# SECTION 23 0500

# COMMON WORK RESULTS FOR HVAC

## PART 1 - GENERAL

### 1.1 SECTION INCLUDES

A. Basic Mechanical Requirements specifically applicable to Division 23 Sections, in addition to the General Requirements.

B. Mechanical work includes the following: furnish and install all mechanical equipment shown on the mechanical drawings and described in these specifications. Contractor shall furnish and install, make operable, and test all mechanical equipment shown on the plans. In connection therewith, contractor shall also furnish and install all necessary work, devices, hardware and systems required to make said equipment properly and safely operable, including but not limited to, mounting hardware and framing, insulation, piping, valves, systems, and control system.

### 1.2 WORK SEQUENCE

A. Install work in phases to accommodate Owner's construction requirements. Refer to Architectural, Structural, Civil, and Electrical Drawings for the construction details and coordinate the work of this division with that of other divisions. Order the work of this division so that progress will harmonize with that of other divisions and all work will proceed expeditiously. During the construction period, coordinate mechanical schedule and operations with General Contractor and any other related subcontractor.

### 1.3 ALTERNATES

A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at the Owner's option. Accepted Alternates will be identified in Owner-Contractor Agreement.

B. Coordinate related work and modify surrounding work as required.

### 1.4 SUBMITTALS

A. Submit the following:

B. Proposed Products List: Include Products specified in the following Sections:

1. Section 23 - Mechanical.

2. Project Drawings

C. Submit shop drawings and product data grouped to include complete submittals of related systems, products, and accessories in a single submittal. Submittals shall be

specific to the fixtures/device/unit being submitted; the data shall be highlighted or marked to be quite clear as to the fixtures/devices/units that shall be provided.

D. Equipment and materials shall be ordered only after satisfactory review by Owner and Engineer.

E. The following statement applies to all items reviewed. "Checking is only for general conformance with the design concept of the project and general compliance with the information given in the contract documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for dimensions which shall be confirmed at the job site; fabrication processes and techniques of construction; coordination of his work with that of other trades; and the satisfactory performance of his work."

F. Contractor shall clearly mark the submittal sheet as to which model number, size, color, etc. when there is more than one choice available.

G. Maintain a complete set of the most current reviewed submittal and shop drawings on site during construction.

H. Submittals shall have table of contents organized by specification section and shall clearly identify electrical characteristics, options provided, color, model number and equipment tag as indicated on the drawings.

1.5 REGULATORY REQUIREMENTS

A. Conform to 2022 California Building Code.

B. Fire Protection: Conform to 2022 California Fire Code, and California State Fire Marshall Regulations, Title 19, Public Safety.

C. Plumbing: Conform to 2022 California Plumbing Code.

D. Mechanical: Conform to 2022 California Mechanical Code.

E. Electrical: Conform to 2022 California Electrical Code.

F. Obtain approved inspections from authority having jurisdiction.

G. Conflicts: Where conflict or variation exists amongst Codes, the most stringent shall govern.

1.6 PROJECT/SITE CONDITIONS

A. Install work in locations shown on drawings, unless prevented by project conditions.

B. Prepare drawings showing proposed rearrangement of work to meet project conditions, including changes to work specified in other Sections. Obtain permission of owner before proceeding.

C. Piping locations: Piping locations shown are diagrammatic only. Contractor shall verify locations of all lateral stubs, offsets, etc. required in the field. The actual locations of lines, cleanouts and connections may vary provided that complete systems are installed in compliance with codes. It is not the intent of the drawings to show necessary offsets required to avoid structure or other trades. It is the intent of this paragraph that all costs associated with this paragraph be borne by the contractor.

D. Construction observation: In addition to the requirement for obtaining inspections by the local jurisdiction, contractor shall notify Engineer at appropriate times during the construction process so that Engineer can visit site to become generally familiar with the progress and quality of contractor's work and to determine if the work is proceeding in general accordance with the contract documents.

E. Scaling of drawings: In no case shall working dimensions be scaled from plans, sections, or details from the working drawings. If no dimension is shown on the architectural drawings, the prime contractor shall request in writing that the architect or engineer provide clarification or the specific dimension.

F. As equal: For an item to be substituted "as equal" the contractor must provide to the engineer a complete submittal no later than 7 days prior to the bid opening. Contractor shall be responsible for any cost associated with the change including architectural design, mechanical, structural and electrical engineering and changes in any element of the building.

G. Unit and duct locations: Heating and air conditioning unit and duct locations shown are approximate only. Contractor shall verify locations of all structural members, other trades, and existing conditions in the field, and locate units and ductwork to avoid interference. All clearances required by unit manufacturer shall be maintained. Entire installation shall be in accordance with codes and the recommended installation procedures published by the manufacturers. It is not the intent of the drawings to show necessary offsets and transitions required to avoid structure or other trades. It is the intent of this paragraph that all costs associated with this paragraph be borne by the contractor.

H. Contractor will verify with owner and site conditions the exact existing roofing system in place and provide compatible roofing materials and products. Contactor to provide written statement regarding existing roofing system and proposed roofing system and provide manufacturer information prior to procurement and installation.

