PART 1 GENERAL

1.1 SUMMARY

Provide a complete Air Source Heat Pump Simultaneous Heating and Cooling with Heat Recovery type Variable Refrigerant Flow (VRF) System consisting of one or more outdoor compressor units and multiple indoor fan coil units as specified in this Section and in accordance with the following:

a. The complete system must be a tested combination in accordance with AHRI 1230.

b. Provide heating /cooling control for each zone.

c. For systems which simultaneously heat and cool, the outdoor units must be interconnected to the indoor units through branch selector boxes in accordance with the manufacturer's engineering data detailing each indoor unit. The indoor units and outdoor must be connected to the branch selector boxes utilizing the manufacturer's specified piping joints and headers.

1.2 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

A. AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI):

AHRI 1230	(2010; Addendum 1 2011; Addendum 2 2014) Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment
ANSI/AHRI 270	(2008) Sound Rating of Outdoor Unitary Equipment
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers
ANSI/AHRI 760	(2014) Performance Rating of Solenoid Valves for Use With Volatile Refrigerants

B. AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS (ASHRAE):

ANSI/ASHRAE 15 & 34	(2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 90.1 - IP	(2019; Errata 1 2019; Errata 2-6 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-Y 2021; Errata 7-8 2021; Interpretation 1-4 2020; Interpretation 5-8 2021; Addenda AS-CB 2022) Energy Standard for Buildings Except Low-Rise Residential Buildings

ASHRAE 90.1 - SI	(2019; Errata 1-4 2020; Addenda BY-CP 2020; Addenda AF-DB 2020; Addenda A-G 2020; Addenda F-AB 2021; Errata 5-7 2021; Interpretation 1-4 2020; Interpretation 5-8 2021) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 135	(2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks

C. AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME):

ASME B31.5	(2020) Refrigeration Piping and Heat Transfer Components
ASME BPVC SEC VIII	(2010) Boiler and Pressure Vessel Codes: Section VIII Rules for Construction of Pressure Vessel
ASME BPVC SEC VIII D1	(2019) BPVC Section VIII-Rules for Construction of Pressure Vessels Division 1

D. AMERICAN WELDING SOCIETY (AWS):

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS Z49.1	(2021) Safety in Welding and Cutting and Allied Processes

E. ASTM INTERNATIONAL (ASTM):

ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM F104	(2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

F. CONSUMER ELECTRONICS ASSOCIATION (CEA):

CEA-709.1-D	(2014) Control Network Protocol Specification

G. MANUFACTURERS STANDARDIZATION SOCIETY OF THE VALVE AND FITTINGS INDUSTRY (MSS):

MSS SP-58	(2018) Pipe Hangers and Supports -

	Materials, Design and Manufacture, Selection, Application, and Installation

H. NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA):

NEMA 250	(2020) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA MG 1	(2016) Motors and Generators - Revision 1: 2018; Includes 2021 Updates to Parts 0, 1, 7, 12, 30, and 31
NEMA MG 2	(2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

I. NATIONAL FIRE PROTECTION ASSOCIATION (NFPA):

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

J. U.S. DEPARTMENT OF DEFENSE (DOD):

MIL-DTL-5541	(2006; Rev F) Chemical Conversion Coatings on Aluminum and Aluminum Alloys

K. U.S. DEPARTMENT OF ENERGY (DOE):

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

L. U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA):

40 CFR 82	Protection of Stratospheric Ozone

M. UNDERWRITERS LABORATORIES (UL):

UL 207	(2009; Reprint Jan 2020) Refrigerant-Containing Components and Accessories, Nonelectrical
UL 429	(2013; Reprint Mar 2021) Electrically Operated Valves
UL 586	(2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air Filter Units
UL 900	(2015) Standard for Air Filter Units
UL 1995	(2015) UL Standard for Safety Heating and Cooling Equipment

1.3 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

Qualification Of Installer

Verification Of Existing Conditions

Drawings:

VRF System Contractor Design Drawings

Product Data:

Spare Parts Data

Coil Corrosion Protection; Manufacturer's Standard Catalog Data

Sample Warranty;

Refrigerant SDS Sheets;

Design Data:

Manufacturer's Engineering Data;

Test Reports:

System Performance Tests;

Certificates Service Organizations:

Warranty;

Electronic Refrigerant Leak Detector Calibration;

Ozone Depleting Substances Technician Certification;

Manufacturer's Instructions:

Manufacturer's Instructions;

Manufacturer's Field Reports:

Refrigerant Charging;

Closeout Submittals:

Posted Instructions;

Inventory

1.4 QUALITY ASSURANCE

Complete VRF systems must be purchased from a single supplier. The VRF system supplier must be responsible for providing a fully functional VRF system.

1.4.1 VRF System Contractor Design Drawings

Submit VRF System Contractor Design Drawings 5 weeks prior to purchasing the VRF components in a single transmittal. Equipment layouts must be drawn to scale. Shop drawings must be approved by the VRF manufacturer’s representative. Include approval with name and contact information of VRF

manufacturer's representative in the submittal. Place separation sheets before each of the following items covering each item with title and number.

a. Equipment layouts which identify assembly and installation details.
Identify scheduled items with indicating marks. Include manufacturer's selection report for equipment, components and fittings.

b. Plans and elevations which identify dimensioned clearances required for maintenance and operation. Show access panels with dimensions.

c. Foundation drawings, bolt-setting information, and foundation bolts.

d. Details which include loadings and type of frames, brackets, stanchions, guides, anchors or other supports. Drawings must conform to Section 23 05 48.19 [SEISMIC] BRACING FOR HVAC.

e. Installation details which includes refrigerant type and charge weight for the system (not only the factory-supplied outdoor unit). Indicate factory setpoints for superheat/subcooling, target evaporating/condensing and corresponding refrigerant pressures/temperatures. Also include saturation reset schedule.

Piping layouts must be to scale and piping must have radial and linear dimensions identifying pipe type. Identify each refrigerant circuit and indicate refrigerant type and mass. Indicate piping expansion components and directions of thermal expansion. Piping layouts must be in accordance with ANSI/ASHRAE 15 & 34.

f. Schedules of equipment, valves, and manufacturer fittings. Mark each item with a common type identifier and unique number.

g. Calculations for refrigerant mass and pipe expansion.

h. Sequence of Operations of system and components.

i. Calculations demonstrating compliance with ANSI/ASHRAE 15 & 34.

1.5 QUALITY CONTROL

1.5.1 Qualifications

1.5.1.1 Qualification of Installer

Submit 3 copies of qualifications prior to installation. The installers must be trained and qualified to install the same type of VRF system components to be installed under this contract by the same manufacturer. Include training certificates in submittal. The installer must have performed three complete installations of VRF systems of the same type and manufacturer that resulted in successful commissioning. Include project VRF installation and product information, location, customer contact information and VRF manufacturer representative contact information. The customer and VRF representative will be contacted to validate information given.

1.5.1.2 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified.

If all products do not contain any refrigerants identified in 40 CFR 82, submit all refrigerant SDS sheets and a general statement of exemption from 40 CFR 82 in alternate to the certifications. Statement of exemption must indicate all equipment containing refrigerants with respective refrigerant types.

1.5.2 Standard Products

Provide materials and equipment that are standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products must have been in satisfactory commercial or industrial use for 3 years immediately prior to the solicitation of this contract. The 3 year use includes applications of equipment and materials under similar circumstances and of similar size. The 3 years' experience must be satisfactorily completed by a product which has been sold on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products must be supported by a service organization. Ensure system components are environmentally suitable for the indicated geographic locations.

