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SECTION 238125 – VARIABLE REFRIGERANT VOLUME (VRV) AIR CONDITIONING SYSTEM

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PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes variable refrigerant split-system air-conditioning and heat pump and heat recovery systems. Either system consists of condensing units (also called outdoor units) containing compressors and coils with fans, and indoor units containing coils and fans. The outdoor and indoor units are connected by suitable piping and control devices. In the heat pump systems, all indoor units connected to one outdoor unit are in either heating or cooling mode. In the heat recovery system, some of the indoor units connected to one outdoor unit may be heating while others connected to the same outdoor unit are cooling. Indoor units are designed for exposed or concealed mounting, and may be connected to ducts.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Provide a spreadsheet listing the indoor units that are served by each outdoor unit. For each indoor unit, list the actual (not nominal) cooling and heating outputs taking design conditions, piping losses, etc into account. Group the rooms by zones and list the de-rated cooling and heating outputs for each zone.

C. Shop Drawings: Diagram power, signal, and control wiring.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For all equipment and systems to include in emergency, operation, and maintenance manuals.

G. Warranty: Special warranty specified in this Section.

1.4 1.4 QUALITY ASSURANCE

A. The units shall be manufactured in a facility registered to ISO 9001 and ISO14001 which is a set of standards applying to environmental protection set by the International Standard Organization (ISO).

B. All wiring shall be in accordance with the National Electrical Code (NEC).

C. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.

D. Outdoor equipment for regions with wind-borne debris shall be designed in accordance with ASCE 7-2002 and installed to resist the wind pressures on the equipment and supports.

E. The VRV system shall be installed by a company certified as qualified by the equipment manufacturer.

F. The VRV system shall be commissioned by the manufacturer or certified manufacturer's agent.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Division 3 Section "Cast-in-Place Concrete."

B. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations specified in Division 7 Section "Roof Accessories."

1.6 WARRANTY

A. Warranty:
   1. The units shall be covered by an extended manufacturer's limited warranty for a period of five (5) years from date of installation.
   2. In addition, the compressor shall have a manufacturer's limited warranty for a period of six (6) years from date of installation.
   3. If, during this period, any part should fail to function properly due to defects in workmanship or material, it shall be replaced or repaired at the discretion of the manufacturer.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Filters: One set of filters for each unit.
   2. Fan Belts: One set of belts for each unit.

PART 2 - 2PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products indicated on the Drawings or comparable product by one of the following:
   1. Mitsubishi / Trane
   2. Daikin
   3. LG

2.2 CONDENSING UNIT (OUTDOOR UNIT)

A. General: The condensing unit shall be suitable for operation with the selected indoor units. The models for heat recovery and heat pumps shall have the required features and controls.
   1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut off valves, oil separators, service ports and refrigerant regulator. Liquid and suction lines must be individually insulated between the condensing and indoor units.
   2. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
   3. Each condensing unit shall be able to support the connection of up to 41 indoor units dependant on the model of the condensing unit.
   4. The units will have low noise levels. The condensing unit shall be capable of operating automatically at further reduced noise during the night.
   5. The system will automatically restart operation after a power failure and will not cause any settings to be lost, thus eliminating the need for reprogramming.
   6. The condensing unit shall be modular in design and should allow for side-by-side installation with minimum spacing.
   7. The following safety devices shall be included on the condensing unit; high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters, fusible plug, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.
   8. Oil recovery cycle shall be automatic occurring at pre-determined intervals. Each system shall maintain continuous heating during oil return operation.
   9. The condensing unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls or an auxiliary heat source.
   10. The outdoor unit will be able to operate in cooling only mode down to 21 F and up to 110 F outdoor temperature.
   11. The system shall continue to provide heat to the indoor units while in the defrost mode.

B. Unit Cabinet:
   1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.

C. Fan:
   1. The condensing unit shall consist of one or more propeller type, direct-drive 750 W fan motors that have multiple speed operation via a DC (digitally commutating) inverter.
   2. The condensing unit fan motor shall have multiple speed operation of the DC (digitally commutating) inverter type, and be of high external static pressure and shall be factory set as standard at 0.12 in. WG. A field setting switch to a maximum 0.32 in. WG pressure shall be available to accommodate field-applied duct for indoor mounting of condensing units.
   3. The fan motor shall have inherent protection and permanently lubricated bearings and be mounted.
   4. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
   5. Night setback control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Night time sound pressure at 3 feet distance from the unit should not exceed 45 dB(A).

