SECTION 238145

VARIABLE REFRIGERANT FLOW HEAT PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Variable refrigerant flow split system heat pump with heat recovery (simultaneous heat/cool).

1.2 REFERENCES

A. ANSI/AHRI 210/240 – Performance Rating of Unitary Air-Conditioning & Air-Source Heat Pump Equipment.

B. ANSI/AHRI 270 - Sound Rating of Outdoor Unitary Equipment.

C. ANSI/ASHRAE 62 - Ventilation for Acceptable Indoor Air Quality.

D. ANSI/ASHRAE/IES Standard 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

E. MIL-H-22547B - Heat Pump, Heating and Cooling (Unitary).

1.3 SUBMITTALS

A. Submit shop drawings and product data under provisions of Section 23 05 00.

B. Indicate water, drain, and electrical rough-in connections on shop drawings or product data.

C. Submit manufacturer's installation instructions.

D. Submit manufacturer’s warranty information.

E. Submit installing contractor’s manufacturer training certification.

F. Submit refrigerant charge. Charge calculation should be based on installed piping lengths and equipment capacities.

G. VRF Piping Layout Drawings:

1. Submit detailed VRF piping layout drawings at 1/8" = 1’-0” minimum scale complete with the following information:

a. Actual pipe routing, fittings, hanger and support types, accessories, etc. with lengths and refrigerant charge noted.

b. Include insulation thickness and type of insulation.

c. Room names and numbers, ceiling types, and ceiling heights.

d. Indicate location of all beams, bar joists, etc., along with bottom of steel elevations, for each member.

2. Submit VRF piping and equipment layout drawings. Verify clearances and interferences with other trades prior to preparing drawings. KJWW will provide electronic copies of piping drawings for Contractor's use if the Contractor signs and returns the "Electronic File Transfer" waiver. KJWW will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Submittals shall be in accordance with Section 23 05 00.

H. Submit Controls Diagrams:

1. Wiring diagrams and layouts for each control panel showing all termination numbers.

2. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Show all interface wiring to the control system.

3. Schematic diagrams for all field sensors and controllers.

4. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.

5. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Label all terminals.

6. All installation details and any other details required to demonstrate that the system will function properly.

7. All interface requirements with other systems.

I. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. **Clearly highlight any deviations from the specified sequences on the submittals.**

J. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.

K. Clearly identify work by others in the submittal.

L. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

1.4 DELIVERY STORAGE AND HANDLING

A. Protect finished cabinets from physical damage by leaving factory packing cases in place before installation and providing temporary covers after installation.

1.5 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

1.6 WARRANTY

A. Installing contractor shall perform tasks required by manufacturer to ensure maximum available warranty is achieved. This will include but is not limited to:

1. System design performed by manufacturer certified designer.

2. System installation performed by manufacturer certified installer.

3. Complete system commissioning paperwork and submit to manufacturer.

B. Provide minimum five (5) year manufacturer's parts warranty (one year basic warranty plus 4 year extended warranty) on all parts (excluding compressors) and one (1) year labor warranty.

C. Provide minimum five (5) year manufacturer’s compressor parts warranty.

D. Contractor shall provide one (1) year parts and labor warranty on the associated controls system, including all devices, wiring, and programming.

1.7 QUALIFICATIONS

A. Contractor Qualifications: This contractor shall be trained and certified by the equipment manufacturer to install and service this system prior to equipment installation. This contractor shall present such documentation upon the request of the Owner or Engineer.

B. Dealer Qualifications: This contractor shall be responsible to verify that the equipment dealer is certified by the manufacturer to supply the equipment included in this specification.

1.8 DEMONSTRATION

A. Engage manufacturer or factory-authorized service representative to train Owner’s maintenance personnel to adjust, operate, and maintain individual units and complete system.