1.5.3 Manufacturer's Engineering Data

Submit VRF manufacturer's engineering data with the shop drawings under separate cover. Strike out irrelevant items and options not to be installed. Provide all input and output reports for all selection procedures required by the manufacturer and as required by this section. Engineering data must include:

a. Selection Procedures:
   (1) Indoor and Outdoor Units
   (2) Branch Selector Units
   (3) Piping Material and Fittings
   (4) Refrigerant Mass for system
   (5) Refrigerant Classification

b. System Efficiency Curves/Data including:
   (1) Efficiency correlated with OAT
   (2) At least five (5) data points covering full range of operation
   (3) Minimum and maximum values over the operational range
   (4) Efficiency at Standard AHRI conditions.

1.5.4 Manufacturer's Instructions

Submit VRF manufacturer's instructions with the shop drawings under separate cover. Strike out irrelevant items and options not to be installed. Provide with the following:

a. Installation: Include mechanical, electrical, controls and piping complete installation requirements.

b. Operation: Include startup, normal operation and shutdown procedures.

c. Maintenance: Include preventative.

1.6 PROJECT SEQUENCING

Project sequencing must be in accordance with project schedule and coordination with all trades.

1.7 DELIVERY, STORAGE, AND HANDLING

Protect stored items from the weather, humidity and temperature variations, dirt and dust, or other contaminants. Properly protect and care for all material both before and during installation. Submit an inventory of all the stored items. Replace any materials found to be damaged, at no additional cost to the Government. During installation, keep piping and similar openings capped to keep out dirt and other foreign matter.

1.8 WARRANTY

Provide VRF manufactured equipment with the 10-year manufacturer's warranty in addition to the Warranty of Construction. Submit Sample Warranty prior to construction. Compare warranty requirements with the requirements of this contract and identify discrepancies in the submittal that would prevent coverage of warranty by the manufacturer.

PART 2 PRODUCTS

All products used to meet this specification must meet the indicated requirements, but not all products specified here will be required by every project.

2.1 Product Data

Provide Manufacturer's standard catalog data, at least 5 weeks prior to the purchase or installation of a particular component, highlighted to show material, size, options, performance charts and curves, in adequate detail to demonstrate compliance with contract requirements. If field installed vibration isolation is specified for a unit, include vibration isolator literature containing catalog cuts and certification that the isolation characteristics of the isolators provided meet the manufacturer's recommendations. Submit data for each specified component. Minimum efficiency requirements must be in accordance with ASHRAE 90.1 - SI ASHRAE 90.1 - IP.

2.1.1 Performance Requirements

2.1.1.1 Energy Efficiency

Provide equipment meeting the efficiency requirements as stated on drawings and in accordance with the Energy Code of NYS and Energy Star Rated, which ever standard is greater.

2.1.2 Safety Devices

Exposed moving parts, parts that produce high operating temperature, parts which may be electrically energized, and parts that may be a hazard to operating personnel must be insulated, fully enclosed, guarded, or fitted with other types of safety devices.

2.2 CONTROLS

The control system, components and network must be in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

2.2.1 Zone Control

Provide a Space Sensor Module for each fan coil unit unless otherwise indicated in contract drawings and with the following additional requirements:

a. Displays the current temperature, temperature setpoint, fans status, occupancy status and conditioning mode at the same time. If information is displayed electronically then it must be illuminated.

b. Temperature setpoint adjustment in one degree increments.

c. Fans speed control (At least: High-low-Auto).

d. Occupancy override button which changes the mode of the zone to occupied for one hour per press of occupancy override button with three hours maximum at any instance.

2.3 INDOOR FAN COIL UNITS

Provide with the following:

a. Factory complete, tested and pre-wired with all necessary electronic

and refrigerant controls.

b. Equipped with auto-restart function and test run capability either via a switch or controller.

c. Refrigerant: Refrigerant circuits factory-charged with dehydrated inert gas.

d. Coils: Direct expansion type constructed from copper, aluminum, or copper and aluminum.

e. Fans: Direct-drive, with statically and dynamically balanced impellers; variable speed ECM or multi-speed supporting at least high and low speeds unless otherwise indicated; motor thermally protected.

f. Return Air Filter: Washable long-life net filter with mildew proof resin, or replaceable, unless otherwise indicated.

g. Condensate Drainage: Built-in condensate drain pan with drain connection.

h. Dedicated electronic modulating refrigerant expansion and flow control.

i. Unit must be in accordance with UL 1995 and AHRI 1230.

j. For units with Built-In Condensate Pumps, provide condensate safety shutoff and alarm. For units without Built-In Condensate Pump, provide built in or field supplied overflow protection.

2.3.1 Concealed-In-Ceiling Units

Provide with the following:

a. Ducted horizontal discharge and return; galvanized steel cabinet.

b. Field adjustable external static pressure switch for high efficiency filter operation.

c. Switch box accessible from side or bottom.

2.3.2 Recessed Ceiling Units

Provide with the following:

a. Four-way airflow cassette with central return air grille, for installation in a fixed ceiling, unless otherwise indicated.

b. Exposed Housing: White, impact resistant, with washable decoration panel.

c. Supply Airflow Adjustment:

(1) Via motorized or manual louvers which can be horizontally and vertically adjusted from 0 to 90 degrees.

(2) Field-modifiable to 3-way and 2-way airflow.

2.3.3 Wall Surface-Mounted Units

Provide with the following:

a. Finished white casing, with removable front grille; sound insulation; wall mounting plate; condensate drain pan.

b. Airflow Control: Auto-swing louver that closes automatically when unit stops; adjustable discharge angle, set using remote controller; upon restart, discharge angle defaulting to same angle as previous operation.

c. Fan: Direct-drive cross-flow type.

d. Condensate Drain Connection: Side (end), not concealed in wall.

2.4 OUTDOOR COMPRESSOR UNIT

Provide with the following:

a. The outdoor unit must have one or more variable capacity compressors or alternative method resulting in three or more steps of capacity needed to load match the indoor unit fan coils at all times.

b. The unit must be factory complete, tested and pre-wired with all necessary electronic and refrigerant controls.

c. The sound pressure dB(A) at rated conditions must be a value of 58 decibels at 1 meter 3 feet from the front of the unit when rated in accordance with ANSI/AHRI 270.

d. The unit must automatically restart normal operation after a power failure of any duration without reprogramming or manual assistance.

e. Oil recovery cycle must be automatic occurring a minimum of 2 hours after start of operation and then at least every 8 hours of operation.

f. Each outdoor unit must have it's own dedicated power feed, each with disconnect and main power circuit breaker.

h. The unit must be in compliance with ANSI/ASHRAE 15 & 34, factory tested, cleaned, dehydrated, charged, and sealed. Provide refrigerant charging valves. Filter-drier must be provided in liquid line.

i. The outdoor unit’s capacity must meet or exceed the scheduled value in the contract drawings. The ratio of the outdoor unit capacity to the total connected indoor capacity must be in accordance with the manufacturer's recommendations for selecting the outdoor unit.

j. Unit must be in accordance with UL 1995 and AHRI 1230.

2.4.1 Air-Cooled

a. See additional specified equipment specification at end of this specification.