D. Condenser Coil:
   1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
   2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
   3. The heat exchanger on the condensing units shall be manufactured from seamless copper tube mechanically bonded on to aluminum fins.
   4. The fins are to be covered with an anti-corrosion acrylic resin and hydrophilic film.
   5. The pipe plates shall be treated with powdered polyester resin for corrosion prevention. The thickness of the coating must be between 2.0 to 3.0 microns.

E. Compressor:
   1. The inverter scroll compressors shall be variable speed (PVM inverter) controlled which is capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit.
   2. The capacity control range shall be as low as 6% to 100%.
   3. Each non-inverter compressor shall also be of the hermetically sealed scroll type.
   4. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector.
   5. Oil separators shall be standard with the equipment together with an intelligent oil management system.
   6. The compressor shall be spring mounted to avoid the transmission of vibration.
   7. Units sized 6-9 tons shall contain a minimum of 2 compressors; 12-20 ton units shall contain a minimum of 4 compressors. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a

proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

8. In units with two compressors, at least one of them shall be variable speed. In units with four compressors, at least two will be variable speed.
9. In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost, or at fixed intervals.

F. Electrical:
1. The power supply to the condensing unit shall be as listed in the schedule drawing.
2. The control circuit between the indoor and condensing unit shall be low voltage DC, stranded 2-conductor cable.

2.3 INDOOR UNITS

A. General: Indoor units shall be of the type and configuration listed in the schedule drawings. These may include floor-mounted, wall-mounted. furred-in, cassette type, etc.

B. Performance: Each unit's performance shall be as listed in the schedule drawing.

C. Indoor Unit Features:
1. The unit shall be completely factory assembled and tested. Included in the unit is factory wiring, piping, electronic proportional expansion valve, control circuit board, fan motor thermal protector, flare connections, condensate drain pan, condensate drain pump, condensate safety shutoff and alarm, self-diagnostics, auto-restart function, fused time delay, and test run switch.
2. Indoor unit and refrigerant pipes will be charged with dehydrated air or nitrogen prior to shipment from the factory.
3. Both refrigerant lines shall be insulated from the outdoor unit.
4. Return air shall be through an antibacterial filter.
5. The indoor units shall be equipped with a condensate pan with antibacterial treatment and condensate pump. The condensate pump provides up to 33-1/2" of lift and has a built in safety shutoff and alarm.
6. The indoor units shall be equipped with a return air thermistor.

D. Unit Cabinet:
1. Outside air intake shall be possible. Suitable opening shall be provided for connecting outside air.
2. The cabinet shall be constructed with sound absorbing foamed polystyrene and polyethylene insulation.
3. Optional high efficiency MERV 8 and 13 air filters shall be available for each model unit.

E. Fan:
1. The fan shall be direct-drive with statically and dynamically balanced impeller with three fan speeds available.

2. The airflow rate shall be available in three settings.
3. The fan motor shall be equipped as standard with adjustable external static pressure (ESP) settings to allow operation with MERV 8 and 13 filter options.
4. The fan motor shall be thermally protected.

F. Filter:
1. The return air shall be filtered by means of a washable long-life filter with mildew proof resin and antibacterial treatment.
2. Optional high efficiency disposable MERV 8 and 13 filters shall be available.

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 will be 1 -1/4 inch outside diameter PVC.
3. A condensate pan with antibacterial treatment shall be located under the coil.
4. A condensate pump shall be located below the coil in the condensate pan with a built in safety alarm.
5. A thermistor will be located on the liquid and gas line.

H. Electrical:
1. Power supply shall be as listed in the schedule drawing. All units shall be capable of satisfactory operation within +/-10% of nominal supply voltage
2. Transmission (control) wiring between the indoor and outdoor unit shall be a maximum of 3,280 feet (total 6,560 feet).
3. Transmission (control) wiring between the indoor unit and remote controller shall be a maximum distance of 1,640 feet.

I. Control:
1. The unit shall have controls provided by the manufacturer to perform input functions necessary to operate the system.
2. The unit shall be compatible with interfacing with a BMS system via BACnet gateway.

