section 23 73 13 - Modular Indoor Central-Station Air-Handling Units

Section 23 73 23 – Factory Fabricated Custom Air Handling Units

QUALITY ASSURANCE

Refer to division 1, General Conditions, Equals and Substitutions.

SUBMITTALS

Refer to division 1, General Conditions, Submittals.

Include unit dimensions, weights, materials of construction, thermal characteristics, ratings, fabrication methods, manufacturer's installation requirements, and appropriate identification.

OPERATION AND MAINTENANCE DATA

All operations and maintenance data shall comply with the submission and content requirements specified under section GENERAL REQUIREMENTS.

Delete the following if there are no additional requirements.

In addition to the general content specified under GENERAL REQUIREMENTS supply the following additional documentation:

1. [A/E and commissioning provider to define detailed operation and maintenance data requirements for equipment specifications added to this section.]

DESIGN CRITERIA

Capacity, efficiency, and operating characteristics as indicated on the drawings and/or as scheduled.

# P A R T 2 - P R O D U C T S

PACKAGED ENERGY RECOVERY UNIT

Packaged energy recovery units contain fans, filters, dampers, heat exchangers, and controls. They do not contain heating or cooling.

Packaged energy recovery units may be used in small systems up to 7,000 cfm. For higher airflows or units with heating/cooling, use the “Standalone Heat Exchanger” paragraphs in conjunction with Section 23 72 13 (Modular Air Handling Units) or Section 23 73 23 (Custom Air Handling Units).

MANUFACTURERS:

Choose the desired type of heat exchanger from the following:

Sensible Fixed Plate: Engineered Air, Venmar CES, Xetex, or approved equal.

Enthalpy Fixed Plate: Daikin, Greenheck, RenewAire, Venmar CES, Xetex, or approved equal.

Sensible Rotary Wheel - Aluminum: Carnes, Xetex, or approved equal.

Enthalpy Rotary Wheel - Molecular Sieve Desiccant: Engineered Air, Xetex, or approved equal.

Enthalpy Rotary Wheel - Silica Gel Desiccant: Greenheck, Venmar CES, or approved equal.

CASING:

Construct casing of double wall panels suitable for flanged duct installation. Exterior walls shall be minimum 22-gauge galvanized steel [with a polyester urethane coating]. Interior walls shall be minimum 22-gauge galvanized steel. Provide hinged and gasketed access doors for cleaning the heat exchanger. Casing shall include 1-inch-thick insulation in the walls, roof, floor, and access doors.

FANS:

Provide outdoor air and exhaust air fans. Fan motors shall meet Section 23 05 13. Provide motors with factory-installed starters and integral thermal protection. Fans shall be direct drive or belt drive. Provide belt drive motors with adjustable pulleys and mounts allowing for blower speed adjustment, proper motor shaft orientation, and proper belt tensioning.

Fan bearings shall be self-aligning, pillow block, regreasable ball type selected for a minimum L50 life of 200,000 hours. Furnish extended grease lines from bearings to allow service without entering the unit. Grease lines may be terminated within the unit if they are easily accessible.

FILTERS:

Provide 2-inch pleated filters and filter racks in both entering airstreams to the heat exchanger. Filters and filter racks shall meet Section 23 41 00.

Include the following paragraph when the heat exchanger will be bypassed as part of the controls sequence (i.e., during economizer). Do not use bypass dampers in 100% outdoor air units.

[BYPASS DAMPERS:

Provide dampers in the outdoor and exhaust airstreams to bypass the heat exchanger. Dampers shall meet Section 23 09 14.]

Choose the desired type of heat exchanger from the following four sections.

HEAT EXCHANGER - SENSIBLE FIXED PLATE:

Provide a fixed plate heat exchanger capable of operating at temperatures from -20 degrees F to 190 degrees F and a maximum differential pressure of 10 inches. Exchanger shall withstand entrained moisture in the outdoor airstream without damage or deterioration of performance.

