

SECTION 23 81 10
VARIABLE FLOW REFRIGERANT SYSTEM

PART 1 - GENERAL**1.1 DESCRIPTION**

- A. This section specifies variable capacity heat pump heat recovery air conditioning system. The system shall be simultaneous cooling and heating split system heat pumps, system shall include outdoor unit, branch circuit controller, indoor units and controls.
- B. Definitions:
1. Energy Efficiency Ratio (EER): The ratio of net cooling capacity is Btu/h to total rate of electricity input in watts under designated operating conditions (Btu hour/Watt).
 2. Seasonal Energy Efficiency Ratio (EER): The ratio of the total cooling output of an air conditioner during its normal annual usage period for cooling in Btu/h divided by total electric energy input in watts during the same period (Btu hour/Watt).
 3. Unitary: A Unitary Air Conditioner consists of one or more factory-made assemblies which normally include an evaporator or cooling coil, a compressor and condenser combination, and may include a heating function as well.
 4. Where such equipment is provided in more than one assembly the separated assemblies are to be designed to be used together and the requirements of rating are based upon use of matched assemblies.

1.2 RELATED WORK

- A. 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.
- B. Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT: Requirements for different types of vibration isolators and noise ratings in the occupied areas.
- C. Section 23 07 11, HVAC and BOILER PLANT INSULATION: Requirements for piping insulation.
- D. Section 23 23 00, REFRIGERANT PIPING: Requirements for refrigerant pipes and fittings.
- E. Section 23 40 00, HVAC AIR CLEANING DEVICES: Requirements for air filtration.
- F. Section 23 08 00 - COMMISSIONING OF HVAC SYSTEMS: Requirements for commissioning, systems readiness checklists, and training.
- G. Section 23 05 93, TESTING, ADJUSTING, and BALANCING FOR HVAC: Requirements for testing and adjusting air balance.

1.3 QUALITY ASSURANCE

- A. Refer to specification Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Safety Standards: ASHRAE Standard 15, Safety Code for Mechanical Refrigeration.

1.4 SUBMITTALS

- A. Submit in accordance with specification Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, and SAMPLES
- B. Manufacturer's literature and data:
 - 1. Sufficient information, including capacities, pressure drops and piping connections clearly presented, shall be included to determine compliance with drawings and specifications for units noted below:
 - a. Indoor Unit (ceiling ducted):
 - b. Outdoor Unit
 - c. Branch Circuit Controller
 - d. Controls
 - 2. Unit Dimensions required clearances, operating weights accessories and start-up instructions.
 - 3. Electrical requirements, wiring diagrams, interlocking and control wiring showing factory installed and portions to be field installed.
 - 4. Mounting and flashing of the roof curb to the roofing structure with coordinating requirements for the roof membrane system.
- C. Certification: Submit proof of specified ARI Certification.
- D. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required sensible-to-heat-ratio, energy efficiency ratio (EER), and coefficient of performance (COP).
- E. Operating and Maintenance Manual: Submit three copies of Operating and Maintenance manual to Resident Engineer three weeks prior to final inspection.
- 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. Military Specifications (Mil. Specs.):
 - MIL-PRF-26915D-06.....Primer Coating, for Steel Surfaces
- C. Air-Conditioning, Heating, and Refrigeration Institute (AHRI):
 - 270-08.....Sound Rating of Outdoor Unitary Equipment

- 310/380-04.....Standard for Packaged Terminal Air-Conditioners and Heat Pumps (CSA-C744-04)
- 340/360-07.....Performance Rating of Commercial and Industrial Unitary Air-Conditioning and Heat Pump Equipment
- 520-04.....Performance Rating of Positive Displacement Condensing Units

D. Air Movement and Control Association (AMCA):

- 210-07.....Laboratory Methods of Testing Fans for Aerodynamic Performance Rating (ANSI)
- 410-96.....Recommended Safety Practices for Users and Installers of Industrial and Commercial Fans

E. American National Standards Institute (ANSI):

- S12.51-02 (R2007).....Acoustics - Determination of Sound Power Levels of Noise Sources Using Sound Pressure - Precision Method for Reverberation Rooms (same as ISO 3741:1999)

F. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):

- 2008 Handbook.....HVAC Systems and Equipment
- 15-10.....Safety Standard for Refrigeration Systems (ANSI)

G. National Electrical Manufacturer's Association (NEMA):

- MG 1-09 (R2010).....Motors and Generators (ANSI)
- ICS 1-00 (R2005, R2008).Industrial Controls and Systems: General Requirements

H. National Fire Protection Association (NFPA) Publications:

- 90A-09.....Standard for the Installation of Air-Conditioning and Ventilating Systems