2.4.2 Water-Cooled – NOT USED

2.4.3 Casing

Construct the unit of zinc coated, heavy-gage (14-gage minimum) galvanized steel. Provide cabinet panels with lifting handles and water- and air-tight seal. Insulate all exposed vertical panels, top covers and base pan.

2.4.4 Compressor

Each compressor system must have the following:

a. High pressure safety switch, and internal thermal overload protection.

b. Factory installed vibration dampeners on all mounting points.

d. Factory installed crank case heater or other control logic to ensure reliable operation in freezing environments.

e. Oil separator with an oil balance circuit.

2.5 COMPONENTS

2.5.1 Fans

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the flow rate required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with an open dripproof enclosure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Direct-drive fan motors must be of the multiple-speed variety.
Belt-driven fans must have adjustable sheaves to provide not less than 25 percent fan-speed adjustment. The sheave size must be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans must be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans must be direct-drive drive type with fixed pitch blades. V-belt driven fans must be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings must be protected with water slingers or shields. V-belt drives must be fitted with guards where exposed to contact by personnel and adjustable pitch sheaves. Axial fans may not be used to distribute air through duct systems.

2.5.2 Supplemental Electric Heating Coil – NOT USED

2.5.3 Air Filters

Air filters must be listed in accordance with requirements of UL 900, except high efficiency particulate air filters of 99.97 percent efficiency must be as listed under the label service and must meet the requirements of UL 586.

2.5.4 Coil Frost Protection (Defrost Mode)

Provide each circuit with a manufacturer's standard coil frost protection (Defrost Mode) system.

2.5.5 Pressure Vessels

Pressure vessels must conform to ASME BPVC SEC VIII D1 or UL 207, as applicable for maximum and minimum pressure or temperature encountered. Where referenced publications do not apply, test pressure components at 1-1/2 times design working pressure.

2.5.5.1 Liquid Receiver

Receiver must be rated in accordance with the recommendations of ANSI/AHRI 495.

2.5.5.2 Suction Accumulator

Accumulators must comply with UL 207. Accumulators over 15 cm 6 inch in diameter must comply with ASME BPVC SEC VIII.

2.5.5.2.1 Vertical Type

Provide heat exchanger or heating element around the U-tube in freezing environments.

2.5.5.2.2 Horizontal Type

Provide only in non-freezing environments.

2.5.5.3 Oil Separator

Separator must be the high efficiency type and be provided with removable flanged head for ease in removing float assembly and removable screen cartridge assembly. Connections to compressor must be as recommended by the compressor manufacturer. Separator must be provided with an oil float valve assembly or needle valve and orifice assembly, drain line shutoff valve, sight glass and strainer. Provide an oil separator for each refrigerant circuit.

2.5.5.4 Oil Reservoir

Reservoir capacity must equal one charge of all connected compressors. Reservoir must be provided with an external liquid gauge glass, plugged drain, and isolation valves. Vent piping between the reservoir and the suction header must be provided with a 35 kPa 5 psi pressure differential relief valve. Reservoir must be provided with the manufacturer's standard filter on the oil return line to the oil level regulators.

2.5.6 Internal Dampers

Dampers must be parallel blade type with renewable blade seals and be integral to the unitary unit. Damper provisions must be provided for each outside air intake, exhaust, economizer, and mixing boxes. Dampers must have minimum position stops and operate as specified.

2.5.7 Mixing Boxes

Mixing boxes must match the base unit in physical size and must include equally-sized openings, each capable of full air flow. Arrangement must be as indicated.

2.5.8 Refrigerant Piping

Provide refrigerant piping external to equipment in accordance with REFRIGERANT PIPING.

2.5.9 Condensate Drain Piping

Provide condensate drain piping.

2.5.10 Ductwork

Provide interface to ductwork.

2.5.11 Refrigerant Solenoid Valves

Solenoid valves must comply with ANSI/AHRI 760 and UL 429, be suitable for continuous duty rated voltage at maximum and minimum encountered pressure and temperature service conditions.

Solenoid valves must be direct-acting or pilot-operating type, packless, seal capped. Manual lifting provisions must be furnished. Solenoid coils must comply with NEMA 250 type 4. Valves must have safe working pressure of 125 percent of maximum working pressure and a maximum operating pressure differential of at least half of the valve maximum working pressure at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the fluid phase and refrigerant used.

2.5.12 Branch Selector Unit

Branch Selector port control must be provided for each connected indoor unit to enable individual heating and cooling selection year round unless otherwise indicated in the contract drawings. The cabinet must be galvanized steel. The branch selector units must be factory assembled, wired, piped and run tested.

2.6 EQUIPMENT ACCESSORIES AND MISCELLANEOUS EQUIPMENT

2.6.1 Refrigerant Leak Detector

Provide continuously-operating, halogen-specific type refrigerant leak detector. Detector must be appropriate for the refrigerant in use. Detector must be specifically designed for area monitoring and must include sampling points installed where required. Detector design and construction must be compatible with the temperature, humidity, barometric pressure and voltage fluctuations of the operating area. Detector must have an adjustable sensitivity such that it can detect refrigerant at or above 3 parts per million (ppm).
Detector must be supplied factory-calibrated for the appropriate refrigerant(s). Detector must be provided with an alarm relay output which energizes when the detector detects a refrigerant level at or above the TLV-TWA (or toxicity measurement consistent therewith) for the refrigerant in use. The detector's relay must be capable of initiating corresponding alarms and ventilation system as indicated on the drawings. Detector must be provided with a failure relay output that energizes when the monitor detects a fault in its operation.[Detector must be compatible with the facility's energy or utility management and control system (EMCS/UMCS). The EMCS/UMCS must be capable of generating an electronic log of the refrigerant level in the operating area, monitoring for detector malfunctions, and monitoring for any refrigerant alarm conditions.]

2.6.2 Refrigerant Relief Valve/Rupture Disc Assembly

The assembly must be a combination pressure relief valve and rupture disc designed for refrigerant usage. The assembly must be in accordance with ASME BPVC SEC VIII D1 and ANSI/ASHRAE 15 & 34. The assembly must be provided with a pressure gauge assembly which will provide local indication if a rupture disc is broken. Rupture disc must be the non-fragmenting type.

2.6.3 Refrigerant Signs

Refrigerant signs must be a medium-weight aluminum type with a baked enamel finish. Signs must be suitable for indoor or outdoor service. Signs must have a white background with red letters not less than 13 mm 0.5 inches in height.

2.6.3.1 Installation Identification

Provide each new refrigeration system with a refrigerant sign which indicates the following as a minimum:

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.6.3.2 Controls and Piping Identification

Provide refrigerant systems containing more than 50 kg 110 lb of refrigerant with refrigerant signs which designate the following as a minimum:

a. Valves or switches for controlling the refrigerant flow[, the ventilation system,] and the refrigerant compressor.

b. Pressure limiting device(s).

2.6.4 Gaskets

Provide gaskets conforming to ASTM F104 - classification for compressed sheet with nitrile binder and acrylic fibers for maximum 370 degrees C 700 degrees F service.

2.6.5 Bolts and Nuts

Bolts and nuts must be in accordance with ASTM A307. The bolt head must be marked to identify the manufacturer and the standard with which the bolt complies in accordance with ASTM A307.

