

SECTION 23 81 46
WATER-SOURCE UNITARY HEAT PUMPS

SPEC WRITER NOTES:

1. Use this section only for NCA projects.
2. Delete between // // if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.
3. This section does not include every possible type of Heat pump available. Edit this section properly to suit specific project.
4. Seismic Design Requirements, H-18-8.
5. Minimum Energy Efficiency Requirements; show on drawings applicable minimum energy efficiency requirements from Table 6.2.1B, ASHRAE 90.1.
6. This section covers ground-source closed loop heat pump systems. If ground-source heat pump is included in this project, the Section 23 81 49, GROUND-SOURCE HEAT PUMP shall be obtained from the VA Masters for open system components.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This Section specifies the following configurations of electrically operated Water-Source Heat Pumps:
 1. Unitary water-source heat pumps.
 2. Water-source heat pumps larger than 21 kW (6 tons).
 3. Console water-source heat pumps.
- B. A complete listing of common acronyms and abbreviations are included in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- C. 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.
 2. Coefficient of Performance (COP) - Cooling: The ratio of the rate of heat removed to the rate of energy input in consistent units, for a complete refrigerating system or some specific portion of that system under designated operating conditions.
 3. Coefficient of Performance (COP) - Heating: The ratio of the rate of heat delivered to the rate of energy input is consistent units for a

complete heat pump system, including the compressor and, if applicable, auxiliary heat under designated operating conditions.

4. Unitary Heat Pump: One or more factory made assemblies that normally include an indoor conditioning coil, compressor(s), and a refrigerant-to-water heat exchanger. These units provide both heating and cooling functions.

1.2 RELATED WORK

SPEC WRITER NOTE: Retain one of two paragraphs below.

- A. //Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects).//
- B. //Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects).//
- C. Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
- D. Section 01 42 19, REFERENCE STANDARDS.
- E. Section 01 81 13, SUSTAINABLE DESIGN REQUIREMENTS.
- F. //Section 01 91 00 GENERAL COMMISSIONING REQUIREMENTS.//

SPEC WRITER NOTE: If Section 13 05 41 is included in this project the section shall be obtained from VA Masters.

- G. //Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-STRUCTURAL COMPONENTS: Seismic reinforcing.//
- H. 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.
- I. Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT.
- J. Section 23 05 93, TESTING, ADJUSTING, AND BALANCING FOR HVAC: Requirements for testing, adjusting and balancing of HVAC system.
- K. //Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//
- L. //Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC: Requirements for controls and instrumentation.//
- M. Section 23 21 13, HYDRONIC PIPING.
- N. Section 23 23 00, REFRIGERANT PIPING: Requirements for field refrigerant piping.
- O. Section 23 31 00, HVAC DUCTS AND CASINGS: Requirements for sheet metal ductwork and ducted supply, return, and outside air.

1.3 APPLICABLE PUBLICATIONS

SPEC WRITER NOTE: Make material requirements agree with requirements specified in the referenced Applicable Publications. Verify and update the publication list to that which applies to

the project, unless the reference applies to all mechanical systems. Publications that apply to all mechanical systems may not be specifically referenced in the body of the specification, but, shall form a part of this specification.

- 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):
 - 260-2012.....Sound Rating of Ducted Air Moving and Conditioning Equipment
 - 350-2015.....Sound Rating of Non-Ducted Indoor Air-Conditioning Equipment
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRAE):
 - 15-2013.....Safety Standard for Refrigeration Systems
 - 52.2-2012.....Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
 - 62.1-2013.....Ventilation for Acceptable Indoor Air Quality
 - 90.1-2013.....Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings
- D. American Society of Testing and Materials (ASTM):
 - B743-2012.....Standard Specification for Seamless Copper Tube in Coils
 - E84-2015a.....Standard Test Method for Surface Burning Characteristics of Building Materials
- E. International Organization for Standardization (ISO):
 - 13256-1-1998.....Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps
- F. Underwriters Laboratory (UL):
 - 181-2013.....Standard for Factory-Made Air Ducts and Air Connectors