PART 2 - PRODUCTS:

2.1 BASIS OF DESIGN

A. LG Multi V 5

In accordance with VAAR 811.104-71 (b), based on the inclusion of VAAR 811.104-71, Brand Name or Equal, bidders proposing to furnish an “equal product other than referenced in the solicitation, shall insert the following description for each equal product (See also VAAR 852.211-73 (c)(1) and (c)(2)). Bidding On: Manufacturer's Name: _____ Brand: _____ No.: _____

2.2 SYSTEM DESCRIPTION

A. The variable capacity, heat recovery, heat pump air conditioning system shall be a variable refrigerant flow split system. The system shall consist of multiple evaporators using PID control and inverter driven outdoor unit. The unit shall consist of direct expansion (DX), air-cooled heat pump air conditioning system, and variable speed driven compressor multi zone split system.

B. Outdoor Unit - General: The outdoor unit is designed specifically for use with the manufacturer’s components:

1. Refrigerant: R410A.

2. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant control. The refrigeration circuit of the outdoor unit shall consist of a compressor, motors, fans, condenser coil, electronic expansion valves, oil separators, service ports, liquid receivers, and accumulators.

3. All refrigerant lines shall be individually insulated between the outdoor and indoor units.

4. The connection ratio of the nominal capacity of indoor units to outdoor unit shall be 50-130%.

5. The sound pressure shall be no greater than 63 dBA at 4 feet from the outdoor unit at full load at fan height.

6. The system shall automatically restart operation after a power failure and shall not cause any settings to be lost, thus eliminating the need for re-programming.

7. The following safety devices shall be included on the outdoor unit: high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers. To ensure the liquid refrigerant does not flash when supplying to the various

indoor units, the circuit shall be provided with a sub-cooling feature. Oil recovery cycle shall be automatic as required to maintain oil levels at the outdoor unit.

8. The outdoor unit shall be able to operate in heating mode to -4°F dry bulb ambient temperature without additional ambient controls.

   a. Heating capacity at design condition of -12°F shall be no less than 50% of the value scheduled on the drawings

9. The outdoor unit shall have air cooled heat exchange coils constructed from copper tubing with aluminum fins. The coils shall be capable of being divided into sections to enable the outdoor unit to match the capacity required by the indoor units and to allow individual defrosting to take place as required.

10. The outdoor unit shall have at least one inverter controlled compressor and at least one high efficiency constant speed compressor, depending on scheduled capacity. The system shall use a control sequence to ensure that indoor loads are matched to the compressor capacity control.

11. The refrigeration process of the outdoor unit will be maintained by pressure and temperature sensors controlling solenoid valves, check valves, and bypass valves. The heating or cooling mode of the outdoor unit will be controlled using a combination of 2 and 3-way valves that shall reverse the cycle of the refrigerant to change the mode of the outdoor unit.

12. Unit Cabinet: The outdoor unit model shall be completely weatherproof and corrosion resistant. The outdoor unit shall be constructed from steel plate and treated with an anti-corrosive paint.

13. Fan:

   a. The outdoor unit shall consist of propeller type, direct-drive fan motors that have multiple speed operation via a DC inverter.

   b. The fans shall be a vertical discharge. The fan motors shall have inherent protection and permanently lubricated bearings.

   c. The fans shall be provided with fan guards.

14. Condenser Coil: The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.

15. Compressor:

a. The variable speed compressor shall be capable of changing the speed to follow the variations in total cooling load as determined by the suction gas pressure as measured in the outdoor unit.

b. The inverter driven compressor in each outdoor unit shall be DC, hermetically sealed, scroll type.

c. The capacity control range shall be a minimum of 20% to 100% of total capacity.

d. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.

e. Oil separators shall be standard with the equipment, together with an oil balancing circuit.

f. The compressor shall be mounted to avoid the transmission of vibration.

C. Heat Recovery Unit:

1. The unit shall be constructed from galvanized steel plate and be internally insulated with polyurethane foam. The connection to the system shall be either via brazed connection or flare nuts.

2. The unit shall be connected to the indoor units or group of indoor units via its own dedicated connection. This connection shall supply power and control signals to the solenoid valves in the unit.