2.7 FINISHES

2.7.1 Coil Corrosion Protection

Provide coil with a uniformly applied epoxy electrodeposition type coating to all coil surface areas without material bridging between fins. Submit product data on the type coating selected, the coating thickness, the application process used, the estimated heat transfer loss of the coil, and verification of conformance with the salt spray test requirement. Coating must be applied at either the coil or coating manufacturer's factory. Coating process must ensure complete coil encapsulation. Coating must be capable of withstanding a minimum 1,000 hours exposure to the salt spray test specified in ASTM B117 using a 5 percent sodium chloride solution.

2.7.2 Equipment and Components Factory Coating

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand 100 hours exposure to the salt spray test specified in ASTM B117. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

Where stipulated in equipment specifications of this section, coat finned tube coils of the affected equipment as specified below. Apply coating at the premises of a company specializing in such work. Degrease and prepare for coating in accordance with the coating applicator's procedures for the type of metals involved. Completed coating must show no evidence of softening, blistering, cracking, crazing, flaking, loss of adhesion, or "bridging" between the fins.

2.7.2.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final

immersion and prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils.

2.7.2.2 Chemical Conversion Coating with Polyelastomer Finish Coat

Dip coils in a chemical conversion solution to molecularly deposit a corrosion resistant coating by electrolysis action. Chemical conversion coatings must conform to MIL-DTL-5541, Class 1A. Cure conversion coating at a temperature of 43 to 60 degrees C 110 to 140 degrees F for a minimum of 3 hours. Coat coil surfaces with a complex polymer primer with a dry film thickness of 0.025 mm 1 mil. Cure primer coat for a minimum of 1 hour. Using dip tank method, provide three coats of a complex polyelastomer finish coat. After each of the first two finish coats, cure the coils for 1 hour. Following the third coat, spray a fog coat of an inert sealer on the coil surfaces. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils. Cure finish coat for a minimum of 3 hours. Coating materials must have 300 percent flexibility, operate in temperatures of minus 46 to plus 104 degrees C 50 to plus 220 degrees F, and protect against atmospheres of a pH range of 1 to 14.

2.7.2.3 Vinyl Coating

Apply coating using an airless fog nozzle. For each coat, make at least two passes with the nozzle. Materials to be applied are as follows:

a. Total dry film thickness, 0.165 mm 6.5 mils maximum

b. Vinyl Primer, 24 percent solids by volume: One coat 0.051 mm 2 mils thick

c. Vinyl Copolymer, 30 percent solids by volume: One coat 0.114 mm 4.5 mils thick

2.7.3 Factory Applied Insulation

Refrigeration equipment must be provided with factory installed insulation on surfaces subject to sweating including the suction line piping. Where motors are the gas-cooled type, factory installed insulation must be provided on the cold-gas inlet connection to the motor in accordance with manufacturer's standard practice. Factory insulated items installed outdoors are not required to be fire-rated. As a minimum, factory insulated items installed indoors must have a flame spread index no higher than 75 and a smoke developed index no higher than 150. Factory insulated items (no jacket) installed indoors and which are located in air plenums, in ceiling spaces, and in attic spaces must have a flame spread index no higher than 25 and a smoke developed index no higher than 50. Flame spread and smoke developed indexes must be determined by ASTM E84. Insulation must be tested in the same density and installed thickness as the material to be used in the actual construction. Material supplied by a manufacturer with a jacket must be tested as a composite material. Jackets, facings, and adhesives must have a flame spread index no higher than 25 and a smoke developed index no higher than 50 when tested in accordance with ASTM E84.

2.8 TESTS, INSPECTIONS, AND VERIFICATIONS

All manufactured units must be inspected and tested, and documentation provided to demonstrate that each unit is in compliance with applicable ANSI/AHRI and UL requirements and that the minimum efficiency requirements of ASHRAE 90.1 - SI ASHRAE 90.1 - IP have been met.

PART 3 EXECUTION

3.1 EXAMINATION

After becoming familiar with all details of the work, submit verification of existing conditions at least 2 weeks prior to beginning construction, indicating the date the site was visited, confirming existing conditions, and noting any discrepancies found.

3.2 INSTALLATION

The VRF system must be installed by the contractor identified in Qualification of Installer. The contractor must install the VRF system in accordance with the manufacturer's instructions and Shop Drawings.

3.2.1 Equipment General

Provide necessary supports for all equipment, appurtenances, and pipe as required. Isolate outdoor units from the building structure. If mechanical vibration isolators are not provided, provide vibration absorbing foundations. Each foundation must include isolation units consisting of machine and floor or foundation fastenings, together with intermediate isolation material. In lieu of concrete pad foundation, concrete pedestal block with isolators placed between the pedestal block and the floor may be provided. Concrete pedestal block must be of mass not less than three times the equipment weight. Concrete for foundations must be as specified in Section 03 30 00 CAST-IN-PLACE CONCRETE. Equipment must be properly leveled, aligned, and secured in place in accordance with manufacturer's instructions. Air-source outdoor units must be installed per manufacturer's recommendations and must not blow air in the direction of other outdoor unit intakes.

3.2.2 Safety Devices

Safety devices must be installed so that proper operation of equipment is not impaired. Welding and cutting safety requirements must be in accordance with AWS Z49.1.

3.2.3 Controls

Install Controls in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, as indicated by the Points Schedule and to provide the following functionality:

a. On/Off selection for each individual fan coil unit and group.

b. Temperature set point adjustment for each fan coil unit.

c. Fan speed adjustment for each fan coil.

d. Heat/cool/automatic changeover mode selection for indoor and outdoor units.

e. Priority settings for restriction of local access for start/stop, heat/cool mode and set point adjustment.

f. Temperature limitation in both heating and cooling mode.

g. Weekly occupancy schedule with start up and shut off times, temperature settings and operation modes. Yearly occupancy schedule for holidays and periods of non-use.

h. Reset for non-blocking malfunction codes and maintenance warnings.

Provide a Local Display panel as indicated on the points schedule and to provide access to the above specified functionality. The Local Display Panel must additionally indicate current date and time.

3.2.4 Isolation Valves

Provide Isolation Valves. Provide with service ports on downstream side.

3.2.5 Electrical Equipment / Motors

Install electrical equipment, motors, motor efficiencies, and wiring in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM.

3.2.6 Branch Selector Unit

Locate Branch Selector Units inside of the facility with full access for inspection, maintenance and removal. The unit must have a minimum clearance of 12 inches from all serviceable sides and be removable without modification to the surroundings.

3.2.7 Condensate Removal

Provide condensate removal through gravity flow where possible. Where gravity flow is not possible, provide a condensate pump sufficient ensure complete removal of condensate.

3.2.8 Access Panels

Provide access panels for all concealed equipment, valves, controls, dampers, refrigerant fittings, and other fittings for inspection, maintenance and removal. Size panel large enough as to be able to remove the part without modification or damage to the surroundings.

3.2.9 Air Filters

Allow access space for servicing filters. Install filters with suitable sealing to prevent bypassing of air. Perform and document that proper indoor air quality during construction procedures, this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed.

3.2.10 Flashing and Pitch Pockets

Provide flashing and pitch pockets for equipment supports and roof penetrations and flashing where piping or ductwork passes through exterior walls.

3.2.11 Identification Tags and Plates

Provide equipment, gages, thermometers, valves, and controllers with tags numbers stamped or engraved into the material for their use. Provide plates and tags of brass or suitable nonferrous rigid material, securely mounted or attached. Provide minimum letter and numeral size of 3.18 mm 1/8 inch high.

