

**SECTION 23 72 00
AIR-TO-AIR ENERGY RECOVERY EQUIPMENT**

SPEC WRITER NOTE: Delete between //----//
if not applicable to project. Also delete
any other item or paragraph not applicable
in the section and renumber the
paragraphs.

PART 1 - GENERAL

1.1 DESCRIPTION

This Section specifies //air to air heat pipe heat exchangers //rotary
air-to-air heat exchangers //air-to-air plate heat exchangers //and
//run-around heat recovery systems//.

1.2 RELATED WORK

- A. Section 01 00 00, GENERAL REQUIREMENTS: Requirements for pre-test of equipment.
- //B. Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic requirements for non-structural equipment.//
- C. Section 23 05 11, COMMON WORK RESULTS FOR HVAC: General mechanical requirements and items, which are common to more than one section of Division 23.
- D. Section 23 21 23, HYDRONIC PUMPS: Requirements for pumping equipment.
- E. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Requirements for piping insulation.
- F. Section 23 21 13, HYDRONIC PIPING: Requirements for piping for expansion tanks.
- G. Section 23 82 16, AIR COILS: Requirements for run-around system coils.
- H. Section 23 31 00, HVAC DUCTS and CASINGS: Requirements for sheet metal ducts and fittings.
- I. Section 23 40 00, HVAC AIR CLEANING DEVICES: Requirements for filters used before heat recovery coils.
- J. Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Requirements for controls and instrumentation.
- K. Section 23 05 93, TESTING, ADJUSTING and BALANCING FOR HVAC: Requirements for testing, adjusting and balancing of HVAC system.
- L. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- M. Section 01 91 00 - GENERAL COMMISSIONING REQUIREMENTS

1.3 QUALITY ASSURANCE

- A. Refer to paragraph, GUARANTEE in specification Section 00 72 00, GENERAL CONDITIONS.

- B. Refer to specification Section 01 00 00, GENERAL REQUIREMENTS for performance tests and instructions to VA personnel.
- C. Refer to paragraph QUALITY ASSURANCE in specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- D. Performance Criteria: Heat recovery equipment shall be provided by a manufacturer who has been manufacturing such equipment and the equipment has a good track record for at least 3 years.
- E. Performance Test: In accordance with PART 3.

1.4 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES.
- B. Manufacturer's Literature and Data:
 - 1. Heat Pipe Heat Exchanger
 - 2. Rotary Heat Exchanger
 - 3. Plate Heat Exchanger
 - 4. Run-Around Energy Recovery System
- C. Certificate: Submit, simultaneously with shop drawings, an evidence of satisfactory service of the equipment on three similar installations.
- D. Submit type, size, arrangement and performance details. Present application ratings in the form of tables, charts or curves.
- E. Provide installation, operating and maintenance instructions, in accordance with Article, INSTRUCTIONS, in Section 01 00 00, GENERAL REQUIREMENTS.
- F. Completed System Readiness Checklists provided by the Commissioning Agent and completed by the contractor, signed by a qualified technician and dated on the date of completion, in accordance with the requirements of Section 23 08 00 COMMISSIONING OF HVAC SYSTEMS.

1.5 APPLICABLE PUBLICATIONS

- A. The publications listed below form a part of this specification to the extent referenced. The publications are referenced in the text by the basic designation only.
- B. Air Conditioning, Heating, and Refrigeration Institute (AHRI)
AHRI 1060-2005 Performance Rating of Air-to-Air Heat Exchangers
for Energy Recovery Ventilation Equipment
- C. American Society of Heating, Refrigeration and Air Conditioning
Engineers (ASHRAE):
 - 15-10 Safety Standard for Refrigeration Systems (ANSI)
 - 52.1-92 Gravimetric and Dust-Spot Procedures for Testing
Air-Cleaning Devices Used in General Ventilation
for Removing Particulate Matter