PART 2 - PRODUCTS

2.1 GENERAL

- A. Performance Rating: Cooling capacity of units shall meet the sensible heat and total heat requirements shown in the contract documents. In selecting unit size, make true allowance for "sensible to total heat ratio" to satisfy required sensible cooling capacity.
- B. Machinery Guards: Provide guards as shown in AMCA 410 for belts, chains, couplings, pulleys, sheaves, shafts, gears and other moving parts regardless of height above the floor. Drive guards may be excluded where motors and drives are inside factory fabricated casings.
- C. The system shall consist of an Outdoor unit, Branch Circuit (BC) Controller, multiple Indoor units and Direct Digital Controls. The outdoor unit shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions

necessary for operation. The outdoor unit shall have a powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.

1. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of outdoor rated capacity.

2.2 OUTDOOR UNIT

A. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel, bonderized and finished with a powder coated baked enamel.

B. Fan:

1. The unit shall be furnished with one direct drive, variable speed propeller type fan.
2. The fan motor shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. The fan motor shall be mounted for quiet operation.
4. The fan shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have vertical discharge airflow.

C. Refrigerant

1. Refrigerant shall be required for outdoor unit systems.

D. Coil:

1. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil shall be protected with an integral metal guard.
3. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
4. The outdoor coil shall include 4 circuits with two position valves for each circuit, except for the last stage.

E. Compressor:

1. The compressor shall be a high performance, inverter driven, modulating capacity scroll compressor.
2. A crankcase heater shall be factory mounted on the compressor.
3. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable down to 16% of rated capacity.
4. The compressor will be equipped with an internal thermal overload.
5. The compressor shall be mounted to avoid the transmission of vibration.

F. Additional:

1. Outdoor unit shall have a sound rating no higher than 60 dB(A).

2. Both refrigerant lines from the outdoor unit to the BC (Branch Circuit) Controller shall be insulated.
3. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
4. The outdoor unit shall have a high pressure safety switch, over-current protection and DC bus protection.
5. The outdoor unit shall have the ability to operate with a maximum height difference of 164 feet and have total refrigerant tubing length of 984-1312 feet. The greatest length is not to exceed 492 feet between outdoor unit and the indoor units without the need for line size changes or traps.
6. The outdoor unit shall be capable of operating in heating down to -4°F ambient temperature without additional low ambient controls.
7. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.

G. Electrical:

1. The control circuit between the indoor units, BC Controller and the outdoor unit shall be 12VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
2. The outdoor unit shall be controlled by integral microprocessors.

2.3 BRANCH CIRCUIT (BC) CONTROLLER FOR SYSTEM

A. General:

1. The BC (Branch Circuit) Controllers shall be specifically used with systems. These units shall be equipped with a circuit board that interfaces to the controls system and shall perform all functions necessary for operation. The unit shall have a galvanized steel finish. The BC Controller shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory. This unit shall be mounted indoors. The sum of connected capacity of all indoor air handlers shall range from 50% to 150% of rated capacity.
2. Each BC Controller branch shall connect to indoor unit(s) not exceeding 54,000 Btu/h per branch. BC Controller models and number of branch shall be in accordance with the manufacturer:

B. BC Unit Cabinet:

1. The casing shall be fabricated of galvanized steel.
2. Each cabinet shall house a liquid-gas separator and multiple refrigeration control valves.
3. The unit shall house two tube-in-tube heat exchangers.

C. Refrigerant

1. Refrigerant shall be required for Controllers in conjunction with outdoor unit systems.

D. Refrigerant valves:

1. The unit shall be furnished with multiple two position refrigerant valves.
2. Each circuit shall have one (54,000 Btu/h or smaller indoor unit section) two-position liquid line valve and a two-position suction line valve.
3. When connecting a 54,000 Btu/h or larger indoor unit section, two branch circuits shall be joined together at the branch controller to deliver an appropriate amount of refrigerant. The two refrigerant valves shall operate simultaneously.
4. Linear electronic expansion valves shall be used to control the variable refrigerant flow.

E. Integral Drain Pan:

1. An integral condensate pan and drain shall be provided.

F. Electrical:

1. The BC Controller shall be controlled by integral microprocessors.
2. The control circuit between the indoor units and the outdoor unit shall be 12VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.4 INDOOR UNIT (CEILING DUCTED)

A. Description: Factory assembled and wired consisting of the following:

1. Cabinet.
2. Fan.
3. Coil.
4. Filter
5. Remote condenser.
6. Air filters.
7. Controls.
8. Full charge of refrigerant and oil.