3.2.12 Refrigerant Signs

Locate refrigerant signs with in reading distance of outdoor unit.

3.2.13 Field Applied Insulation

Apply field applied insulation as specified in Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS, except as defined differently herein.

3.2.14 Piping

3.2.14.1 Pipe Hangers and Supports

Design and fabrication of pipe hangers, supports, and welding attachments must conform to MSS SP-58. Installation of hanger types and supports for bare and covered pipes must conform to MSS SP-58 for the system temperature range. Unless otherwise indicated, horizontal and vertical piping attachments must conform to MSS SP-58.

3.2.14.2 Refrigerant Piping

Cut pipe to measurements established at the site and work into place without springing or forcing. Install piping with sufficient flexibility to provide for expansion and contraction due to temperature fluctuation and as indicated in shop drawings. Where pipe passes through building structure pipe joints must not be concealed, but must be located where they may be readily inspected. Install piping to be insulated with sufficient clearance to permit application of insulation. Install piping as indicated and detailed, to avoid interference with other piping, conduit, or equipment. Except where specifically indicated otherwise, run piping plumb and straight and parallel to walls and ceilings. Provide sleeves of suitable size for lines passing through building structure. Braze refrigerant piping with silver solder complying with AWS A5.8/A5.8M. Inside of tubing and fittings must be free of flux. Clean parts to be jointed with emery cloth and keep hot until solder has penetrated full depth of fitting and extra flux has been expelled. Cool joints in air and remove flame marks and traces of flux. During brazing operation, prevent oxide film from forming on inside of tubing by slowly flowing dry nitrogen through tubing to expel air. Make provisions to automatically return oil on halocarbon systems. Installation of piping must comply with ASME B31.5. All refrigerant lines external to units must have field applied insulation per Section 23 07 00 THERMAL INSULATION FOR MECHANICAL SYSTEMS unless otherwise indicated.

All refrigerant lines external to units must be isolated from system vibrations including those generated by compressors, fans, or pumps, to minimize the risk of refrigerant leaks.

3.2.14.3 Condenser Water Piping – NOT USED

3.2.14.4 Solenoid Valve Installation

Install liquid solenoid valves in horizontal lines with stem vertical and with flow in direction indicated on valve. If not incorporated as integral part of the valve, provide a strainer upstream of the solenoid valve. Provide service valves upstream of the solenoid valve, upstream of the strainer, and downstream of the solenoid valve. Remove the internal parts of the solenoid valve when brazing the valve.

3.2.15 Auxiliary Drain Pans, Drain Connections, And Drain Lines

Provide auxiliary drain pans under units located above finished ceilings or over mechanical or electrical equipment. Pan must extend beyond the limits of the units. Provide separate drain lines for the unit drain and auxiliary drain pans. Trap drain pans from the bottom to ensure complete pan drainage. Provide drain lines full size of drain opening.

3.3 REFRIGERANT PIPING TESTS

Perform refrigerant piping tests as per manufacturer's recommendations in the presence of the contracting officer. Use electronic type leak detector with a sensitivity of 3 grams/year 0.1 ounces/year and a calibrated reference leak rated at 5 grams/year 0.17 ounces/year. Submit current electronic refrigerant leak detector calibration certificate prior to testing. Before testing the refrigerant piping system, perform a test of the leak detector with the reference leak fitting in the presence of the Contracting Officer.

3.4 REFRIGERANT CHARGING

After refrigerant piping test and before system performance test, perform evacuation and dehydration procedures in accordance with manufacturers recommendations and requirements. Evacuate system to a minimum of 100 microns 0.004 inches Hg for one hour or per manufacturers requirements. Use fresh oil in the vacuum pump. Connect electronic vacuum gauge to system piping for measurement. The refrigerant must be to the weight specified in the shop drawing calculations. The supplemental refrigerant must be weighed in with an electronic scale. Supplemental refrigerant must be introduced

to the system in a liquid state for refrigerant blends. Conduct refrigerant charging in the presence of the Contracting Officer. Submit refrigerant charging report before system performance test. Outline refrigerant charging procedures in the report. Report must indicated who performed and witnessed the task. Provide signatures from all parties.

3.5 SYSTEM PERFORMANCE TESTS

Before each VRF system is accepted, conduct tests to demonstrate the general operating characteristics of the VRF. Submit three bound copies of the report as 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Include manufacturer commissioning report for each VRF system.

For equipment providing heating and cooling the system performance tests must be performed during the heating and cooling seasons. For systems capable of simultaneous heating and cooling, perform testing of this mode.

a. Submit a schedule, at least 2 weeks prior to the start of related testing, for the system performance tests. The schedules must identify the proposed date, time, and location for each test. Tests must cover a period of not less than 48 hours for each system and must demonstrate that the entire system is functioning in accordance with the drawings and specifications.

b. Make corrections and adjustments, as necessary, tests must be re-conducted to demonstrate that the entire system is functioning as specified. Prior to acceptance, install and tighten service valve seal caps and blanks over gauge points.

c. If tests do not demonstrate satisfactory system performance, correct deficiencies and retest the system. Conduct tests in the presence of the Contracting Officer. Water and electricity required for the tests will be furnished by the Government. Provide all material, equipment, instruments, and personnel required for the test.

d. Coordinate field tests with TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS]. Submit 3 copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart):
(1) Date and outside weather conditions.
(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures.

(e) Running current, voltage and proper phase sequence for each phase of all motors.

(3) The actual on-site setting of operating and safety controls.

(4) Electronic expansion valve superheat - value as determined by field test.

(5) Subcooling.

(6) High and low refrigerant temperature switch set-points

(7) Low oil pressure switch set-point.

(8) Defrost system timer and thermostat set-points.

(9) Moisture content.

(10) Capacity control set-points.

(11) Field data and adjustments which affect unit performance and energy consumption.

(12) Field adjustments and settings which were not permanently marked as an integral part of a device.

3.6 CLEANING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that are operated during construction, and new filters must be installed after all construction dirt has been removed from the building. System must be maintained in this clean condition until final acceptance. Bearings must be properly lubricated with oil or grease as recommended by the manufacturer. Belts must be tightened to proper tension. Control valves and other miscellaneous equipment requiring adjustment must be adjusted to setting indicated or directed. Fans must be adjusted to the speed indicated by the manufacturer to meet specified conditions.

3.7 CLOSEOUT ACTIVITIES

Provide closeout activities in addition to and in accordance with Section 01 78 00 CLOSEOUT SUBMITTALS.

3.7.1 Extra Materials

Submit spare parts data for each different item of equipment specified, after approval of detail drawings and not later than 2 months prior to the date of beneficial occupancy. Include in the data a complete list of parts and supplies, with current unit prices and source of supply, a recommended spare parts list for 1 year of operation, and a list of the parts recommended by the manufacturer to be replaced on a routine basis.

3.7.2 Maintenance Service Providers

Submit a certified list of qualified permanent service organizations, which includes their addresses and qualifications, for support of the equipment. The service organizations must be reasonably convenient to the equipment installation and be able to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

3.7.3 Warranty

Submit warranty certificate to the Owner. Provide warranty management plan in accordance with CLOSEOUT SUBMITTALS.

3.7.4 VRF Operation and Maintenance Manual

Provide the following:

a. Condensed operating instructions listing step-by-step procedures required for system startup, operation, abnormal shutdown, emergency shutdown, and normal shutdown.

b. Manufacturer's Engineering Data.

c. Manufacturer's Instructions.

d. Shop Drawings on 279 by 432 mm 11 by 17 inches sheets.