- 52.2-07 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- 84-08 Method of Testing Air-to-Air Heat/Energy Exchangers
- D. American Society for Testing and materials (ASTM)
- D635-10 Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position
- E84-10 Standard Test Method for Surface Burning Characteristics of Building Materials
- E. American Society of Civil Engineers (ASCE)
- ASCE 7-10 Minimum Design Loads for Buildings and Other Structures
- F. Underwriters Laboratories, Inc (UL)
- 1812-2009 Standard for Ducted Heat Recovery Ventilators
- 1815-2009 Standard for Nonducted Heat Recovery Ventilators

PART 2 - PRODUCTS

DESIGNER'S NOTE: For high-humidity locations (VA HVAC Design Manual), provide copper tubes and copper fins. See Section 23 82 16, AIR COILS for details

2.1 AIR-TO-AIR HEAT PIPE HEAT EXCHANGERS

- A. Thermal recovery units shall be capable of operating at temperatures ranging from a minimum of -29 degrees C (-20 degrees F) to a maximum of 49 degrees C (120 degrees F). The heat transfer between air streams shall take place in a counterflow arrangement. The unit shall have no moving part and shall be one piece construction.
- B. Tube core shall be either 18-mm (5/8 inch) or 25-mm (1 inch) OD seamless //aluminum//copper// tubing permanently expanded into the fins to form a firm, rigid and complete metal pressure contact between the tube and fin collar of all operating conditions. For high-humidity locations, provide copper tubes and copper fins.
- C. Fin: //Aluminum//Integral aluminum//copper//
1. Fin Spacing: //3.2 mm (0.125 inch)//2.3 mm (0.091 inch)//1.8 mm (0.071 inch)//1.7 mm (0.067 inch)//1.4 mm (0.056 inch)//0.2 mm (0.0075 inch)//
 2. Fin and Tube Joint: Mechanical bond and silver brazed.
- D. Coating: //Thermoplastic vinyl//epoxy//Synthetic resin//phenolic//Polytetrafluoroethylene//Vinyl ester// apply to supply and exhaust.

- E. Secondary surfaces shall be of continuous plate type aluminum fins, 0.18 mm (0.007 inch) thick, and of corrugated design to produce maximum heat transfer efficiencies.
- F. Basic capillary wick shall be an integral part of the inner wall of the tube and provide a completely wetted surface for maximum heat pipe capacity with minimum heat transfer resistance.
- G. Refrigerants used shall be approved by EPA.
- H. Exhaust and supply airstreams shall be separated from each other by a vertical partition, so that there will be no cross-contamination.
 - 1. Partition Material: //Galvanized steel //Stainless steel//.
 - 2. Partition Material Thickness: 1.7 mm (16-Gauge).
- I. Casing shall be a minimum of 1.9 mm (14-Gauge) galvanized steel flanged casing, with airtight partition between airstreams.
- J. End covers shall be a minimum of 1.0 mm (20-Gauge) galvanized steel.
- K. Tilt-Control Mechanism: For summer-winter operation with an electric actuator; and having control panels and sensing bulbs as shown on the drawings.

SPEC WRITER NOTE: Show control panels and sensing bulbs on drawings

- L. Provide flexible connectors for each side of the unit. The flexible connector shall be fabricated in a manner that will allow the unit to tilt without binding.
- //M. Control: Integral plenum containing heat-pipe coil and gasketed, face-and-bypass, opposed-blade dampers with rods extended outside casing for damper operator and linkage.//
- //N. Control: Pivot center of bottom of heat-pipe coil on shaft and bearings to tilt coil. Include tilt controls with electric actuator and linkage, thermostats, sensors, and polyester fabric with PVC-coated flexible connector for automatic supply temperature regulation, summer/winter changeover, and frost protection.//

2.2 ROTARY AIR-TO-AIR HEAT EXCHANGER:

- A. Exchanger Rotor or Wheel: Aluminum transfer media with a flame spread rating of 25 and less and smoke developed rating of 50 and less, and independently tested in accordance with ASTM standard E-84. Rotor media shall be independently tested in accordance with ASHRAE Standard 84. It shall allow laminar flow (but not radial) when operating within published operating airflow ranges and prevent leakage, bypassing and cross contamination by cross flow within wheel. Size the transfer media to allow passage of //300//500//800//1200// micrometers particles without fouling or clogging. When latent heat transfer is required, treat media with non-degrading //desiccant//silica-gel desiccant

coating// that is bacteriostatic, non-corroding and non-toxic. No asbestos material will be allowed. Wheel shall not condense water directly or require a condensate drain for summer or winter operation. Performance rating shall be in accordance with AHRI Standard 1060.