Heat exchanger shall transfer sensible energy only. The heat exchange surfaces shall be aluminum or stainless steel in a crossflow configuration. The edges shall be sealed with high temperature sealant. The exchanger shall bear the AHRI 1060 certified label.

Include the following paragraph for exhaust airstreams that contain corrosive chemicals.

[Provide a corrosion-resistant coating in the exhaust airstream of the energy recovery unit including the cabinet, fans, dampers, and heat exchanger. The coating shall be specifically chosen for resistance to the chemicals in the exhaust airstream.]

Provide an 18-gauge stainless steel drain pan with a 1-inch exterior connection.

Exchanger shall be cleanable with steam, hot water, or light detergent without degrading the performance.

HEAT EXCHANGER - ENTHALPY FIXED PLATE:

Provide a fixed plate heat exchanger capable of operating at temperatures from -20 degrees F to 140 degrees F and a maximum differential pressure of 2 inches. Exchanger shall withstand entrained moisture in the outdoor airstream without damage or deterioration of performance.

Heat exchanger shall transfer sensible and latent energy. The heat exchange surfaces shall be a polymer/desiccant material in a crossflow configuration. The edges shall be sealed with high temperature sealant. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with UL 723. Exchanger shall be ISO 846 certified for mold and bacteria resistance. The exchanger shall bear the AHRI 1060 certified label.

Provide an 18-gauge stainless steel drain pan with a 1-inch exterior connection.

Exchanger shall be cleanable with water or light detergent without degrading the performance.

HEAT EXCHANGER - SENSIBLE ROTARY WHEEL:

Provide a rotary wheel heat exchanger that transfers sensible energy only. The design of the wheel media shall ensure laminar airflow through the wheel.

The wheel media shall be sheet aluminum with a polymer coating to prevent oxidation. The media shall be coated prior to forming and assembly of the wheel. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with ASTM E84. The wheel shall bear the AHRI 1060 certified label.

Provide a welded rigid tubular steel or heavy-duty aluminum frame. Wheel deflection due to differential pressure shall not exceed 1/32 inch. Frame shall be finished with a corrosion resistant paint. Support the wheel from two sealed and permanently lubricated bearings that can be replaced without removing the wheel from the frame or the media from the spoke system.

Provide face and full perimeter seals. Seals shall be labyrinth or brush style.

Provide a factory-set and field-adjustable purge section. Adjust the purge angle to limit the Exhaust Air Transfer Ratio (EATR) to less than 4 percent.

Provide a self-adjusting belt around the entire perimeter of the wheel assembly and an electric motor with gear reduction.

Provide a variable frequency drive designed for rotary wheel applications with manual override speed adjustment. The VFD and motor shall be capable of 20:1 speed turndown. The drive shall include a start/stop input from a dry contact and a 0-10 VDC speed control input. Provide rotation detection dry contacts for connection to a direct digital controller.

The media shall be cleanable with hot water or light detergent without degrading the performance.

HEAT EXCHANGER - ENTHALPY ROTARY WHEEL:

Provide a rotary wheel heat exchanger that transfers sensible and latent energy. The design of the wheel media shall ensure laminar airflow through the wheel.

Select the appropriate wheel media/desiccant from the following two paragraphs. Use molecular sieve desiccant where odor or chemical carryover is a concern.

[The wheel media shall be sheet aluminum coated with a non-migrating 4 angstrom (maximum) molecular sieve desiccant. The media shall be coated prior to forming and assembly of the wheel. Desiccants that are surface sprayed, dip coated, or require reapplication over time are not acceptable. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with ASTM E84. The wheel shall bear the AHRI 1060 certified label.]

[The wheel media shall be polymer or sheet aluminum with a permanently bonded silica gel desiccant. The desiccant shall be applied prior to forming and assembly of the wheel. Desiccants that are surface sprayed, dip coated, or require reapplication over time are not acceptable. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with ASTM E84. The wheel shall bear the AHRI 1060 certified label.]