I. Proceed with roofing work only when existing and forecasted weather conditions will permit a unit of work to be installed in accordance with manufacturer’s recommendations and warranty requirements.

J. Flashings and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Complete flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

## 1.7 QUALITY ASSURANCE

A. Qualification of Manufacturer: Products used in work shall be produced by manufacturers regularly engaged in the manufacture of similar items.

B. Qualification of Installer: Use adequate number of skilled workman, thoroughly trained and experienced in the necessary crafts, and completely familiar with the specified requirements contained in the plans and specifications. Engage an experienced installer to perform work who has specialized in installing roofing similar to that required for this project; who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product; and who is eligible to receive the standard roofing manufacturer's warranty.

C. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.

D. Provide products and materials that are new, clean, free from defects, damage, and corrosion.

E. Provide name/data plates on major components with manufacturer's name, model number, serial number, date of manufacturer, capacity data, and electrical characteristics permanently attached in a conspicuous location on the equipment.

F. Applicable equipment and materials to be listed by Underwriters' Laboratories and manufactured in accordance with ASME, AWWA, or ANSI standards. Power using equipment shall be meet the California energy efficiency standards as defined in the current Title 24 requirements.

## 1.8 DRAWINGS AND SPECIFICATIONS

A. Drawings and specifications are intended to complement each other. Where a conflict exists between the requirements of the drawings and/or specifications, immediately and before commencing work, request clarification from Engineer.

B. The Engineer shall interpret the drawings and the specifications, and the Engineer's decision as to the true intent and meaning thereof and the quality, quantity, and sufficiency of the materials and workmanship furnished thereunder shall be accepted as final and conclusive.

C. In case of conflicts not clarified prior to Bidding deadline, use the most costly alternative (better quality, greater quantity, or larger size) in preparing the Bid. A clarification will be issued to the successful Bidder as soon as feasible after the Award and if appropriate a deductive change order will be issued.

D. All provisions shall be deemed mandatory except as expressly indicated as optional by the word "may" or "option".

E. Examine and compare the contract drawings and specifications with the drawings and specifications of other trades. Report any discrepancies to the architect. Install and coordinate the work in cooperation with the other trades.

PART 2 – NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install all equipment per the manufacturer's instructions for installing, connecting, and adjusting. A copy of the instructions shall be kept at the equipment during installation and provided to the engineer at his/her request.

B. All equipment shall be firmly anchored to building structural elements.

3.2 COORDINATION OF WORK

A. The contract documents establish scope, materials, and quality but are not detailed installation instructions. Drawings are diagrammatic.

B. The contract documents show the general arrangement of equipment, ductwork, piping,

3.3 OPERATING INSTRUCTIONS AND OPERATOR TRAINING

A. Provide two copies of all operating and maintenance manuals to owner. Include parts lists and suppliers' names and phone numbers.

END OF SECTION

SECTION 230501
HVAC SYSTEM REPAIR

Part 1. PRODUCT(S) - Outdoor Units (Variable Refrigerant Flow Systems)

A. Multi V™ 5 Heat Recovery and Heat Pump System(s) – (6 to 42 tons nominal) ARUM121BTE5

B. Product Design

1. LG Multi V 5 heating and cooling system shall be an air cooled system allowing user to configure in the field a heat pump or a heat recovery system consisting of one to three outdoor unit modules, conjoined to make a 6-42 ton single refrigerant circuit.

a) Heat recovery systems, employing three pipes, shall be connected to Heat recovery (heat recovery) unit(s) and indoor unit(s). Multi-port heat recovery units shall allow simultaneous heating and cooling of individual zone(s) at various capacities as required to satisfy their zone requirements.

2. All three-phase VRF heat pump and heat recovery outdoor units shall be from the same product development generation. Mixing of outdoor units from different development generations is not acceptable.

C. Operating Conditions

1. Outdoor Unit shall be capable of continuous compressor operation between the following operating ambient air conditions, operation outside of these conditions are possible and may involve non-continuous operations.

2. Operating Ambient Air Conditions:

a) Cooling: 5°F DB to 122°F DB

b) Heating: -22°F WB to 61°F WB

c) Cooling Based (ODU reversing valve in cooling position) Synchronous: 14°F DB to 81°F DB (Heat Recovery Operation Only)

d) Heating Based (ODU reversing valve in heating position) Synchronous: 14°F WB to 61°F WB (Heat Recovery Operation Only)

D. Electrical

e) All air source heat pump and heat recovery frame(s) shall be designed and electrically protected to maintain stable continuous compressor operation when provided with 208-230/60/3 power with the following specifications:

i. 208-230/60/3>

1. Voltage fluctuation of ± 10%

ii. Voltage imbalance of up to two percent;

iii. Power surge of up to 5kA RMS Symmetrical.