3.7.5 Posted Instructions

Submit the field posted instructions, at least 2 weeks prior to construction completion. Including equipment layout, wiring and control diagrams, piping, valves and control sequences, and typed condensed operation instructions on one sheet of paper. The condensed operation instructions must include preventative maintenance procedures, methods of checking the system for normal and safe operation, and procedures for safely starting and stopping the system. The posted instructions must cover all of the items contained in the approved operation and maintenance manuals as well as demonstrations of routine maintenance operations. The posted instructions must be framed under glass or laminated plastic and be posted where indicated by the Contracting Officer.

3.7.6 Training

Provide training, for all items provided under this section. The training period must consist of a total 8 hours of normal working time for items covered in this section.

Specified Manufacturer Specific Specifications

A. Multi V™ 5 Heat Recovery and Heat Pump System(s) – (6 to 42 tons nominal) ARUM168DTE5, ARUM192DTE5, ARUM264DTE5, ARUM288DTE5, ARUM360DTE5 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.

b) Heat pump systems shall require two pipes, simultaneous heating and cooling shall not be supported. The heat recovery system shall consist of three pipes, liquid, suction and hot gas pipes. Heat recovery systems operating at 0°F that cannot deliver single phase superheated refrigerant vapor at a minimum of 162°F while operating in the heating mode shall not be acceptable.

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.*

B. 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 with the option for low ambient kit from -9.9°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)

C. Electrical

a) 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 460/60/3 power with the following specifications:

i. 460/60/3

1. *Voltage tolerance 414V – 528V*

ii. Voltage imbalance of up to two percent;

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

D. 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.

b) 22 to 34 ton units shall be dual frame only.

c) 36 to 42 ton heat recovery units shall be triple 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.

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.

i. 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.

ii. 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.

iii. 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:

1. *Maximize energy savings*

2. *Balance the rate of temperature change with energy consumed.*

3. *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.

b) Manual Seasonal Refrigerant Charge Adjustments
(Applicable for VRF systems without Active Refrigerant Charge)

i. Alternates: Systems that **CANNOT** passively and automatically modify the active refrigerant charge using the method(s) stated in the section *Active Refrigerant Charge* shall clearly state so in bold capital letters in the proposal that this feature is not included.

1. *VRF systems that cannot perform active refrigerant control may submit their proposal as an Alternate. However all Alternate proposals must BUT include as part of the equipment price the cost of to provide bi-annual refrigerant charging services for 15 years. Service shall be performed by the factory authorized agent only. Service shall include refrigerant, parts, labor, truck and/or trip charges, and any miscellaneous fees necessary to analyze the current state of the system and perform the refrigerant charge adjustment. Service must occur one month before the winter season and one month before the summer season.*

ii. If the VRF system requires a charge adjustment more frequently to maintain stable operation, the VRF manufacturer shall provide additional services at no additional charge.

iii. The 15 year period shall begin on the date the equipment is commissioned or the date the building occupancy permit was issued for the area(s) served by the system – whichever date is later.

iv. This service shall be underwritten, warranted, and administered by the VRF equipment manufacturer – not the local distributor or applied representative.

v. The selected service provider shall be mutually agreeable between the building owner (or owners agent) and must be licensed, insured, and trained to work on the VRF system. No third party service (subcontracted service) providers will be acceptable.

vi. If the service provider is not an employee of the VRF manufacturer, the service provider shall be reimbursed for services rendered directly from the manufacturer. Labor rate for services shall be paid at the prevailing union wage rate in place at the time of service.

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.

E. 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.*
5. *The installation of pipe hangers, supports, insulation, and in general the methods chosen to attach the pipe system to the structure must allow for expansion and contraction of the piping system and shall not interfere with that movement.*
6. *The elevation differences for heat recovery systems shall be:*
   a) Heat recovery unit to connected indoor unit shall be 49 feet
   b) Heat recovery unit to heat recovery unit shall be 98 feet
   c) Indoor unit to indoor unit connected to same heat recovery unit shall be 49 feet
   d) Indoor unit to indoor unit connected to separate parallel piped heat recovery units shall be 131 feet.
7. *The acceptable elevation difference between two series connected heat recovery units shall be 16 feet.*

F. 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.

G. 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.

H. 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.*

I. 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.*

J. 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 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 – 1500 hours
   b) ASTM B-117 Acid Salt Test – 900 hours
   c) The Black Fin 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.*

K. 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 Aero-bearing 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.

    c) Low side shell (LSS) type compressors that use suction vapor to cool the compressor motor shall not be acceptable.

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.

    c) Low side shell (LSS) and compressors that use low pressure, low temperature refrigerant gas to cool the motor are not acceptable.

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) 12, 14, 16, 18 and 20 ton 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.

L. 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.*

M. 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

N. Wind Load Installations for Outdoor Units

1. *Provide Florida wind Load Installation Drawings that meet the requirements of the 2017 Florida Building Code, 6th Edition and ASCE Standard 7-2010 with submittal.*

O. Seismic Installations

1. *Provide with submittal: 1) OSHPD Special Seismic Certification Preapproval (OSP) documents for certified product list of VRF equipment to be installed in high seismic risk areas. 2) Equipment installation documents in conformance with CBC 2013, 2016 and 2019 California Building Code and IBC 2012, 2015 and 2018 International Building Code.*

P. 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*

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.

1.02 **PRODUCT(S) - Heat Recovery Units (Heat Recovery Systems Only) PRHR023A, PRHR043A, PRHR063A &PRHR083A**

A. General

1. *Heat recovery unit shall be designed and manufactured by the same manufacturer of VRF indoor unit(s) and outdoor unit(s).*

2. *Heat recovery unit casing shall be constructed with galvanized steel.*

3. *Heat recovery unit shall require 208-230V/1-phase/60Hz power supply.*
4. *Heat recovery Unit shall be an intermediate refrigerant control device between the air source outdoor unit and the indoor units to control the systems cooling and heating operation.*
5. *Heat recovery unit shall be engineered to work with a three pipe VRF system comprising of:*
   a) High Pressure Vapor Pipe
   b) Low Pressure Vapor Pipe
   c) Liquid Pipe
6. *Heat recovery units' main 3 pipe connections shall be capable of series or parallel pipe configuration.*
7. *The quantity of heat recovery units that can be piped in series shall be limited to 16.*
8. *Heat recovery units shall be engineered for installation in a semi-conditioned space where temperature and humidity is maintained between -22Deg F to 130Deg F. Heat recovery unit's case and internal components where surface temperatures may operate below dew point shall be factory insulated. Heat recovery units that condense and require condensate drain shall not be acceptable.*
9. *A single string of series piped heat recovery units shall be capable of serving any combination of styles of VRF indoor units with a combined nominal capacity of up to 230 MBh.*
10. *Heat recovery unit shall have 2, 3, 4, 6 or 8 ports, each port supporting one or more indoor units with a maximum connected capacity of 60 MBH.*
11. *Each port shall be capable of operating in cooling or heating independently regardless of the operating mode of any other port on the heat recovery unit or in the system.*
12. *Each port shall be capable of connecting from 1 to 8 indoor units.*
13. *Connection to indoor units totaling greater than 60MBh nominal capacity shall be twinned to two adjacent ports of the heat recovery unit using a reverse Y-branch connector supplied by manufacture.*
14. *Heat recovery unit shall be internally piped, wired, assembled and run tested at the factory.*
15. *Heat recovery unit shall be designed for installation in a conditioned environment per specifications.*
16. *Heat recovery unit shall employ a liquid bypass valve.*
17. *Heat recovery unit shall have (2) electronic expansion refrigerant valves per port.*
18. *Heat recovery unit shall have a balancing valve to control the pressure between the high pressure and low pressure pipe during mode switching to minimize any change-over pressure related sounds.*
19. *Heat recovery unit shall employ an electronic expansion valve to ensure proper sub cooling of the refrigerant.*
20. *Heat recovery unit shall contain one double spiral sub-cooling heat exchanger per port.*
21. *Heat recovery unit shall not require a condensate drain or connection.*
22. *Heat recovery unit shall be internally factory insulated.*