1.4 SUBMITTALS

- A. Submittals, including number of required copies, shall be submitted in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

- B. Information and material submitted under this section shall be marked "SUBMITTED UNDER SECTION 23 81 46, WATER-SOURCE UNITARY HEAT PUMPS", with applicable paragraph identification.
- C. Manufacturer's Literature and Data including: Full item description and optional features and accessories. Include dimensions, weights, materials, applications, standard compliance, model numbers, size, and capacity.
 - 1. Water-Source Unitary Heat Pumps:
 - a. Console type
 - b. Horizontal type
 - c. Rooftop type
- D. Certification: Submit, simultaneously with shop drawings, a proof of certification that this product has been certified by AHRI.
- E. Performance Rating: Submit catalog selection data showing equipment ratings and compliance with required cooling and heating capacities, EER, and COP values as applicable.
- F. Complete operating and maintenance manuals including wiring diagrams, technical data sheets, information for ordering replacement parts, and troubleshooting guide:
 - 1. Include complete list indicating all components of the systems.
 - 2. Include complete diagrams of the internal wiring for each item of equipment.
 - 3. Diagrams shall have their terminals identified to facilitate installation, operation and maintenance.
- G. //Completed System Readiness Checklist 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.//
- H. //Submit training plans and instructor qualifications in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.//

1.5 QUALITY ASSURANCE

- A. Refer to paragraph QUALITY ASSURANCE, in Section 23 05 11, COMMON WORK RESULTS FOR HVAC.
- B. Comply with ASHRAE 15.
- C. Comply with ASHRAE 90.1 for equipment efficiencies.

1.6 AS-BUILT DOCUMENTATION

SPEC WRITER NOTE: Coordinate O&M Manual requirements with Section 01 00 01, GENERAL REQUIREMENTS (Major NCA Projects) or Section 01 00 02, GENERAL REQUIREMENTS (Minor NCA Projects). O&M manuals shall be submitted for content review as part of the close-out documents.

- A. Submit manufacturer's literature and data updated to include submittal review comments and any equipment substitutions.
- B. Submit operation and maintenance data updated to include submittal review comments, substitutions and construction revisions shall be //in electronic version on CD or DVD// inserted into a three ring binder. All aspects of system operation and maintenance procedures, including applicable piping isometrics, wiring diagrams of all circuits, a written description of system design, control logic, and sequence of operation shall be included in the operation and maintenance manual. The operations and maintenance manual shall include troubleshooting techniques and procedures for emergency situations. Notes on all special systems or devices shall be included. A List of recommended spare parts (manufacturer, model number, and quantity) shall be furnished. Information explaining any special knowledge or tools the owner will be required to employ shall be inserted into the As-Built documentation.
- C. The installing contractor shall maintain as-built drawings of each completed phase for verification; and, shall provide the complete set at the time of final systems certification testing. As-built drawings are to be provided, and a copy of them in Auto-CAD version //____// provided on CD or DVD. Should the installing contractor engage the testing company to provide as-built or any portion thereof, it shall not be deemed a conflict of interest or breach of the 'third party testing company' requirement.
- D. Certification documentation shall be provided to COR 10 working days prior to submitting the request for final inspection. The documentation shall include all test results, the names of individuals performing work for the testing agency on this project, detailed procedures followed for all tests, and certification that all results of tests were within limits specified.

PART 2 - PRODUCTS**2.1 GENERAL REQUIREMENTS FOR WATER-SOURCE HEAT PUMPS**

- A. System Characteristics of a Closed-Loop System: The system consists of multiple units connected to a 2-pipe, closed-loop hydronic system with continuous water circulation. Temperature of the water loop to be maintained at approximately 18 to 35 degrees C (65 to 95 degrees F) by means of a ground loop.