E. General Features

1. The air-conditioning system shall use R410A refrigerant.
2. Each system shall consist of one, two or three air source outdoor unit modules conjoined together in the field to result in the capacity specified elsewhere in these documents.
3. Dual and triple frame configurations shall be field piped together using manufacturer's designed and supplied Y-branch kits and field provided interconnecting pipe to form a common refrigerant circuit.
4. System shall have following frame configurations vs. capacity.
   a) 6 to 20 ton units shall be a single frame only.
5. System shall employ self-diagnostics function to identify any malfunctions and provide type and location of malfunctions via fault alarms.
6. Field Provided Refrigerant Piping
   a) The refrigerant piping system shall be constructed using field provided ACR copper rated for the use with refrigerant R410A, de-hydrated pipe field engineered and assembled with manufacturer supplied Heat recovery unit(s) and Y- branches, as may be required, connected to multiple (ducted, non-ducted or mixed combination) indoor units to effectively and efficiently control the heat pump operation or simultaneous heating and cooling operation of the heat recovery VRF system. Other pipe materials, if used, shall perform, at a minimum, as well as that specified above, shall not have any adverse reactions, for example galvanic corrosion or branch to branch differential pressure drop, with any other components or materials also in use in the system and shall be installed per manufacturer's instructions.
   b) The unit shall be shipped from the factory fully assembled including internal refrigerant piping, inverter driven compressor(s), controls, temperature sensor, humidity sensor, contacts, relay(s), fans, power and communications wiring as necessary to perform both Heat Pump and Heat Recovery operations.
   c) Each outdoor unit refrigeration circuit shall include, but not limited to, the following components:
      i. Refrigerant strainer(s)
      ii. Check valve(s)
      iii. Inverter driven, medium pressure vapor injection, high pressure shell compressors

iv. Liquid refrigerant cooled inverter PCB

v. Oil separator(s)

vi. Accumulator /controlled volume receiver(s)

vii. 4-way reversing valve(s)

1. Vapor injection valve(s)

viii. Variable path heat exchanger control valve(s)

ix. Oil balancing control

x. Oil Level sensor(s)

xi. Electronic expansion valve(s)

1. Sub-cooler (s)

2. Vapor Injection Valve(s)

xii. High and low side Schrader valve service ports with caps

1. Service valves

7. Field Insulation:

a) All refrigerant pipe, y-branches, elbows and valves shall be individually insulated with no air gaps. Insulation heat transfer resistance shall not be less than the minimum called for by the local building code, local energy code or as a minimum per manufacture installation requirements. In no case shall the insulation be installed in a compressed state at any point in the system.

i. All joints shall be glued and sealed per insulation manufactures instructions to make a vapor tight assembly. Exterior refrigerant piping shall be installed with closed cell neoprene with aluminum jacket and aluminum fittings.

8. Microprocessor**:**

a) Factory installed microprocessor controls in the outdoor unit(s), heat recovery unit(s), and indoor unit(s) shall perform functions to optimize the operation of the VRF system and communicate in a daisy chain configuration between outdoor unit and heat recovery unit(s) and indoor unit(s) via RS485 (shielded twisted wire pair) network. Control devices shall also be available to control other building systems as required from the VRF control system. DIO/AIO capabilities shall be available as well as a central controller to perform operation changes, schedules and other duties as required by this specification. Addition of separate building control system shall not be required. Other control devices and sequences shall be as specified in other sections of this project specification.

9. Inverter PCB Cooling:

   a) Cooling of the inverter PCB shall be conducted by way of high pressure, sub-cooled liquid refrigerant via heat exchanger attached to the inverter PCB. The full capacity flow of refrigerant shall pass though the heat exchangers to maximize the cooling effect of the PCBs and to aid in the evaporation process and capacity of the outdoor coil during the heating mode. The recovered heat of the PCBs must be used to enhance the overall heating process, other uses or dissipation of heat to ambient shall not be permitted.

10. Compressor Control:

   a) Fuzzy control logic shall establish and maintain target evaporating temperature (Te) in cooling mode and condensing temperature (Tc) in heating mode by Fuzzy control logic to ensure the stable system performance.

11. Initial Test Run (ITR) (Heating or Cooling) / Fault Detection Diagnosis (FDD) Code:

   a) This control mode shall monitor and display positive or negative results of system initial startup and commissioning. Heating or Cooling ITR mode will be automatically selected. It shall monitor and provide performance metrics for the following, but not be limited to, refrigerant charge validation, auto-charge operation verification, refrigerant cycle stability, connection ratios, indoor unit status, error status, and number of indoor units connected. This commissioning specific control mode shall not replace the system error monitoring control system during normal operation.

12. BMS Integration:

   a) The VRF system shall be able to integrate with Building Management Systems via BACnet™ IP gateway. This gateway converts between BACnet™ IP or Modbus TCP protocol, and RS-485 LGAP (LG Aircon protocol) allowing third party control and monitoring of the LG A/C system, or LonWorks™ gateways. See controls specification for points list.