23. *All field refrigerant lines between outdoor unit and heat recovery unit and from heat recovery unit to indoor unit shall be field ACR tubing, insulated per building or energy code and as instructed by the manufacture.*
24. *The heat recovery unit shall not exceed a net weight of 68 lbs.*
25. *Heat recovery units, for line length and pressure drop calculations, shall not exceed a maximum equivalent pipe length value of 8.2 feet.*
26. *The VRF manufacturer shall provide published documentation that specifically allows the installation of field provided isolation valves on all pipes connected to the Heat recovery unit to allow the servicing of heat recovery units, refrigerant circuit or the replacement of heat recovery unit without evacuating the balance of the piping system.*

B. Controls

1. *Heat recovery unit(s) shall have factory installed unit mounted control boards and integral microprocessor to communicate with other devices in the VRF system.*
2. *Heat recovery unit shall communicate with the indoor units via a 2-conductor stranded communications cable terminated using a daisy chain configuration.*
3. *The contractor is instructed to review the Electrical and ATC drawings and specifications for other items or tasks which this contractor is or may be responsible to provide materials and or labor under this contract. Failure to do so will not relieve this contractor of their responsibility to provide such materials and or labor and in no case shall this contractor be further compensated as a result.*

C. Seismic Installations

1. *Provide with submittal: 1) OSHPD Special Seismic Certification Preapproval (OSP) documents for certified product list of VRF equipment to be installed in high seismic risk areas. 2) Equipment installation documents in conformance with CBC 2013, 2016 and 2019 California Building Code and IBC 2012, 2015 and 2018 International Building Code.*

D. Warranty

1. *Please refer to the respective outdoor unit for applicable warranty.*

Ducted – High Static Units

1.03 Ducted – High Static < ARNU073BHA4><ARNU093BHA4><ARNU123BHA4><ARNU153BHA4><ARNU183BHA4><ARNU243BHA4><ARNU073M2A4><ARNU093M2A4><ARNU123M2A4><ARNU153M2A4><ARNU183M2A4><ARNU243M2A4><ARNU283M2A4><ARNU283M3A4><ARNU363M2A4><ARNU363M3A4><ARNU363B8A4><ARNU423M2A4><ARNU423M3A4><ARNU423B8A4><ARNU483M3A4><ARNU483B8A4><ARNU543M3A4><ARNU763B8A4><ARNU963B8A4>

E. General

1. *Unit shall be manufactured by LG.*
2. *Unit shall be designed to be installed for indoor application.*
3. *Unit shall be designed to mount fully concealed above the finished ceiling.*
4. *Unit shall have opening to supply air from front horizontal and a dedicated rear horizontal return.*
5. *The supply air shall be flanged for field installed ductwork that shall not exceed the external static pressure limitation of the unit.*

F. Casing/Panel

6. *Unit case shall be manufactured using galvanized steel plate.*
7. *The cold surfaces of the unit shall be covered internally with a coated polystyrene insulating material.*
8. *The cold surfaces of the unit shall be covered externally with sheet insulation made of Ethylene Propylene Diene Monomer (M-Class) (EPDM)*
9. *The external insulation shall be plenum rated and conform to ASTM Standard D-1418.*
10. *Unit shall be provided with hanger brackets designed to support the unit weight on four corners.*
11. *Hanger brackets shall have pre-punched holes designed to accept field supplied, all thread rod hangers.*

G. Cabinet Assembly

12. *Unit shall have horizontal supply air discharge outlets and a return air inlet*
13. *Unit shall be equipped with factory installed temperature thermistors for:*
    a) Return air
    b) Refrigerant entering coil
    c) Refrigerant leaving coil
14. *Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.*
15. *Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.*
16. *Unit shall have the following functions as standard:*
    a) Self-diagnostic function
    b) Auto addressing
    c) Auto restart function
    d) Auto changeover function (Heat Recovery system only)
    e) Auto operation function
    f) Child lock function
    g) Forced operation
    h) Dual thermistor control
    i) Sleep mode
    j) External static pressure (ESP) control
    k) Dual set point control
    l) Multiple aux heater applications
    m) Filter life timer

n) External on/off input

o) Wi-Fi compatible

p) Auto fan operation

q) Leak detection logic

H. Fan Assembly

17. *The unit shall have two direct drive Sirocco fans made of high strength ABS GP-2200 polymeric resin.*
18. *The fan impeller shall be statically and dynamically balanced.*
19. *The fans shall be mounted on a common shaft.*
20. *The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.*
21. *The fan motor shall include thermal, overcurrent and low RPM protection.*
22. *The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.*
23. *The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm that provides a minimum of three pre-programed fan speeds, each setting is also adjustable by field setting to compensate for a limited amount of additional resistance to airflow by adjusting the RPM of the fan motor.*
24. *In cooling mode, the indoor fan shall have the following settings; Low, Med, High, and Auto.*
25. *In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.*
26. *Each of the settings can be field adjusted from the factory setting (RPM/ESP).*
27. *Unit shall be designed for high speed air volume against an external static pressure of up to 0.98" water gauge, model dependent.*

I. Filter Assembly

28. *The return air inlet shall have a factory supplied removable, washable filter. MERV 13 filter rack is available as an option, model dependent.*
29. *The filter access shall be from the rear of the unit.*

J. Coil Assembly

30. *Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.*
31. *The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.*
32. *Unit shall have a minimum two to three row coil, 19-21 fins per inch.*
33. *Unit shall have a factory supplied condensate drain pan below the coil constructed of HIPS (high impact polystyrene resin).*
34. *Unit shall include an installed and wired condensate drain lift pump capable of providing minimum 27.5 inch lift from bottom surface of the unit. The unit drain pan is supplied with a secondary drain port/plug allowing the pan to be gravity drained and serviced.*
35. *The drain pump shall have a safety switch to shut off the unit if condensate rises too high in the drain pan, model dependent.*

36. *Unit shall have provision of 45° flare refrigerant pipe connections.*
37. *The coil shall be factory pressure tested at a minimum of 550 psig.*
38. *All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately. Thickness and heat transfer characteristics shall be determined by the design engineer and shall meet all code requirements.*