2.2 UNITARY WATER-SOURCE HEAT PUMPS (1-1/2 TO 6 TONS)

- A. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ISO 13256-1. Provide //vertical// //horizontal// type unit, with ducted air delivery. Comply with ISO 13256-1.
- B. Cabinet: Manufacturer's standard galvanized steel. Provide with access panels and flanged duct connections. Provide cabinet with factory insulated with fiber glass duct liner, minimum 15 mm (1/2 inch) thick and complying with UL 181. Provide units with knockouts for electrical, piping, and condensate drain connections.
- C. Fan: Direct driven, centrifugal, with permanently lubricated multi-speed motor, resiliently mounted in fan inlet
- D. Compressor: Scroll compressor installed on vibration isolators; with a slide-out chassis and housed in an acoustically treated enclosure. Provide factory-installed safeties, anti-recycle timer, high-pressure cutout, low-pressure cutout or loss-of-charge switch, internal thermal-overload protection, and freeze stat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 2 degrees C (35 degrees F). Condensate overflow switch stops compressor with high condensate level in condensate drain pan. Compressor lockout circuit capable of being reset at either remote thermostat or circuit breaker.
- E. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
- F. Pipe Insulation: Refrigerant minimum 10 mm (3/8 inch) thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E84.
- G. Refrigerant Metering Device: //Capillary tube// //Thermal expansion valve// to allow specified operation with entering-water temperatures from minus 4 to plus 52 degrees C (25 to 125 degrees F).

- H. Condensate Drainage: Plastic non-corrosive drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.
- I. Airstream Surfaces: Surfaces in contact with the airstream to comply with requirements in ASHRAE 62.1.
- J. Sound Attenuation Package: Manufacturer's standard package rated in accordance with AHRI 260.
- K. General Motor Requirements: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Multispeed motor permanently lubricated, //permanent split capacitor// //ECM//.
- L. Water-to-Refrigerant Heat Exchanger: Coaxial heat exchangers with //copper// //cupronickel// water tube with enhanced heat-transfer surfaces inside a steel shell. Leak test both shell and tube to 3102 kPa (450 psig) on refrigerant side and 2758 kPa (400 psig) on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.
- SPEC WRITER NOTE: Verify availability of water-side economizer with manufacturer. Water-side economizer may be field installed on this type of water-source heat pump. Partial free cooling is available at 13 degrees C (55 degrees F).
- M. //Water-Side Economizer: Copper tube and aluminum fin coil with three-way valve and entering-water temperature sensor and controller. Valve diverts water to water-side economizer coil ahead of refrigerant-to-water heat exchanger when entering-water temperature falls to 13 degrees C (55 degrees F).//
- N. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves close when heat-pump compressor is not running.
- O. Motorized Water Valve: Stop water flow through the unit when compressor is off.
- P. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 3102 kPa (450 psig).
- Q. Refrigerant Circuit Components: Sealed refrigerant circuit charged with HCFC or CFC free refrigerant.
1. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.

2. Charging Connections: Service fittings on suction and liquid for charging and testing.
 3. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
 4. Refrigerant Metering: Extended temperature range device or a bi-directional thermal expansion valve.
- R. //Electric Heating Coil: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports. Energize on call for heating when entering-water-loop temperature is less than 13 degrees C (55 degrees F) with an adjustable range between minus 4 to plus 15 degrees C (25 to 59 degrees F).//
- S. Hot-Gas Reheat: Reheat valve, pilot-operated, sliding-type with replaceable magnetic coil to divert refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.
- T. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.
- U. Filters: Disposable, glass-fiber, flat type, 25 mm (1 inch) thick, and having a MERV 8 rating according to ASHRAE 52.2.
- V. Controls:
1. Basic Unit Controls:
 - a. Low- and high-voltage protection.
 - b. Overcurrent protection for compressor and fan motor.
 - c. Random time delay, three to ten seconds, start on power up.
 - d. Time delay override for servicing.
 - e. Control voltage transformer.
 2. Thermostat: Wall-mounted Automatic Programmable Thermostat// with lockable cover//.
 3. //Comply with requirements in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC.//
- W. Electrical Connection: Control box with single electrical connection factory installed and tested// with fused disconnect//.
- SPEC WRITER NOTE: Show a list of Input/ Output Point Summary on drawings for maintenance of controls and alarms.
- X. //Dampers: Motorized outdoor air intake damper for WSHP. The damper opens when the unit is energized.//
- Y. //Hangers with vibration isolators for horizontal type heat pumps.//