13. Wi-Fi Communication:

   a) The outdoor unit microprocessor shall be capable of being monitored via an optional Wi Fi wireless communications dongle or embedded Wi Fi transmitter. Wi-Fi shall allow service or maintenance personal access to the complete operating system, via LGMV mobile, without need of tools other than smart phone or tablet. Active live system review, collection of all system data for a field determined duration presented in a .csv file format or collection of all operating conditions, including all indoor units, valves, sensors, compressor speeds, refrigerant pressures, etc., by snapshot of conditions and placing that snapshot into a power point slide to be reviewed at another time. Systems that require computers, hard wire only connection or other devices to collect, review or record operating conditions shall not be allowed.

14. Indoor Unit Connectivity:

    a) The system shall be designed to accept connection up to <64> indoor units of various configuration and capacity, depending on the capacity of the system.

15. Power and Communication Interruption:

    a) The system shall be capable of performing continuous operation when an individual or several indoor units are being serviced; communication wire cut or power to indoor unit is disconnected from power for a minimum of a 24 hour period. Systems that alarm and/or shut down because of a lack of power to any number of indoor units shall not be acceptable.

16. Connection Ratios:

    a) The maximum allowable system combination ratio for all VRF systems shall be 130% and the minimum combination ratio shall be 50%.

17. Comfort Cooling Mode:

    a) Comfort cooling shall be initiated via a field setting at the outdoor unit during commissioning or anytime thereafter. Comfort cooling shall allow user to select all or some of the indoor units of a system to automatically modify each of the indoor unit's superheat target set point based on the impending total cooling load of on the indoor unit, the rate of change of the zone temperature relative to set point and optionally, if specified, the rate of change of the zone humidity level.

18. The outdoor unit shall be provided with a factory installed fusible plug or rupture disc. The fusible plug connection shall be threaded for easy connection with a field provided vent pipe to safely discharge the system's refrigerant charge away from the outdoor unit if a building fire causes an extreme pressure condition in the outdoor unit refrigerant circuit employ for safety a threaded fusible plug.

19. Refrigerant Flow Control

    a) An active refrigerant -in-circulation control system consisting of a refrigerant storage container, interconnecting refrigerant piping control valves, pressure transducers, microprocessor control, and software to continuously monitor necessary refrigeration cycle operating parameters to maintain stable cycle operation between minus (-)22°F and 122°F ambient conditions. The refrigerant system operating conditions shall be checked by the algorithm at three minute intervals and if needed automatically and dynamically remove and store refrigerant to the storage tank or inject refrigerant from the tank into the refrigerant circuit.

        i. The algorithm shall adjust refrigerant charge automatically:

            1. As the outdoor air temperature changes;

2. System mode of operation changes;

3. The path of refrigerant flow through the outdoor coil is modified;

4. The system's target suction and head pressure control values are adjusted.

b) Subcooler: The VRF outdoor unit shall include a factory provided and mounted sub-cooler assembly consisting of a shell and tube-type sub-cooling heat exchanger and EEV providing refrigerant sub-cooling modulation control by fuzzy logic of EEV and by mode of operation to provide capacity and efficiency as required. Brazed plate heat exchangers shall not be allowed for this function.

c) Advanced Smart Load Control: The air source unit shall be provided with Smart Load Control (SLC) enhanced energy saving algorithm that reduces compressor lift during off-peak operation to further reduce system energy consumption when weather and load conditions permit.

ii. The SLC algorithm shall be monitoring in real time, the rate of change of the outdoor ambient air temperature, either the outdoor ambient air relative humidity or the indoor air relative humidity [field selectable], and the rate of change of the building load.

iii. The SLC algorithm shall foresee pending changes in the building load, outdoor temperature and humidity (or indoor humidity) and proactively reset head and/or suction pressure targets in anticipation of the reduction/increase in building load.

iv. The SLC algorithm shall provide no fewer than three (3) field selection options to maximize the control of the VRF system operation during morning warm-up or cool-down following night-setback reset. The selection shall be set by the commissioning agent (or at any other time thereafter). Selectable algorithm choices include:

2. Maximize energy savings

3. Balance the rate of temperature change with energy consumed.

4. Quickly cool/heat the building.

20. Refrigerant Volume Management

a) Active Refrigerant Charge

i. The VRF system shall be able to operate at any and all published conditions year round in cooling or heating mode without the need of adding or removing refrigerant from the system.

ii. The air source unit shall be provided with an isolated vessel, interconnecting piping, valves and sensors to store refrigerant and actively pass refrigerant to (or from) the refrigerant circuit in real time as necessary to maintain stable refrigeration cycle operation.

iii. The air source unit microprocessor shall be provided with an algorithm that monitors the VRF system head pressure, suction pressure, subcooling, superheat, compressor speed, high and low side temperatures and the load on the system at three minute intervals and if needed, automatically and dynamically remove and store refrigerant to the storage tank or inject refrigerant from the tank into the refrigerant circuit.