Provide a welded rigid tubular steel or heavy-duty aluminum frame. Wheel deflection due to differential pressure shall not exceed 1/32 inch. Frame shall be finished with a corrosion resistant paint. Support the wheel from two sealed and permanently lubricated bearings that can be replaced without removing the wheel from the frame or the media from the spoke system.

Provide face and full perimeter seals. Seals shall be labyrinth or brush style.

Provide a factory-set and field-adjustable purge section. Adjust the purge angle to limit the Exhaust Air Transfer Ratio (EATR) to less than 4 percent.

Provide a self-adjusting belt around the entire perimeter of the wheel assembly and an electric motor with gear reduction.

Provide a variable frequency drive designed for rotary wheel applications with manual override speed adjustment. The VFD and motor shall be capable of 20:1 speed turndown. The drive shall include a start/stop input from a dry contact and a 0-10 VDC speed control input. Provide rotation detection dry contacts for connection to a direct digital controller.

The media shall be cleanable with hot water or light detergent without degrading the performance.

Select DDC or standalone controls below and edit as needed. Consult with the DFD controls reviewer on what type of controls are required.

DDC CONTROLS:

Controls shall meet Section 23 09 15. Sequence of operations shall meet Section 23 09 93.

STANDALONE CONTROLS:

Provide standalone controls to operate the energy recovery unit including dampers, fans, and frost control.

The AE shall define any interlocks required to start/stop the unit and operate the bypass dampers in section 23 09 93.

An external signal shall start/stop the energy recovery unit. On a signal to start the unit, the outdoor air and exhaust air dampers shall open and the outdoor air and exhaust air fans shall run.

An external signal shall open/close the bypass dampers, if provided.

AE shall review the need for frost control with the DFD Project Manager before selecting equipment. Frost can form below 30 degrees F outdoor air temperature. Cycling the outdoor air fan is not an acceptable form of frost control. Select one of the three paragraphs below and modify the specification as needed to fulfill the project requirements.

[On a drop in outdoor air temperature below the frost control set point, the controls shall modulate the outdoor air bypass damper to control frost development on the heat exchanger.]

[On a drop in outdoor air temperature below the frost control set point, the controls shall energize the preheat coil and maintain a preheat coil discharge temperature of [30] degrees F to control frost development on the heat exchanger.]

[On a drop in outdoor air temperature below the frost control set point, the controls shall energize a traversing plate to control frost development on the static plate heat exchanger.]

Provide an outdoor air temperature sensor to operate the frost control sequence, if provided.

On unit shutdown, fans shall be off and dampers shall close.

STANDALONE HEAT EXCHANGER

Standalone heat exchangers are field installed in air handling units. Refer to Section 23 72 13 (Modular Air Handling Units) or Section 23 73 23 (Custom Air Handling Units) for the air handler requirements.

MANUFACTURERS:

Choose the desired type of heat exchanger from the following:

Sensible Fixed Plate: Innergy Tech, Munters or approved equal.

Enthalpy Fixed Plate: Airxchange, CORE, Innergy Tech, or approved equal.

Sensible Rotary Wheel - Aluminum Media: Innergy Tech, Semco, Thermotech, or approved equal.

Sensible Rotary Wheel - Polymer Media: Airxchange or approved equal.

Enthalpy Rotary Wheel - Molecular Sieve Desiccant: Innergy Tech, Semco, Thermotech, or approved equal.

Enthalpy Rotary Wheel - Silia Gel Desiccant: Airxchange or approved equal.

SENSIBLE FIXED PLATE:

Provide a fixed plate heat exchanger capable of operating at temperatures from -20 degrees F to 190 degrees F and a maximum differential pressure of 10 inches. Exchanger shall withstand entrained moisture in the outdoor airstream without damage or deterioration of performance.

Heat exchanger shall transfer sensible energy only. The heat exchange surfaces shall be aluminum or stainless steel in a crossflow configuration. The edges shall be sealed with high temperature sealant. The exchanger shall bear the AHRI 1060 certified label.

Include the following paragraph for exhaust airstreams that contain corrosive chemicals.