2.3 WATER-SOURCE HEAT PUMPS LARGER THAN 21 KW (6 TONS)

- A. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ISO 13256-1.
- B. Chasis: Manufacturer's standard galvanized steel.
- C. Fan: Belt driven, centrifugal, with permanently lubricated single-speed motor installed on an adjustable fan base resiliently mounted in chasis.
- D. Compressor: Scroll compressor installed on vibration isolators; with a slide-out chassis and housed in an acoustically treated enclosure. Provide factory installed safeties, anti-recycle timer, high-pressure cutout, low-pressure cutout or loss-of-charge switch, internal thermal-overload protection, and freeze stat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 2 degrees C (35 degrees F). Condensate overflow switch stops compressor with high condensate level in condensate drain pan. Compressor lockout circuit capable of being reset at either remote thermostat or circuit breaker.
- E. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
- F. Pipe Insulation: Refrigerant minimum 10 mm (3/8 inch) thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E84.
- G. Refrigerant Metering Device: //Capillary tube// //Thermal expansion valve// to allow specified operation with entering-water temperatures from minus 4 to plus 52 degrees C (25 to 125 degrees F).
- H. Condensate Drainage: Plastic or stainless steel drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.
- I. Airstream Surfaces: Surfaces in contact with the airstream to comply with requirements in ASHRAE 62.1.
- J. Sound Attenuation Package: Manufacturer's standard package rated in accordance with AHRI 260.
- K. General Motor Requirements: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Multispeed motor permanently lubricated, permanent split capacitor.
- L. Water-to-Refrigerant Heat Exchanger: Coaxial heat exchangers with //copper// //cupronickel// water tube with enhanced heat-transfer

surfaces inside a steel shell. Leak test both shell and tube to 3102 kPa (450 psig) on refrigerant side and 2758 kPa (400 psig) on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.

SPEC WRITER NOTE: Verify availability of water-side economizer with manufacturer. Water-side economizer may be field installed on this type of water-source heat pump. Partial free cooling is available at 13 degrees C (55 degrees F).

- M. //Water-Side Economizer: Copper tube and aluminum fin coil with three-way valve and entering-water temperature sensor and controller. Valve diverts water to water-side economizer coil ahead of refrigerant-to-water heat exchanger when entering-water temperature falls to 13 degrees C (55 degrees F).//
- N. Water Regulating Valves: Limit water flow through refrigerant-to-water heat exchanger, and control head pressure on compressor during cooling and heating. Valves close when heat-pump compressor is not running.
- O. Motorized Water Valve: Stop water flow through the unit when compressor is off.
- P. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 3102 kPa (450 psig).

SPEC WRITER NOTE: Verify maximum capacity for single refrigerant circuits. Insert value if different than 35 kW (10 tons).

- Q. Refrigerant Circuit Components: Minimum of 2 circuits required. Intertwine multiple circuits in refrigerant to air coil. Charge with HCFC or CFC free refrigerant.
 1. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
 2. Charging Connections: Service fittings on suction and liquid for charging and testing.
 3. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
 4. Refrigerant Metering: Extended temperature range device or a bi-directional thermal expansion valve.
- R. //Electric Heating Coil: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports. Energize on call for heating when entering-water-loop temperature is less than 13

degrees C (55 degrees F) with an adjustable range between minus 4 to plus 15 degrees C (25 to 59 degrees F).//

- S. Hot-Gas Reheat: Reheat valve, pilot-operated, sliding-type with replaceable magnetic coil to divert refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.
- T. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.
- U. Filters: Disposable, glass-fiber, flat type, 50 mm (2 inch) thick, MERV 8 according to ASHRAE 52.2
- V. //Comply with requirements in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for control equipment and sequence of operation.//
- W. Controls:
 - 1. Basic Unit Controls: Low- and high-voltage protection. Overcurrent protection for compressor and fan motor. Random time delay, three to ten seconds, start on power up. Time delay override for servicing and control voltage transformer.
 - 2. Thermostat: Wall-Mounted Automatic Programmable Thermostat// with lockable cover//.
- X. Electrical Connection: Control box with single electrical connection factory installed and tested// with fused disconnect//.