21. VRF Systems with Onboard Alternate Operating Mode Selection Capability

a) All VRF systems equipped with field selectable Alternate Operating Modes via DIP Switch or other means, for example but not limited to, High Heat, High Ambient Cooling, High Sensible, or Enhanced Efficiency selections. Performance using the proposed field selected Alternate Operating Mode shall be tested using AHRI Standard 1230 and published in the AHRI Directory.

b) Acceptable Alternate Operating Modes must ship with all models of the VRF product offering and must be factory embedded. Custom factory or field modifications to factory provided algorithms created to meet scheduled requirements are not acceptable.

c) Provide a copy of instructions required to set the Alternate Operation Mode with the initial submittal.

d) For systems that provide field selectable Alternate Operating Modes, ALL technical data provided in the submittal data sheets showing product rated condition performance data, must also provide separate data sheets that show product performance data at each of the field selectable Alternate Operating Modes available. Capacity, power input, and acoustic performance data for each mode offered shall be reported separately. Mixing of ODU, IDU, or VRF system performance capability operating in one mode with for example the power consumption, sound power rating, or electrical requirements of the same system operating in another mode is not acceptable.

F. Field Supplied Refrigerant Piping Design Parameters

1. The outdoor unit shall be capable of operating at an elevation difference of up to 360 feet above or below the lowest or highest indoor unit respectively without the requirement of field installed subcooler or other forms of performance enhancing booster devices.

2. The outdoor unit shall be capable of operating with up to 3280 equivalent length feet of interconnecting liquid line refrigerant pipe in the network.

3. The outdoor unit shall be capable of operating with up to 656 actual feet or 738 equivalent length feet of liquid line refrigerant pipe spanning between outdoor unit and farthest indoor unit.
4. The piping system shall be designed with pipe expansion and contraction possibilities in mind. Required expansion devices shall be field designed, supplied and installed based on proper evaluation of the proposed piping design. In addition to these requirements, the piping system installation must conform to the VRF equipment manufacturer's published guidelines.

G. Defrost Operations

1. The outdoor unit(s) shall be provided with a minimum of 4 independent field adjustable defrost cycle algorithms to maximize the effectiveness of the defrost cycle to the local weather conditions. Intelligent Defrost shall melt accumulated frost, snow and ice from the outdoor unit heat exchanger. The defrost cycle length and sequence shall be based on outdoor ambient temperatures, outdoor unit heat exchanger temperature, and various differential pressure variables. Intelligent Heating Mode, when outdoor unit humidistat is engaged, shall extend the normal heating sequences by adjusting the outdoor unit coil target temperature to be above the ambient dew point temperature delaying the need for defrost operations, so long as heating demand is being met.
2. Smart Heating**:** This feature shall be capable of eliminating several defrost actions per day based on outdoor air temperature and humidity conditions. Smart heating shall extend the heating operation cycle by delaying the frost formation on the outdoor coil by adjusting the surface temperature to keep it above the current outdoor ambient dew point. The algorithm shall delay while maintaining indoor space temperature.
3. Defrost Mode Selection: The outdoor unit shall be provided with a minimum of three field selectable defrost operation modes: Normal, Fast, or Forced.

    a) Normal Defrost: Operation intended for use in areas of the country that experience adverse winter weather with periods of heavy winter precipitation and extremely low temperatures. This strategy shall maximize the systems heating performance and maintain operational efficiency. When the ambient temperature is either: a) above 32°F or b) below 32°F with the humidity level below 60% RH, Intelligent Defrost shall continue heating regardless of ice build-up on the coil until the quality of the heated air (i.e. discharge air temperature) decreases. At temperatures below 4°F, a defrost cycle shall occur every two hours to optimize system heating efficiency.

    b) Fast Defrost: Operation intended for use in areas of the country with mild winter temperatures and light to moderate humidity levels. The strategy minimizes defrost cycle frequency allowing frozen precipitation to build longer in between cycles. Minimum time between defrost cycles shall be 20 minutes. Intelligent Defrost shall choose between split coil/frame and full system methods based on current weather conditions to minimize energy consumption and maximize heating cycle time.

c) Forced Defrost: Operation shall be available for the service provider to test defrost operations at any weather condition and to manually clear frozen water from the outdoor coil surfaces.

4. Defrost Method Selection: The outdoor unit shall be provided with two field selectable defrost operation methods: Split Coil/Frame and Full System. Split Coil/Frame option provides continuous heating of the occupied space during defrost operation.

   a) Split Coil/Frame method shall be available when Normal Defrost mode is selected. Split Coil method shall be available on all Heat Pump and Heat recovery single-frame VRF systems. Split Frame defrost shall be available on all Heat Pump and Heat recovery multi-frame outdoor units.

   b) Split Coil method shall remove ice from the bottom half of the outdoor unit coil first for a maximum time of six minutes, then the top half for a maximum of six minutes. Next the bottom coil shall be heated again for an additional three minutes to remove any frozen water that may have dripped onto the lower coil during the top coil defrost operation.

   c) When Split Coil/Frame method is selected, a Full System defrost shall occur every 1-9 (field selectable) defrost cycles to assure 100% of the frozen precipitation has been removed to maintain efficient performance.

   d) Full System method shall be available as a field selectable option. All outdoor units located in areas of the country where large volumes of frozen precipitation are common, the commissioning agent shall be able to select the Full System only defrost method.