3. The unit shall have integral controls and be factory assembled, wired, and piped.

4. The unit shall include an integral drain pan and condensate pump as required.

5. The unit electrical power shall be 208-230V/1-phase/60Hz or as noted on the drawings.

6. Provide unit with at least two (2) additional unused connections for future expansion and maintenance. Provide isolation valves and caps on unused connections.

D. Oil Recovery System:

1. System shall be equipped with an oil recovery system to ensure stable operation with long refrigerant piping.

2. System shall be designed for proper oil return to compressor, along with distribution of oil to individual compressor.

E. Indoor Units:

1. General – Each indoor unit shall have a heat exchanger that shall be constructed from copper tubing with aluminum fins. The flow of refrigerant through the heat exchanger shall be controlled by an electronic modulating expansion valve. This valve shall be controlled by internal temperature sensors and shall be capable of controlling the variable capacity of the indoor unit between at least 25% and 100%. The units shall be shipped from the factory fully charged with dehydrated air.

2. Wall Mounted:

a. The indoor units shall be designed for installation onto a wall within a conditioned space to be connected to a heat pump outdoor unit.

b. Acoustic Performance: The indoor units' sound pressure shall not exceed 35 dBA at low speed measured at 3.3 feet from the units.

c. Construction:

1) The indoor units shall be completely factory assembled and tested. Included in each unit is factory wiring, piping, electronic modulating expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch. Each unit shall have at least one auto-swing louver for efficient air distribution, which closes automatically when the unit stops. The remote controller shall be able to set five (5) steps of discharge louver angle. The front grille shall be easily removed for washing. The discharge angle shall automatically set at the same angle as the previous operation upon restart. The condensate drain pipe shall be able to be connected to either left or right sides.

d. The indoor units shall be equipped with a return air thermistor.

e. The indoor unit shall be separately powered.

f. Unit Cabinet:

1) The cabinet shall be affixed to a factory supplied wall mounting template and located in the conditioned space.

2) The cabinet shall be constructed of molded plastic cover with sound absorbing foamed polystyrene and polyethylene insulation.

g. Fan:

1) The fan shall be a direct-drive cross-flow type, statically and dynamically balanced with high and low fan speeds available.

2) The fan motor shall be thermally protected.

h. Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

i. Coils:

1) Coils shall be of the direct expansion type, constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

2) The refrigerant connections shall be flare connections and the condensate shall be coordinated with piping material specified in Section 23 21 00.

3) A condensate pump with at least 18 inches lift shall be located below the coil in the condensate pan, with a built-in high level safety alarm to shut down the unit.

4) A thermistor shall be located on the liquid and gas line.

3. Four-way Ceiling-Recessed Cassette:

a. The indoor unit shall be a ceiling cassette for installation into the ceiling cavity, equipped with an air panel grille to be connected to the indoor unit as scheduled and specified in this section. The indoor unit shall have four-way air distribution and an ivory white, impact resistant, washable decoration panel. The supply air shall be distributed via motorized louvers that can be horizontally and vertically adjusted from 0° to 90° angle.

b. Acoustic Performance: The indoor units' sound pressure shall not exceed 33 dBA at low speed measured at 5 feet from the unit.

c. Construction:

1) The indoor unit shall be completely factory assembled and tested. The unit shall include factory wiring, piping, electronic modulating expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2) The 4-way supply airflow shall be field modifiable to 3-way and 2-way airflow to accommodate various installation configurations, including corner installations.

3) Return air shall be through the concentric panel, which shall include a filter.

4) The indoor units shall be equipped with a return air thermistor.

5) The indoor unit shall be separately powered.

d. Unit Cabinet:

1) The cabinet shall be space saving and shall be recessed into the ceiling.

2) Provide fresh air intake kit where used and indicated on the drawings. A branch duct knockout shall exist for branch ducting supply air.

3) The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

e. Fan:

1) The fan shall be direct-drive type, with statically and dynamically balanced impeller with high and low fan speeds available.