SPEC WRITER NOTE: Show a list of Input/ Output Point Summary on drawings for maintenance of controls and alarms.
- Y. //Dampers: Motorized outdoor air intake damper. The damper opens when the unit is energized.//
- Z. //Hangers with vibration isolators for horizontal type heat pumps.//

2.4 CONSOLE WATER-SOURCE HEAT PUMPS (1/2 TO 1-1/2 TONS)

- A. Description: Packaged water-source heat pump with temperature controls; factory assembled, tested, and rated according to ISO 13256-1.
- B. Cabinet and Chassis: Manufacturer's standard galvanized-steel casing, with return-air opening. Provide with access panels and knockouts for electrical and piping connections. Provide cabinet with factory insulated with glass-fiber duct liner, 15 mm (1/2 inch) thick and complying with UL 181. Unit with a plastic or stainless steel drain pan with condensate drain piping projecting to unit exterior and complying with ASHRAE 62.1. Double deflection discharge grille with adjustable discharge air pattern.

- C. Fans: Direct driven, centrifugal, with permanently lubricated multi-speed motor resiliently mounted in fan inlet
- D. Compressor: Rotary compressor installed on vibration isolators; with a slide-out chassis and housed in an acoustically treated enclosure. Provide factory-installed safeties, anti-recycle timer, high-pressure cutout, low-pressure cutout or loss-of-charge switch, internal thermal-overload protection, and freeze stat to stop compressor if water-loop temperature in refrigerant-to-water heat exchanger falls below 2 degrees C (35 degrees F). Condensate overflow switch stops compressor with high condensate level in condensate drain pan. Compressor lockout circuit capable of being reset at either remote thermostat or circuit breaker.
- E. Refrigerant Piping Materials: ASTM B743 copper tube with wrought-copper fittings and brazed joints.
- F. Pipe Insulation: Refrigerant minimum 10 mm (3/8 inch) thick, flexible elastomeric insulation on piping exposed to airflow through the unit. Maximum 25/50 flame-spread/smoke-development indexes according to ASTM E84.
- G. Refrigerant Metering Device: Thermal expansion valve to allow specified operation with entering-water temperatures from 18 to 38 degrees C (65 to 100 degrees F).
- H. Condensate Drainage: Plastic non-corrosive drain pan with condensate drain piping projecting through unit cabinet and complying with ASHRAE 62.1.
- I. Airstream Surfaces: Surfaces in contact with the airstream to comply with requirements in ASHRAE 62.1.
- J. Sound Attenuation Package: Manufacturer's standard package rated in accordance with AHRI 350.
- K. General Motor Requirements: Comply with requirements in Section 23 05 12, GENERAL MOTOR REQUIREMENTS FOR HVAC EQUIPMENT. Multispeed motor permanently lubricated, //permanent split capacitor// //ECM//.
- L. Water-to-Refrigerant Heat Exchanger: Coaxial heat exchangers with //copper// //cupronickel// water tube with enhanced heat-transfer surfaces inside a steel shell. Leak test both shell and tube to 3102 kPa (450 psig) on refrigerant side and 2758 kPa (400 psig) on water side. Factory mount heat exchanger in unit on resilient rubber vibration isolators.