5. Indoor Unit Fan Operation During Defrost

   a) During partial defrost operation indoor units operating in cooling or dry mode shall continue normal operation.

   b) During partial defrost operation, indoor units that are commissioned with fans set for continuous operation shall maintain normal fan speed unless the leaving air temperature drops, then the fan speed will be reduced to low speed for the remainder of the defrost cycle.

   c) During full system defrost operation indoor unit fans will cycle off and remain off during the remainder of the defrost cycle.

H. Oil Management

1. The system shall utilize a high pressure oil return system to ensure a consistent film of oil on all moving compressor parts at all points of operation. Oil is returned to compressor through a separate high pressure oil injection pipe directly into the oil sump. Oil returned to the compressor via the suction port of the compressor shall not be allowed.

2. Each compressor shall be provided with a high efficiency independent centrifugal cyclone type oil separator, designed to extract oil from the oil/refrigerant gas stream leaving the compressor.
3. The system shall have an oil level sensor in the compressor to provide direct oil level sensing data to the main controller. The sensor shall provide data to main outdoor unit PCB to start oil return mode and balance oil levels between multiple compressors.
4. The system shall only initiate an oil return cycle if the sensed oil level is below oil level target values as determined by the microprocessor. The system shall display an error if the oil sensor signals low oil level for a period of 130 minutes or longer.
5. A default oil return algorithm shall automatically initiate the oil return mode if the system detects a failure of the oil sump sensor. A fault code shall be reported by the system.
6. Timed oil return operations or systems that do not directly monitor compressor oil level shall not be permitted.
7. Indoor Unit Fan Operation during Oil Return Cycle

    a) During oil return cycle indoor units operating in cooling or dry mode shall continue normal operation.

    b) During oil return, indoor units that are commissioned with fans set for continuous operation shall maintain normal fan speed unless the leaving air temperature drops, then the fan speed will be reduced to low speed for the remainder of the oil return cycle.

    c) During oil return cycle indoor unit fans will cycle off and remain off during oil return cycle while operating in all modes.

I. Fan and Motor Assembly

1. 6 ton frames shall be equipped with one direct drive variable speed propeller fan with Brushless Digitally Controlled (BLDC) motor with a vertical air discharge.
2. 8 to 20 ton frames shall be equipped with two direct drive variable speed propeller fan(s) with BLDC motor(s) with a vertical air discharge.
3. The fan(s) blades shall be made of Acrylonitrile Butadiene Styrene (ABS) material and incorporate biomimetic technology to enhance fan performance and reduce fan generated noise.
4. The fan(s) motor shall be equipped with permanently lubricated bearings.
5. The fan motor shall be variable speed with an operating speed range of 0-1150 RPM cooling mode and 0-1150 RPM heating mode.
6. The fan shall have a guard to help prevent contact with moving parts.

7. The cabinet shall have option to redirect the discharge air direction from vertical to horizontal with the addition of optional factory provided air guides.
8. The fan controller shall have a DIP switch setting to raise external static pressure of the fan up to 0.32 inch of W.C. to accommodate ducted installations.
9. The fan control shall have a function setting to remove excess snow automatically.
10. The fan control shall have a function setting to remove access dust and light debris from the outdoor unit and coil.

J. Cabinet

1. Outdoor unit cabinet shall be made of 20 gauge galvanized steel with a weather and corrosion resistant enamel finish. Outdoor unit cabinet finish shall be tested in accordance with ASTM B-117 salt spray surface scratch test (SST) procedure for a minimum of 1000 hours.
2. Cabinet weights and foot prints shall vary between 430 lbs., 7.61 sq. ft. (1.27 sq. ft. per ton), for 6 ton cabinet to 666 lbs., 10.14 sq. ft. (.51 sq. ft. per ton), for 20 ton cabinet for single cabinet configurations. The front panels of the outdoor units shall be removable type for access to internal components.
3. A smaller service access panel, not larger than 7” x 7” and secured by a maximum of (2) screws, shall be provided to access the following:
   a) Service tool connection
   b) DIP switches
   c) Auto addressing
   d) Error codes
   e) Main microprocessor
   f) Inverter PCB
4. The cabinet shall have piping knockouts to allow refrigerant piping to be connected at the front, right side, or through the bottom of the unit.
5. The cabinet shall have a factory installed coil guard.

K. Outdoor Unit Coil

1. Outdoor unit coil shall be designed, built and provided by the VRF outdoor unit manufacturer.
2. The outdoor unit coil for each cabinet shall have lanced aluminum fins with a maximum fin spacing of no more than 17 Fins per Inch (FPI). All the outdoor unit coils shall be a 2 or 3 rows consisting of staggered tubes for efficient air flow across the heat exchanger