2) The fan motor shall be thermally protected.

f. Filter: The return air shall be filtered by a washable long-life filter with mildew proof resin.

g. Coil:

1) Coils shall be of the direct expansion type, constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

2) The refrigerant connections shall be flare connections and the condensate shall be coordinated with piping material specified in Section 23 21 00.

3) A condensate pump with at least 18 inches lift shall be located below the coil in the condensate pan, with a built-in high level safety alarm to shut down the unit.

4) A thermistor shall be located on the liquid and gas line.

4. Ceiling Concealed Ducted (High Static Pressure):

a. The indoor unit shall be a built-in ceiling concealed indoor unit, high static pressure (HSP), for installation into the ceiling cavity. The unit shall be constructed of a galvanized steel casing to be connected to a heat pump outdoor unit. The indoor unit shall be manufactured for ducted horizontal discharge air, with ducted horizontal return air or bottom return air configuration (as scheduled or shown on the drawings). The external static pressure shall be as scheduled on the drawings.

b. Acoustic Performance: The indoor units' sound pressure shall not exceed 31 dBA at low speed 5 feet from the unit.

c. Construction:

1) The indoor unit shall be completely factory assembled and tested. The unit shall include factory wiring, piping, electronic modulating expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, self-diagnostics, auto-restart function, 3-minute fused time delay, and test run switch.

2) The indoor units shall be equipped with a return air thermistor.

3) The indoor unit shall be separately powered.

4) The switch box shall be reached from the side or bottom for ease of service and maintenance.

d. Unit Cabinet:

1) The cabinet shall be located in the ceiling and ducted to the supply and return openings.

2) The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.

3) The cabinet shall be factory insulated for use in unconditioned indoor spaces.

e. Fan:

1) The fan shall be direct-drive type, with statically and dynamically balanced impeller with high and low fan speeds.

2) The fan motor shall be thermally protected.

f. Filter: The return air shall be filtered by means of a washable long-life filter with mildew proof resin.

g. Coils:

1) Coils shall be of the direct expansion type, constructed from copper tubes expanded into aluminum fins to form a mechanical bond.

2) The refrigerant connections shall be flare connections, and the condensate shall be coordinated with piping material specified in Section 23 21 00.

3) A condensate pump with at least 18 inches of lift shall be located below the coil in the condensate pan, with a built-in high level safety alarm to shut down the unit.

4) A thermistor shall be located on the liquid and gas line.

2.3 PIPING

A. Design Pressure: 450 psig.

1. Maximum Design Temperature: 250 F.

B. Piping - 4" and under.

1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.

2. Provide pre-insulated line sets constructed of ACR copper for piping between the control box and fan units or hard pipe and insulation in accordance to manufacturer’s recommendations.

3. Joints: Brazed with silver solder.

4. Fittings: Wrought copper solder joint, ANSI B16.22.

5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

PART 3 - CONTROLS

3.1 GENERAL

A. The unit shall have controls provided with the unit by the manufacturer to perform input functions necessary to operate the system.

B. Computerized PID control shall be used to maintain room temperature within 1°F of setpoint.

C. VRF System Controls shall be wired to enable auxiliary heating when VRF heating is not sufficient to heat the space:

3.2 ROOM CONTROLLER –

A. The wired room controller shall be able to control one zone and shall be able to function as follows:

1. The controller shall have a self-diagnosis function that constantly monitors the system for malfunctions.

2. The controller shall be able to immediately display fault location and condition.

3. An LCD digital display shall allow the temperature to be set in 1°F units.

4. The controller shall be equipped with a thermostat sensor in the remote controller, making possible more comfortable room temperature control.

B. The wired remote controller shall have the following features:

1. Operation: Start/Stop, Temperature Setting, Fan Speed.

2. Monitoring: Status, malfunction flashing, malfunction content, filter sign, operation mode, temperature setting, permit/prohibit selection, fan speed, airflow direction.