DESIGNER NOTE: 3 Angstrom (3A) and 4 Angstrom (4A) molecular sieves desiccant coatings provide superior protection to cross contamination.

- B. Rotor: //Glass-fiber//Polymer//segmented wheel strengthened with radial spokes impregnated with non-migrating, water-selected, //3A//4A// molecular-sieve desiccant coating.
1. Maximum Solid Size for media to pass://500//800//1200//micrometers.//
- C. Casings shall be sealed on periphery of rotor as well as on duct divider and purge section. Seals shall be adjustable, of extended life materials and effective in limiting air leakage.
- D. Wheel shall be supported by ball or roller bearings and belt driven by a fractional horsepower, totally enclosed, NEMA Standard motor through a close coupled positively lubricated speed reducer, or gear/chain speed reduction. Refer to Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT.
1. Motors for constant speed exchanger wheels shall be an AC motor.
 2. Variable-speed exchanger wheels shall have exchanger wheel speed and leaving-air temperature controlled by means of a variable-speed motor controller. // The speed shall be controlled as noted in paragraph G below. //Operation shall be from 115/1/60 and by a proportioning temperature controller which shall vary output voltage of a silicon controlled rectifier (SCR) to a rectified power motor which will change speed in proportion to changes of voltage to its armature.// Automatic changeover for summer-winter operations shall be controlled by an adjustable thermostwitch. Set point of adjustable proportioning temperature controller and thermostwitch shall be indicated on visible scale. System shall be capable of speed reduction down to 5 percent of capacity while maintaining adequate torque at any point of operation to rotate wheel.
- E. An automatic, factory-fabricated, field-adjustable purge unit shall limit exhaust air carry-over to less than 1.0 percent of rated volume. Purge shall be effective when static pressure difference between supply and exhaust is 125 Pa (one-half, inch wg) or greater, and it shall have provision for restriction or adjustment to limit purge air volume to not over five percent of rated air flow when a static pressure difference up to 2.5 kPa (10 inch wg) exists.

- F. Unit shall be constructed of heavy gage steel to insure rigidity and stability. Casing side panels shall be removable to insure easy access to internal parts and have integral flanges for flanged duct connection and lifting holes or lugs.
- G. Controls starting relay shall be factory mounted and wired, and include a manual motor starter for field wiring. // Variable frequency controller shall be factory mounted and wired, permitting input of field connected 4-20 mA or 1-10-V control signal.// Variable frequency controller shall be factory mounted and wired, with exhaust-air sensor to vary rotor speed and maintain exhaust temperature above freezing //Variable frequency controller shall be 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. When exhaust-air temperature is less than outdoor-air temperature, the rotor shall be at maximum speed.
- //1. Pilot-Light Indicator: Display rotor rotation and speed. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.//
- H. Filters: MERV 7, 2-inch throw-away type. Refer to Section 23 40 00 HVAC Air Cleaning Devices.

2.3 AIR-TO-AIR PLATE HEAT EXCHANGER

- A. Comply with UL Standards 1812.
- B. Plates: Corrugated 0.53 mm (0.021 inch)// diamond embossed aluminum//stainless steel//polypropylene copolymer (high density plastic)// enthalpic // spacing as recommended by the manufacturer.
- C. Bedding: Thermosetting reinforced resin. Provide plate seal-off and passage separation at top, bottom and center divider. The resins shall be self-extinguishing type in accordance with ASTM D635.
- D. Casing and End Strips: Casing of 1.6 mm (16 gage) galvanized steel, except casings for corrosive air streams shall be stainless steel. End strips of the same material as exchanger plates. Ends of unit exchanger plates shall be sealed with high temperature silicon sealant prior to installation of end strip for corrosive air streams provide welded end strips to avoid cross contaminations.
- E. Casings shall have integral flanges for flanged duct connections and shall have lifting holes or lugs.
- F. Drain Pan: Same material as unit casing. Drain-pan surface shall be covered with molded ABS, and shall have drain connections on exhaust and supply side. Comply with requirements in ASHRAE 62.1-2004.
- G. Accessories: Furnish where indicated on the drawings.