3. Outdoor unit coil shall be comprised of aluminum fins mechanically bonded to copper tubing with inner surfaces having a riffling treatment to expand the total surface of the tube interior
4. The aluminum fin heat transfer surfaces shall have factory applied corrosion resistant Black Fin II coating. The copper tubes shall have inner riffling to expand the total surface of the tube interior.
    a) ISO 21207 Salt Spray Test Method B
    b) ASTM B-117/ISO 9227 Acid Salt Test – 10,000 hours
    c) The Black Fin II coating shall be certified by Underwriters Laboratories and per ISO 21207. The above conditions shall establish the minimum allowable performance which all alternates must comply.
5. Variable Path Heat Exchanger: System shall have a variable flow and path outdoor heat exchanger function to vary the refrigerant flow and volume and path. Control of the variable path circuits shall be based on system operating mode and operating conditions as targeted to manage the coil heat transfer capacity and efficiency. The variable path heat exchanger technology shall be provided to maintain stable refrigeration cycle operation during mild weather conditions and maintain a robust hot vapor temperature system head pressure that delivers "gas-furnace leaving air temperature" from the indoor unit at sub-zero outdoor air temperature down to minus (-) 22°F.The outdoor unit coil, all indoor units and pipe network shall be field tested to a minimum pressure of 550 psig.

L. Compressor(s)

1. Compressor shall be designed and assembled by the VRF manufacturer specifically for use in the air source VRF product line. Third party manufactured, branded, or designed to the VRF system's OEM specifications by a third party manufacturer shall not be acceptable.
2. Compressor shall be a hermetic, high-side shell (HSS), commercial grade, compliant scroll direct-drive design.
    a) Compressor Design: The compressor design shall be of the high pressure shell scroll type where the internal pressure below the suction valves of the compressor shall be at the same high pressure and high temperature. The motor shall be cooled by high pressure gas at temperatures above saturation conditions and minimize the mixing of refrigerant liquid with oil in the sump. The system shall employ a high pressure oil return method returning recovered oil from the oil separator directly into the oil sump of the compressor; oil shall not be allowed to return via the suction line. Bearing surfaces are continually coated with oil. The compressor shall employ an Aerobearing constructed with high lubricity materials increasing operation time in case of low sump oil level. Compressor shall have a nominal operating range from 12Hz to 150 Hz.

3. The fixed and oscillating compressor scroll components shall be made of high grade (GC25) or denser steel material. All scrolls shall be heat treated and tempered.
4. The oscillating scroll shall be finely machined and polished. PVE refrigerant oil shall be used as the sole liquid used to maintain a seal between the high and low sides of the compression chamber. Compressors that requires the use of any type of mechanical or wearable sealant material between the moving surfaces of the compression chamber is NOT ACCEPTABLE.
5. Vapor Injection: System shall have a medium pressure gas vapor injection function employed in the heating and cooling modes to increase system capacity when the outdoor ambient temperatures are low and lower compressor lift when temperatures are high. The compressor vapor injection flow amount shall be controlled by the vapor injection sub-cooling algorithm reset by discharge gas temperatures of the compressor.
6. Bearing surfaces shall be coated with Teflon® equal. Bearings shall be lubricated using a constant flow of PVE refrigerant oil to the bearing surfaces The film of oil separating the crankshaft journals and bearing surfaces shall be consistent at all times the crankshaft is in motion and shall be maintained irrelevant of crankshaft rotational speed.
7. An internal, integrated, mechanically driven gear pump shall draw oil from the compressor sump reservoir, pressurize the oil and inject the oil directly to the crankshaft journals maintaining a consistent film of oil between all moving parts. Auxiliary, indirect, or electronically driven pumps are not acceptable.
8. The viscosity property of the PVE oil in the compressor sump shall be maintained irrelevant or compressor operation and the surrounding ambient temperature.

    a) The compressor shall be equipped with an external thermally protected electric crankcase heater that is automatically activated only when the ambient temperature is below freezing and the compressor is not running to maintain the temperature of the oil in the sump above the refrigerant boiling point.

    b) During stable operation, irrelevant of ambient air temperature outside the water source unit, the temperature of refrigerant vapor in contact with the surface of the oil in the compressor sump shall be maintained above 140°F to prevent foaming and to eliminate refrigerant from mixing with the oil degrading the viscosity of the oil in the sump.

9. The compressor motor shall be designed to operate at high temperatures.

    a) The motor winding insulation shall be designed to operate continuously at a minimum temperature of 180°F without deterioration.

    b) The motor cooling system shall be designed to maintain acceptable operational temperature at all times and in all conditions using high pressure, hot refrigerant vapor as motor coolant.

10. Inverter Compressor Controller(s)

    a) Each compressor shall be equipped with a dedicated inverter compressor drive. The control of multiple compressors using a single drive is not acceptable.

    b) The inverter drive shall vary the speed of the compressor crankshaft between zero (0) Hz and 140 Hz.

    c) The inverter driver controller shall be matched with the physical properties of the compressor. The drive shall be manufactured by the VRF air source unit manufacturer. The inverter drive and matching compressor shall have been thoroughly tested as a matched pair. The inverter drive shall be programmed to avoid operating the compressor at any speed that results in harmonic vibration, nuisance noise, or mechanical damage to either the driver or the compressor with power provided that is within the tolerance specification.

    d) The compressor inverter drive assembly and software must be designed, manufactured, and supplied by the VRF product manufacturer. Third party branded inverter driver hardware and/or driver software or inverter driver hardware and/or software provided by a third party manufacturer to meet OEM specifications of the VRF water source manufacturer will not acceptable.

    e) All inverter drive hardware or software manufactured in, is a product of, or sourced from China, or using a broker or third party provider as an intermediary that obtains the product from CHINA shall not be acceptable.