K. Microprocessor Control

39. *The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system with or without the use of a wall mounted controller. The unit shall have a factory mounted return air thermistor for use as a space temperature control device. All operating parameters except scheduling shall be stored in non-volatile memory resident on the microprocessor. The microprocessor shall provide the following functions, self-diagnostics, auto re-start after a power failure and a test run mode.*
40. *The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, two core, stranded, twisted, and shielded communication cable.*
41. *The unit controls shall operate the indoor unit using one of the five operating modes:*
    a) Auto changeover (Heat Recovery System only)
    b) Heating
    c) Cooling
    d) Dry
    e) Fan only
42. *The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.*
43. *The unit shall be able to operate with the fan turned off during system cooling thermal off.*
44. *The unit shall be able to operate with a continuous fan setting.*
45. *The unit shall have adjustable, multi-step cooling and heating mode thermal on/off temperature range settings.*
46. *The system shall include a product check function to access and display indoor unit type and capacity from a wired programmable thermostat controller.*

L. Electrical

47. *The unit electrical power shall be 208-230/1/60 (V/Ph/Hz).*
48. *The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.*

M. Controls

49. *Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS-485 daisy chain.*

N. Seismic Installations

50. *Provide with submittal: 1) OSHPD Special Seismic Certification Preapproval (OSP) documents for certified product list of VRF equipment to be installed in high seismic risk areas. 2) Equipment installation documents in conformance with CBC 2013, 2016 and 2019 California Building Code and IBC 2012, 2015 and 2018 International Building Code.*

Warranty

1. *Please refer to the respective outdoor unit for applicable warranty.*

Wall Mounted Units

1.04 Wall Mounted – Standard ARNU073SJA4

O. General

1. *Unit shall be manufactured by LG.*
2. *Unit shall be designed to be installed for indoor application.*
3. *Unit shall be attached to an installation plate/bracket that secures unit to the wall.*
4. *The depth of the unit shall not exceed 8.25 inches.*

P. Casing/Panel

5. *Unit case shall be manufactured using Acrylonitrile Butadiene Styrene (ABS) polymeric resin and has a pearl white finish designed for mounting on a vertical surface and includes an installation mounting template and hanging bracket.*

Q. Cabinet Assembly

6. *Unit shall have one supply air outlet and one return air inlet with a manual or motorized sweeping guide vane that automatically changes the direction of airflow from side-to-side and up-and-down.*
7. *Unit shall be equipped with factory installed temperature thermistors for:*
   a) Return air
   b) Refrigerant entering coil
   c) Refrigerant leaving coil
8. *Unit shall have a factory assembled, piped and wired electronic expansion valve (EEV) for refrigerant control.*
9. *Unit shall have a built-in control panel to communicate with other indoor units and to the outdoor unit.*
10. *Unit shall have the following functions as standard:*
    a) Self-diagnostic function
    b) Auto addressing
    c) Auto restart function
    d) Auto changeover function (Heat Recovery system only)
    e) Auto operation function
    f) Auto clean function

g) Child lock function

h) Forced operation

i) Dual thermistor control

j) Sleep mode

k) Dual set point control

l) Filter life timer

m) External on/off control input

n) Wi-Fi compatible

o) Auto fan operation

p) Refrigerant Refrigerant Leak detection logic

11. *Unit shall be capable of refrigerant piping in four different directions.*
12. *Unit shall be capable of drain piping in two different directions.*

R. Fan Assembly

13. *The unit shall have a single, direct driven crossflow tangential Sirocco fan made of high strength ABS BSN-7530 polymeric resin.*
14. *The fan impeller shall be statically and dynamically balanced.*
15. *The fan motor is Brushless Digitally commutated (BLDC) with permanently lubricated and sealed ball bearings.*
16. *The fan motor shall include thermal, overcurrent and low RPM protection.*
17. *The fan/motor assembly shall be mounted on vibration attenuating rubber grommets.*
18. *The fan speed shall be controlled using microprocessor based direct digitally controlled algorithm that provides a minimum of three pre-programed fan speeds in the heating mode and fan only mode and four speeds in the cooling mode. The fan speed algorithm provides a field selectable fixed speed.*
19. *In cooling mode, the indoor fan shall have the following settings: Low, Med, High, Power Cool, and Auto.*
20. *In heating mode, the indoor fan shall have the following settings: Low, Med, High, and Auto.*
21. *Unit shall have factory installed motorized louver to provide flow of air in up and down direction for uniform airflow.*
22. *Unit shall have factory installed motorized guide vane to control the direction of flow of air from side to side.*

S. Filter Assembly

23. *The return air inlet shall have a factory supplied removable, washable filter*
24. *The filter access shall be from the front of the unit without the need of tools.*

T. Coil Assembly

25. *Unit shall have a factory built coil comprised of aluminum fins mechanically bonded on copper tubing.*

26. *The copper tubing shall have inner grooves to expand the refrigerant contact surface for high efficiency heat exchanger operation.*
27. *Unit shall have a minimum two row coil, 18 fins per inch.*
28. *Unit shall have a factory supplied condensate drain pan below the coil constructed of EPS (expandable polystyrene resin).*
29. *Unit shall be designed for gravity drain.*
30. *Unit shall have a 5/8" inside diameter factory insulated drain hose to handle condensate.*
31. *Unit shall have provision of 45° flare refrigerant pipe connections.*
32. *The coil shall be factory pressure tested at a minimum of 550 psig.*
33. *All refrigerant piping from outdoor unit to indoor unit shall be field insulated. Each pipe should be insulated separately.*
34. *Thickness and heat transfer characteristics shall be determined by the design engineer and shall meet all code requirements.*

U. Microprocessor Control

35. *The unit shall have a factory installed microprocessor controller capable of performing functions necessary to operate the system with or without the use of a wall mounted zone controller. The unit shall have a factory mounted return air thermistor for use as a space temperature control device. All operating parameters except scheduling shall be stored in non-volatile memory resident on the microprocessor. The microprocessor shall provide the following functions, self-diagnostics, auto re-start after a power failure and a test run mode.*
36. *The unit shall be able to communicate with other indoor units and the outdoor unit using a field supplied minimum of 18 AWG, two core stranded, twisted, and shielded communication cable (RS-485).*
37. *The unit controls shall operate the indoor unit using one of the five operating modes:*
    a) Auto changeover (Heat Recovery System only)
    b) Heating
    c) Cooling
    d) Dry
    e) Fan only
38. *The unit shall be able to operate in either cooling or heating mode for testing and/or commissioning.*
39. *The unit shall be able to operate with the fan turned off during system cooling thermal off.*
40. *The unit shall have adjustable, multi-step cooling and heating mode thermal on/off temperature range settings.*
41. *The system shall include a product check function to access and display indoor unit type and capacity from a wired programmable thermostat controller.*
42. *Unit shall have a field settable method to choose auto fan speed change operation based on mode of operation, on/off fan operation based on mode of operation, or continuous minimum set fan speed operation.*

V. Electrical

43. *The unit electrical power shall be 208-230/1/60 (V/Ph./Hz).*
44. *The unit shall be capable of operating within voltage limits of +/- 10% of the rated voltage.*

W. Controls

45. *Unit shall use controls provided by the manufacturer to perform all functions necessary to operate the system effectively and efficiently and communicate with the outdoor unit over an RS485 daisy chain.*

X. Seismic Installations

46. *Provide with submittal: 1) OSHPD Special Seismic Certification Preapproval (OSP) documents for certified product list of VRF equipment to be installed in high seismic risk areas. 2) Equipment installation documents in conformance with CBC 2013, 2016 and 2019 California Building Code and IBC 2012, 2015 and 2018 International Building Code.*

Y. Warranty

47. *Please refer to the respective outdoor unit for applicable warranty.*
48. *warranty.*

End of Section