1. Face and Bypass Dampers: Manufacturer's standard, complete with operators, with factory-installed controls to operate face-and-bypass dampers during summer and winter.
- //2. Defrost System. Factory installed and capable of maintaining at least 85 percent of the non-frosted performance at -29 degrees C (-20 degrees F).//
- //H. Water Wash: Automatic system with spray manifold to individual spray tubes or traversing type with stainless-steel-screw operating mechanism and electric motor drive; activated by time clock with detergent injection.//
- I. Extended-Surface, Disposable Panel Filters: MERV 7, 2-inch throw-away type. Refer to Section 23 40 00 HVAC Air Cleaning Devices.

SPEC WRITER NOTE: For high-humidity locations (VA HVAC Design Manual), provide E-coated aluminum fins.

2.4 RUN-AROUND ENERGY RECOVERY SYSTEM

- A. System shall be field fabricated, as shown, containing coils, piping and ___percent glycol, pumps, insulation, and accessories.
- B. Automatic Temperature Controls and Sequence of Operations: As shown on drawings and as specified in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.//In areas with climates where the outdoor design temperature is below freezing, the sequence shall include a defrost cycle to modulate glycol flow to the outdoor air coil as required to maintain the exhaust air temperature above freezing.//
- C. Components shall comply with requirements in the following specification sections:
 1. Pumps: Section 23 21 23, HYDRONIC PUMPS
 2. Insulation: Section 23 07 11, HVAC AND BOILER PLANT INSULATION
 3. Pipes, Fittings, and Specialties: Section 23 21 13, HYDRONIC PIPING
 4. Coils: Section 23 82 16, AIR COILS
 5. Controls: Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

2.5 AIR FILTERS

Air Filters: Disposable air filters, with a MERV rating of 7, shall be provided //standard on all air entering sides of air-to-air heat exchangers, // upstream of outdoor air and exhaust run-around loop air coils// and as indicated on the drawings. Comply with requirements in specification Section 23 40 00, HVAC AIR CLEANING DEVICES.

PART 3 - EXECUTION**3.1 INSTALLATION**

- A. Follow the equipment manufacturer's instructions for handling and installation, and setting up of ductwork for makeup and exhaust air steamers for maximum efficiency.
- B. Rotary Air-to-Air Exchanger: Adjust seals and purge as recommended by the manufacturer. Verify correct installation of controls.
- C. Seal ductwork tightly to avoid air leakage.
- D. Install units with adequate spacing and access for cleaning and maintenance of heat recovery coils as well as filters.
- E. Brace heat recovery equipment installed in projects in the Seismic area according to specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS.
- //F. Secure outdoor heat recovery equipment to withstand a wind velocity of _____km/h (____mph).//

3.2 FIELD QUALITY CONTROL

- A. Operational Test: Perform tests as per manufacturer's written instructions for proper and safe operation of the heat recovery system.
 - 1. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Adjust seals and purge.
 - 3. Test and adjust controls and safeties.
- B. Replace damaged and malfunctioning controls and equipment.
- C. Set initial temperature and humidity set points. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Prepare test and inspection reports to the Senior Resident Engineer in accordance with specification Section 01 00 00, GENERAL REQUIREMENTS.

3.3 INSTRUCTIONS

Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of heat recovery equipment.

3.4 STARTUP AND TESTING

- A. The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the Resident Engineer and Commissioning Agent. Provide a minimum of 7 days prior notice.

3.5 COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS for all inspection,

start up, and contractor testing required above and required by the System Readiness Checklist provided by the Commissioning Agent.

- B. Components provided under this section of the specification will be tested as part of a larger system. Refer to Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS and related sections for contractor responsibilities for system commissioning.

3.6 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.
- B. Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS.

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