[Provide a corrosion-resistant coating in the exhaust airstream of the energy recovery unit including the cabinet, fans, dampers, and heat exchanger. The coating shall be specifically chosen for resistance to the chemicals in the exhaust airstream.]

Provide an 18-gauge stainless steel drain pan with a 1-inch exterior connection.

Exchanger shall be cleanable with steam, hot water, or light detergent without degrading the performance.

ENTHALPY FIXED PLATE:

Provide a fixed plate heat exchanger capable of operating at temperatures from -20 degrees F to 140 degrees F and a maximum differential pressure of 2 inches. Exchanger shall withstand entrained moisture in the outdoor airstream without damage or deterioration of performance.

Heat exchanger shall transfer sensible and latent energy. The heat exchange surfaces shall be a polymer/desiccant material in a crossflow configuration. The edges shall be sealed with high temperature sealant. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with UL 723. Exchanger shall be ISO 846 certified for mold and bacteria resistance. The exchanger shall bear the AHRI 1060 certified label.

Provide an 18-gauge stainless steel drain pan with a 1-inch exterior connection.

Exchanger shall be cleanable with water or light detergent without degrading the performance.

SENSIBLE ROTARY WHEEL:

Provide a rotary wheel heat exchanger that transfers sensible energy only. The design of the wheel media shall ensure laminar airflow through the wheel.

Select the appropriate wheel media from the following two paragraphs.

[The wheel media shall be sheet aluminum with a polymer coating to prevent oxidation. The media shall be coated prior to forming and assembly of the wheel. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with ASTM E84. The wheel shall bear the AHRI 1060 certified label.]

[The wheel media shall be polymer without desiccant. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with ASTM E84. The wheel shall bear the AHRI 1060 certified label.]

Provide a welded rigid tubular steel or heavy-duty aluminum frame. Wheel deflection due to differential pressure shall not exceed 1/32 inch. Frame shall be finished with a corrosion resistant paint. Support the wheel from two sealed and permanently lubricated bearings that can be replaced without removing the wheel from the frame or the media from the spoke system.

Provide face and full perimeter seals. Seals shall be labyrinth or brush style.

Provide a factory-set and field-adjustable purge section. Adjust the purge angle to limit the Exhaust Air Transfer Ratio (EATR) to less than 4 percent.

Provide a self-adjusting belt around the entire perimeter of the wheel assembly and an electric motor with gear reduction.

Provide a variable frequency drive designed for rotary wheel applications with manual override speed adjustment. The VFD and motor shall be capable of 20:1 speed turndown. The drive shall include a start/stop input from a dry contact and a 0-10 VDC speed control input. Provide rotation detection dry contacts for connection to a direct digital controller.

The media shall be cleanable with hot water or light detergent without degrading the performance.

ENTHALPY ROTARY WHEEL:

Provide a rotary wheel heat exchanger that transfers sensible and latent energy. The design of the wheel media shall ensure laminar airflow through the wheel.

Select the appropriate wheel media/desiccant from the following two paragraphs. Use molecular sieve desiccant where odor or chemical carryover is a concern.

[The wheel media shall be sheet aluminum coated with a non-migrating 4 angstrom (maximum) molecular sieve desiccant. The media shall be coated prior to forming and assembly of the wheel. Desiccants that are surface sprayed, dip coated, or require reapplication over time are not acceptable. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with ASTM E84. The wheel shall bear the AHRI 1060 certified label.]

[The wheel media shall be polymer or sheet aluminum with a permanently bonded silica gel desiccant. The desiccant shall be applied prior to forming and assembly of the wheel. Desiccants that are surface sprayed, dip coated, or require reapplication over time are not acceptable. The Flame Spread Index (FSI) shall not exceed 25 and the Smoke Developed Index (SDI) shall not exceed 50 when tested in accordance with ASTM E84. The wheel shall bear the AHRI 1060 certified label.]

Provide a welded rigid tubular steel or heavy-duty aluminum frame. Wheel deflection due to differential pressure shall not exceed 1/32 inch. Frame shall be finished with a corrosion resistant paint. Support the wheel from two sealed and permanently lubricated bearings that can be replaced without removing the wheel from the frame or the media from the spoke system.