11. Compressor(s)

    a) Each 6, 8, 10 ton frames shall be equipped with a single hermetically sealed, inverter driven, High Side Shell (HSS) scroll compressor.

    b) 12ton frames shall be equipped with dual hermetically sealed, inverter driven, High Side Shell (HSS) scroll compressors.

    c) Each inverter driven, HSS scroll compressor shall be capable of operating from 12 Hz up to 150 Hz in any and all modes (cooling, heating or simultaneous modes).

    d) The compressor shall be designed for a separate port for oil to be directly returned to the compressor oil sump.

    e) The compressor bearing(s) shall have Teflon™ coating and shall be an aero type design using High lubricity materials.

    f) The compressor(s) shall be protected with:

        i. High Pressure switch

ii. Over-current /under current protection

iii. Oil sump sensor

iv. Phase failure

v. Phase reversal

vi. Compressor shall be capable of receiving injection of medium pressure gas at a point in the compression cycle where such injection shall allow a greater mass flow of refrigerant at lower outdoor ambient and achieving a higher heating capability. The VRF outdoor unit shall have published performance data for heating mode operation down to -22°F on both heat pump and heat recovery systems.

g) Standard, non-inverter driven compressors shall not be permitted nor shall a compressor without vapor injection or direct sump oil return capabilities.

M. Operational Sound Levels

1. The compressor(s) shall be mounted on rubber isolation grommets. Compressor shall ship with removable clamps that secure the compressor in place while transported. The installing contractor shall remove and discard (or optionally adjust the clamps to allow the isolator to properly function) the clamps prior to commissioning the water source unit.
2. Each single frame outdoor unit shall be rated with an operational sound pressure level not to exceed as listed on below chart when tested in an anechoic chamber under ISO 3745 standard at the highest field selectable heating operating modes available. Such documentation shall be presented in all submittals, manufactures who elect to rate their equipment at other than tested in an anechoic chamber under ISO 3745 standard at the highest field selectable heating operating modes available and the highest field selectable conditions shall not be allowed.
3. A field setting shall be available to program the outdoor unit to reduce sound levels at night, when desired, to a selectable level while still able to meet building load requirement. This mode is available in both cooling and heating modes.

N. Sensors

1. Each outdoor unit module shall have:

a) Suction temperature sensor

b) Discharge temperature sensor

c) Oil level sensor

d) High Pressure sensor

e) Low Pressure sensor

f) Outdoor temperature sensor

g) Outdoor humidity sensor

h) Outdoor unit heat exchanger temperature sensors

O. Warranty

1. Limited Warranty Period

a) STANDARD ONE-YEAR PARTS WARRANTY FOR A QUALIFIED SYSTEM - The Part(s) of a qualified System, including the compressor, are warranted for a period (the "Standard Parts Warranty Period") ending on the earlier to occur of one (1) year after the date of original installation, or eighteen (18) months from the date of manufacture.

b) ADDITIONAL SIX (6) YEAR COMPRESSOR PART WARRANTY - The Compressor is warranted for an additional six (6) year period after the end of the applicable Standard Part Warranty Period (the "Compressor Warranty Period").

2. Extended Warranty – Include in bid.

a) The Standard Warranty Period and the Compressor Warranty Period are extended to a total of ten (10) years (the "Extended Warranty Period") for qualified Systems that have been (a) commissioned by a party that has completed the current Training Requirements, (b) such commissioning is pursuant to LG's current published instructions, and (c) the System commissioning results and supporting documents are entered correctly into LG's online commissioning system. Commissioning of a System requires one (1) hour of LG Monitoring View (LGMV) data. Commissioning results must be entered into LG's online commissioning system within sixty (60) days of System startup.

P. Installation

1. The existing outdoor unit shall be replaced with a new next generation unit. Contractor shall remove existing refrigerant and properly dispose per EPA requirements. The piping system shall be flushed with Rectorseal Turbo-clean. The piping system shall be pressure tested and then evacuated per manufacturer's requirements. Provide documentation of each procedure. Entire system piping lengths shall be determined and sent to manufacturer for determination of proper refrigerant charge. The system shall be properly charged with new refrigerant and oil.
2. The existing system controller shall be replaced with a current generation controller. A Bacnet connection shall be made to a new ALC controller connected to the campus ALC network. New controller shall be programmed to incorporate all existing indoor units and the new outdoor unit.

3. The system shall be functioned test for proper operation in all modes. Discharge air temperatures shall be measured at each indoor unit and recorded. Provide report to the engineer
4. All work on the LG system shall be performed by LG trained technicians (provide training certificate prior to beginning work). All ALC work and Bacnet integration shall be performed by licensed ALC dealer.
5. Provide 2 hours training to Moorpark College staff after completion of work.

END OF SECTION