B. Cabinet Frame and Panels: Structural-steel frame with galvanized-steel panels with access doors or panels. Integral return air filter or optional return filter box as scheduled on drawings and control circuit board.

1. Drain Pan: Galvanized steel with corrosion-resistant coating complying with ASHRAE 62.1-2007.
2. Isolation: Spring isolators for mounting from structure.
3. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007.

- C. Fan: Galvanized steel, direct drive, double-width, double-inlet forward-curved centrifugal fans; statically and dynamically balanced. Unit shall have a ducted air outlet and inlet.
- D. Fan Motors: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC and STEAM GENERATION EQUIPMENT and shall be multi-speed with permanently lubricated bearings. (High, Mid1, Mid2 and Low).
- E. Coil: Non ferrous construction with smooth plate fins on copper tubing.
 - 1. Tubing shall have inner grooves for high efficiency heat exchange.
 - 2. All tube joints shall be brazed with phos-copper or silver alloy and factory pressure tested.
 - 3. Electronic modulating linear expansion device.
- F. Refrigerant Piping: Both refrigerant lines to the indoor and outdoor units shall be insulated.

2.5 CONTROLS

- A. Physical characteristics:
 - 1. General: The physical controllers shall be plastic material with a neutral color. Each remote controller, at a minimum, shall have a LCD (Liquid Crystal Display) that shows room temperature, set point, and fan speed.
- B. Electrical Characteristics
 - 1. General: The electrical voltage from each circuit board to the controls shall be 12 volts DC. The voltage may fluctuate up or down depending on communication packets being sent and received.
 - 2. Wiring: Control wiring shall be installed in a daisy chain configuration from indoor unit to indoor unit then to the BC controller and outdoor unit. Control wiring shall run from the indoor unit terminal block to the controller associated with that unit.
 - 3. Wiring size: Wiring shall be 2-conductor 16 AWG or 18 AWG stranded wire with a shield.
 - 4. Shielding the cable: The wire shall be 2-conductor, twisted pair shielded and connected to the appropriate terminals within the indoor units and outdoor unit as well as the BC controller.
- C. Remote Controllers
 - 1. The remote controllers shall operate indoor units. The wiring for the remote controllers shall be simple, non-polar, two-wire connections. All remote controllers shall be wall-mounted and contain a microprocessor that constantly monitors operation to maintain smooth indoor unit operation. Set temperature shall be adjusted in increments of 1°F or 2°F, depending on the systems and controllers. In the event of an abnormality, the remote controller shall display a four-digit error code and the indoor unit address.

D. Cassettes

1. Unit shall be factory wired with electronic modulating linear expansion device, control circuit board and shall have a self-diagnostic function, 3-minute time delay mechanism and an auto restart function

PART 3 EXECUTION

3.1 INSTALLATION

- A. Roof Curb: Install on roof structure, level and secure, according to ARI Guideline B. Install units on curbs and coordinate roof penetrations and flashing with roof construction specified in Section 07 72 00, ROOF ACCESSORIES. Secure unit to curb and secure curb base to roof framing with anchor bolts.
- B. Install units level and plumb maintaining manufacturer's recommended clearances and tolerances.
- C. Install vibration spring isolators under base of self contained unit, with minimum static deflection of 25 mm (1 inch) unless otherwise indicated. Refer to Section 23 05 41, NOISE and VIBRATION CONTROL FOR HVAC PIPING and EQUIPMENT
- D. Install roof-mounting compressor-condenser components on equipment supports specified in Section 07 72 00, ROOF ACCESSORIES. Anchor units to supports with removable, cadmium-plated fasteners.
- E. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.
- F. Install wall sleeves in finished wall assembly and weatherproof.

3.2 CONNECTIONS

- A. Verify condensate drainage requirements.
- B. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.
- C. Install piping adjacent to units to allow service and maintenance.
- D. Connect supply ducts to units with flexible duct connectors specified in Section 23 31 00, HVAC DUCTS and CASINGS.
- E. Ground equipment and install power wiring, switches, and controls for self contained and split systems.
- F. Connect refrigerant piping to coils with shutoff valves on the suction and liquid lines at the coil and a union or flange at each connection at the coil and condenser.
- G. Install ducts to the units with flexible duct connections.

3.3 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.

- B. Tests and Inspections: After installing units and after electrical circuitry has been energized, test units for compliance with requirements. Inspect for and remove shipping bolts, blocks, and tie-down straps. 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. Remove and replace malfunctioning units and retest as specified above.

3.4 INSTRUCTIONS

- A. Provide services of manufacturer's technical representative for four hours to instruct VA personnel in operation and maintenance of units.

3.5 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.

3.6 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.

3.7 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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