Provide face and full perimeter seals. Seals shall be labyrinth or brush style.

Provide a factory-set and field-adjustable purge section. Adjust the purge angle to limit the Exhaust Air Transfer Ratio (EATR) to less than 4 percent.

Provide a self-adjusting belt around the entire perimeter of the wheel assembly and an electric motor with gear reduction.

Provide a variable frequency drive designed for rotary wheel applications with manual override speed adjustment. The VFD and motor shall be capable of 20:1 speed turndown. The drive shall include a start/stop input from a dry contact and a 0-10 VDC speed control input. Provide rotation detection dry contacts for connection to a direct digital controller.

The media shall be cleanable with hot water or light detergent without degrading the performance.

# P A R T 3 - E X E C U T I O N

INSTALLATION

Install equipment in accordance with unit manufacturer installation requirements in locations indicated on the drawings and as detailed. Pipe the condensate drain pan to the nearest floor drain.

PACKAGED ENERGY RECOVERY UNIT

Hinged and gasketed access doors shall be installed on the entering and leaving sides of the heat exchanger on both airstreams.

Install thermometers in the outdoor and exhaust airstreams at the inlet and outlet connections. Thermometers shall meet Section 23 09 14.

LEAKAGE TEST

Verify the need for a leakage test on packaged energy recovery units. Most units will not require a Leakage Test.

Seal all openings and dampers at the energy recovery unit to the pressure class listed below before performing the test. A minimal amount of ductwork may be connected to the energy recovery unit in order to seal off large openings. The ductwork must meet or exceed [-5] inches static pressure.

Test draw through packaged energy recovery units at [-5] inches static pressure. The contractor and/or the unit manufacturer may brace the access doors in positive sections of the energy recovery unit to meet the testing requirements.

Verify each energy recovery unit on a case-by-case basis and edit the static pressure requirements accordingly.

If excessive air leakage is found, locate the leak(s), repair in the area of the leak, seal, and retest.

Leakage rate shall not exceed more that 1% of the total system air quantity when subjected to [-5] inches static pressure.

Submit a signed report to the Division's Construction Representative, indicating test apparatus used, results of the leakage test, and any remedial work required to bring energy recovery units into compliance with specified leakage rates.

CONSTRUCTION VERIFICATION ITEMS

Contractor is responsible for utilizing the construction verification checklists supplied under specification Section 23 08 00 in accordance with the procedures defined for construction verification in Section 01 91 01 or 01 91 02.

FUNCTIONAL PERFORMANCE TESTING

Contractor is responsible for utilizing the functional performance test forms supplied under specification Section 23 08 00 in accordance with the procedures defined for functional performance testing in Section 01 91 01 or 01 91 02.

AGENCY TRAINING

All training provided for agency shall comply with the format, general content requirements and submission guidelines specified under Section 01 91 01 or 01 91 02.

END OF SECTION

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| **ENERGY RECOVERY UNIT - LEAKAGE TEST REPORT** |
| **State of Wisconsin** |  | **DFD Project Number: \_\_\_\_\_\_\_\_\_\_\_\_\_** |
| **Department of Administration** |  |  |
| **Division of Facilities Development** |  | **Date Submitted: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
|  |  |  |  |
| **Project** | **Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
|  | **Location: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
|  | **Contractor: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
|  | **Contractor Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
|  | **DFD Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
|  |  |  |  |
| **System Data** | **AHU No: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |  | **Test Pressure: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_” S.P.** |
|  | **AHU Design CFM: \_\_\_\_\_\_\_\_\_\_\_\_\_\_** |  | **Leakage at 1% of total design CFM (CFM): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |
|  |  |  | **Test Leakage at Test Pressure (CFM): \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**\_\_\_\_ |
|  |  |  |  |
| **Test Equipment** | **Manufacturer: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |  |  |
|  | **Model No: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |  |  |
|  | **Serial No: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** |  |  |