- M. Refrigerant Circuit Components: Sealed refrigerant circuit charged with HCFC or CFC free refrigerant.
1. Filter-Dryer: Factory installed to clean and dehydrate the refrigerant circuit.
 2. Charging Connections: Service fittings on suction and liquid for charging and testing.
 3. Reversing Valve: Pilot-operated sliding-type valve designed to be fail-safe in heating position with replaceable magnetic coil.
 4. Refrigerant Metering: Extended temperature range device or a bi-directional thermal expansion valve.
- N. //Electric Heating Coil: Helix-wound, nickel-chromium wire-heating elements in ceramic insulators mounted on steel supports. Energize on call for heating when entering-water-loop temperature is less than 13 degrees C (55 degrees F) with an adjustable range between minus 4 to plus 15 degrees C (25 to 59 degrees F).//
- O. Refrigerant-to-Air Coils: Copper tubes with aluminum fins, leak tested to 3102 kPa (450 psig).
- P. Hot-Gas Reheat: Reheat valve, pilot-operated, sliding-type with replaceable magnetic coil to divert refrigerant hot gas to reheat coil when remote humidistat calls for dehumidification.
- Q. Hot-Gas Bypass: Include constant pressure expansion valve, solenoid valve, and controls to maintain continuous refrigeration system operation at 10 percent of full load on lead compressor.
- R. Filters: Disposable, glass-fiber, flat type, 25 mm (1 inch) thick, MERV 8 according to ASHRAE 52.2.
- S. //Comply with requirements in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC for control equipment and sequence of operation.//
- T. Controls:
1. Basic Unit Controls:
 - a. Low- and high-voltage protection.
 - b. Overcurrent protection for compressor and fan motor.
 - c. Random time delay, three to ten seconds, start on power up.
 - d. Time delay override for servicing.
 - e. Control voltage transformer.
 2. Thermostat: Unit mounted with temperature control thermostat knob, on/off/cool/heat and fan speed control// and key lock cover//.
- U. Electrical Connection: Control box with single electrical connection factory installed and tested// with fused disconnect//.

SPEC WRITER NOTE: Show a list of Input/
Output Point Summary on drawings for
maintenance of controls and alarms.

- V. //Dampers: Motorized outdoor air intake damper. The damper opens when the unit is energized and have a manual override switch.//

PART 3 - EXECUTION

3.1 INSTALLATION

- A. If an installation is unsatisfactory to the COR, the Contractor shall correct the installation at no additional cost or time to the Government.
- B. //Floor-Mounted Units: Support on neoprene pads with minimum 3.2 mm (1/8 inch) static deflection. Secure units to anchor bolts installed in concrete bases.//
- C. Suspended Units: Suspend from structure with threaded steel rods and //minimum 6 mm (1/4 inch) static deflection rubber-in-shear// //vibration isolators// //and seismic restraints//.
- D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls// or as required in Section 23 09 23, DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC//.

3.2 //SEISMIC BRACING

- A. Where applicable provide Seismic bracing as required under specification Section 13 05 41, SEISMIC RESTRAINT REQUIREMENTS FOR NON-Structural Components.//

3.3 CONNECTIONS

- A. Connect supply and return hydronic piping to heat pump with //unions and shutoff valves// //hose kits//.
- B. Connect heat-pump condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.
- C. Connect supply- and return-air ducts to water-source heat pumps with flexible duct connectors. Comply with requirements in Section 23 31 00, HVAC DUCTS AND CASINGS.
- D. Install electrical devices furnished by manufacturer but not specified to be factory mounted.
- E. Install piping adjacent to machine to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

- A. Perform the following field tests and inspections and prepare test reports:

1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

3.5 STARTUP AND TESTING

- A. Make tests as recommended by product manufacturer and listed standards and under actual or simulated operating conditions and prove full compliance with design and specified requirements. Tests of the various items of equipment shall be performed simultaneously with the system of which each item is an integral part.
- B. When any defects are detected, correct defects and repeat test at no additional cost or time to the Government.
- C. //The Commissioning Agent will observe startup and contractor testing of selected equipment. Coordinate the startup and contractor testing schedules with the COR and Commissioning Agent. Provide a minimum notice of 10 working days prior to startup and testing.//

3.6 //COMMISSIONING

- A. Provide commissioning documentation in accordance with the requirements of Section 23 08 00, COMMISSIONING OF HVAC SYSTEMS.
- B. Components provided under this section of the specification will be tested as part of a larger system.//

3.7 DEMONSTRATION AND TRAINING

- A. Provide services of manufacturer's technical representative for //four// // // hour//s// to instruct each VA personnel responsible in the 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.//

- - - E N D - - -