2.4 HEAT RECOVERY SELECTOR UNITS FOR SIMULTANEOUS HEATING & COOLING

A. General:
1. Heat recovery selector units shall be designed for use with VRF/VRV equipment of the same manufacturer.
2. Heat recovery selector units shall have factory installed control boards that interface to the VRV equipment controls system and shall perform all functions to effectively and efficiently control the simultaneous heating and cooling VRV system.
3. Heat recovery selector units shall be completely factory assembled, internally piped and wired.
4. Heat recovery selector units shall be run tested at the factory.
5. Shall be designed for indoor installation.
6. Shall use R410A refrigerant or other HFC refrigerant.

7. All refrigerant lines from the outdoor unit to the indoor units shall be field insulated.
8. Each heat recovery unit shall allow several indoor units to be connected to it.
9. The following piping shall be allowed.
    a. Indoor units up to 130 equivalent feet of piping length from the respective heat recovery unit.
    b. Indoor units up to 295 equivalent feet of piping length from the first branch
    c. Indoor units at least 16 feet above or below the heat recovery unit
    d. Elevation difference between the highest and lowest elevation indoor unit at least 16 feet.

B. Heat Recovery Unit Construction:
1. The heat recovery unit shall have several ports which can individually accommodate one indoor unit.
2. The heat recovery unit housing shall be galvanized steel.
3. Each heat recovery unit shall contain piping, valves and controls to divert refrigerant for optimum efficiency.
4. Heat recovery units shall be internally insulated.

C. Refrigerant System:
1. R410A refrigerant (or another HFC) shall be used for all VRF equipment and components including indoor units, outdoor units, refrigerant piping, valves, Y-branches, heat recovery units, etc. as applicable.

D. Refrigerant valves:
1. Each port shall be circuited with automatic valves to control refrigerant flow path.
2. Isolation valves shall be field supplied and installed for ease of service to the heat recovery unit without evacuating the entire system refrigerant charge.

E. Electrical:
1. All units shall be capable of satisfactory operation within +/-10% of nominal supply voltage.
2. The heat recovery unit shall be controlled by integral microprocessors from the main controller.
3. The control circuit between the indoor units, heat recovery box and the outdoor unit shall be low voltage DC completed using a 2-conductor cable.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for piping and electric installations for indoor and outdoor units to verify actual locations of piping connections and electrical conduits before installation.

3.2 Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Outdoor Equipment Mounting: Install units using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: As needed to give 90% isolation efficiency.

B. Indoor Equipment Mounting: Install indoor units with continuous-thread hanger rods and spring hangers of size required to support weight of units.
   1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Piping and Equipment."
   2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

C. Install wall-mounting thermostats, humidistats, and switch controls in electrical outlet boxes at heights to match lighting controls or as required in Section 230900 "Instrumentation and Control for HVAC."

3.4 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install refrigerant piping connecting indoor and outdoor units and heat recovery selector units according to manufacturer’s instructions.
   2. Connect condensate drain pan to indirect waste connection with condensate trap of adequate depth to seal against fan pressure. Install cleanouts in piping at changes of direction.

B. Duct installation requirements are specified in other Sections. Drawings indicate general arrangement of ducts. Specific connection requirements are as follows:
   1. Connect supply and return ducts to VRV units with flexible duct connectors specified in Section 233300 "Air Duct Accessories."

C. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

D. Install piping adjacent to machine to allow service and maintenance.

E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following field tests and inspections:
   1. After installing the units and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
   1. Inspect for visible damage to unit casing.
   2. Inspect for visible damage to compressor, coils, and fans.
   3. Inspect internal insulation.
   4. Verify that labels are clearly visible.
   5. Verify that clearances have been provided for servicing.
   6. Verify that controls are connected and operable.
   7. Verify that filters are installed.
   8. Adjust vibration isolators.
   9. Verify bearing lubrication on fan.
   10. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
   11. Adjust fan belts to proper alignment and tension.
   12. Start unit according to manufacturer's written instructions.
   13. Complete startup sheets and attach copy with Contractor's startup report.
   14. Inspect and record performance of interlocks and protective devices; verify sequences.
   15. Operate unit for an initial period as recommended or required by manufacturer.
   16. Verify thermostat and humidistat calibration.
   17. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
   18. Inspect controls for correct sequencing of heating, cooling, refrigeration, and normal and emergency shutdown.

3.7 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.8 CLEANING

A. Replace filters used during construction prior to air balance or Substantial Completion.

B. After completing installation of exposed, factory-finished, outdoor units, inspect exposed finishes and repair damaged finishes.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain the VRV air conditioning system.

END OF SECTION 238125