3. Control Management: Field Setting Mode, Group Setting, Auto Restart.

4. The controller shall also be able to switch an external dry contact via a 12-volt DC relay (field supplied).

3.3 CENTRAL CONTROLLER – TYPE D

A. This controller shall be wall mounted and hard wired, to all room controllers, condensing unit, heat recovery units/branch selector boxes and to the FMCS via gateway. It shall continuously provide information to the FMCS and receive commands back. It shall manage control of all VRF system components. It shall be manufactured in ABS plastic with an LCD display and shall be the manufacturer’s standard color. The controller shall be capable of individually controlling the following functions on at least 64 indoor units:

1. On/off
2. Operating mode
3. Setpoint
4. Fan speed
5. Louver position
6. Timer settings
7. Test run

B. The controller shall also be capable of displaying the following information individually for at least 64 indoor units:

1. On/off
2. Operating mode
3. Setpoint
4. Fan speed
5. Louver position
6. Timer settings
7. Test run
8. Fault diagnosis

C. Each central controller unit can be accessed either locally or remotely via standard internet software. The central controller will be able to indicate system alarms via volt free contacts, as well as providing control points for other devices. Additionally, the central controller shall be able to monitor individual usage of heating and cooling demands, report alarm and conditions to nominated email address, and enable remote alteration of systems setpoints to registered users. All required software costs and licensing fees shall be included for the life of the systems.

3.4 MAINTENANCE ACCESS

A. Provide all gateways and connection cabling for performing maintenance functions on system.

B. Provide all software and registration codes as required to allow access into advanced maintenance functions.

3.5 SEQUENCE OF OPERATIONS

A. Refer to drawings.

3.6 SYSTEM INTEGRATION

A. The manufacturer’s control system shall be capable of integrating with the building automation system with built in hardware or separate add-on interfaces. All additional devices shall be provided by the manufacturer.

B. The system shall be compatible with LonWorks®, BACnet®, Modbus®, or N2®. Refer to Section 23 09 00.

PART 4 - EXECUTION

4.1 INSTALLATION

A. Install in accordance with manufacturer’s instructions. Install all piping, fittings, and insulation to meet manufacturer’s requirements. Install units level and plumb. Evaporator fan components shall be installed using manufacturer’s standard mounting devices securely fastened to building structure. Install and connect refrigerant tubing and fittings.

B. Installing contractor shall attend manufacturer sponsored training to obtain installation certification.

C. Installer shall supply isolation ball valves for zoned refrigerant isolation. Installer shall supply isolation ball valves with Schrader connection for isolating refrigerant charge and evacuation at each connected indoor unit and outdoor unit. Isolation ball valves, with Schrader connection, are required for instances of indoor unit isolation for troubleshooting, repair, or replacement without affecting the remainder of the system. Isolation ball valves with Schrader connection are also required at outdoor unit connection to isolate unit for troubleshooting, repair, or replacement and as required to provide partial capacity heating/cooling in the instance of a failure of one of the multiple outdoor unit compressors.

D. Engage manufacturer or factory-authorized service representative to perform startup service. Manufacturer shall provide on-site startup and commissioning assistance through job completion. Complete installation and startup checks according to manufacturer’s written instructions.

E. Fully charge system with refrigerant per manufacturer’s requirements.

F. Field Quality Control:

1. Manufacturer’s Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing.

2. Perform the following field tests and inspections, and prepare test reports:

a. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

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

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

G. Coordinate installation of units with architectural and electrical work. Coordinate installation of ceiling recessed units with ceiling grid layout. Additional ceiling grid reinforcement or modification is the responsibility of the Mechanical Contractor and shall be coordinated with the General Contractor.

H. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Height above finished floor shall not exceed 48”.

I. Contractor is responsible for routing all condensate drains from all indoor equipment to a nearby floor drain or standpipe. If ceiling heights or space finish does not accommodate gravity drainage, Contractor is responsible for providing a condensate pump and all electrical work required.

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