To: All Planholders
From: Nomi Design
Re: Marion County Public Library

This addendum contains (63) 8½” x 11” pages and (1) 30” x 42” sheet.

ADDENDUM 02

The purpose of this addendum is to clarify further requirements of the construction documents. The contractors shall be governed by the information in the addendum as if included in the drawings / specifications. The addendum will become part of the contract documents. The bidders shall acknowledge receipt of the addendum in their form of proposal.

GENERAL ITEMS:

N/A

SITE ITEMS:

1. Reference: Demo Sketch  
   Clarification: Civil Sketch depicts areas of asphalt and concrete that shall be removed to earth in their entirety.

2. Reference: Sheet C2  
   Clarification: Revised seat wall node to STW/C6. SW/C6 is for concrete sidewalk. See attached Civil Sketch.

3. Reference: Sheet C3  
   Clarification: Added Top of Wall and Bottom of Wall elevations to Site Retaining Wall. See attached Civil Sketch.

4. Reference: Sheet C6  
   Clarification: Revised Retaining Wall detail to add handrail. Added Seat Wall detail. Seat Wall (including capstone) shall be a height of 18” above adjacent concrete sidewalk. See attached Civil Sketch.
**STRUCTURAL ITEMS:**

1. Please refer to PDFs for Sections 3/S3.01 and 4/S3.01.
2. Per the updated architectural roof plan in Addendum 2, roofs are to slope ¼” / 12”. Please field verify the existing roof elevations to determine the top of steel elevations.
3. Please refer to Section 4/S3.00.
4. Please refer to architect response.

**ARCHITECTURAL ITEMS:**

1. Locate fire extinguisher cabinets as required by code and near exit doors: 100B, 103A, 117B, and 123B. Locate portable extinguishers as required by code and in: Program Room (105), Maker Space (108), Mech. (113), and Serving (126).
2. Refer to specifications section 07 42 13 – FORMED METAL WALL PANELS, part 2.1, item E – Available Manufacturers.
   a. Add Metal Roofing Systems, Inc. to the list of approved manufacturers.
   b. Replace the material requirements 3., 3.a., 3.b., and 3.c. with the following:
      i. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper.
         1. Thickness: 20 oz./sq. ft. (0.68 mm thick).
         2. Exposed Finish: Pre-patina
         3. Pre-patinated Color: Verdigris
3. Refer to specifications section 07 42 93 – SOFFIT PANELS, part 2.2, B. Add Atas, Inc. and Metal Roofing Systems, Inc. to the list of approved manufacturers.
4. Refer to specifications section 08 80 00 – GLAZING, parts 2.9 – MONOLITHIC GLASS TYPES and 2.10 – INSULATING GLASS TYPES. Remove Glass Types: GL-1, GL-2 and GL-3. Add the glass types from the attached list:
5. Refer to specifications section 101419 – DIMENSIONAL LETTER SIGNAGE, part 2.2, 1. Manufacturers. Add Signarama, Inc. to the list of approved manufacturers.
6. Refer to specifications section 101419 – DIMENSIONAL LETTER SIGNAGE. Note that both types of signs in part 1.2, A., Steel Cutout Dimensional Symbols and Fabricated Channel Dimensional Characters shall have integrated LED backlighting. Coordinate locations for junction boxes with electrical.

7. Refer to specifications section 10 22 39 – FOLDING PANEL PARTITIONS, part 2.01 – ACCEPTABLE MANUFACTURERS. Add Panelfold, Inc. to the list of acceptable manufacturers.

8. Refer to specifications section 10 50 10 – PREFABRICATED ALUMINUM SUNSHADES, part 1.4 – SUBMITTALS. Remove item B. (LEED Project Submittals).

9. Refer to specifications section 12 48 13 – ENTRANCE FLOOR MATS AND FRAMES.
   a. Add Mats, Inc. and Pawling Corporation to the list of approved manufacturers.
   b. Remove the Basis of Design product from the specifications and replace it with the following:
      i. The basis of design product for the recessed entry grate in VEST (Room 123) is “Grate Grid” by Mats, Inc. with carpet insert. This grate is recessed into the concrete slab. See the attached sheet A03 for threshold detail.
      ii. The basis of design for the entry mat in VEST (Room 100) is “Grate Mat” by Mats, Inc. This mat is installed on top of the existing floor slab but should be flush with the top of the new ceramic tile floor.

10. Add the wall section on attached sheet A03 to the drawing set. This section is taken through the exterior canopy and Vestibule (Room 123) on the Plan-North building façade.

11. Add the Garden (Room 141) seat wall and railing details on attached sheets A05 & A06 to the drawing set.

12. Refer to drawing sheet A1.02 – ENLARGED FLOOR PLANS. Revise information for monument sign at Harrison Street Entry per attached sheet A07.

13. Refer to drawing sheet A1.03 - OVERALL ROOF PLAN, drawing #2 – OVERALL ROOF PLAN. The typical slope for the new and existing roofs is ¼” / 12” (not ½” / 12”).
14. Refer to drawing sheet A4.20, drawing D3 – INT. ELEVATION – MENS RR 1. Remove this drawing and replace it with the drawing on attached sheet A04 – TYPICAL RESTROOM ELEVATION.

15. Refer to drawing sheet A6.02 – FINISH PLAN & SCHEDULE, FINISH SCHEDULE. “VEST.” (Room 100) shall have the same finishes as “VEST.” (Room 123).

PLUMBING ITEMS:

Refer to attached one page narrative from Kerr-Greulich Engineers, Inc.

MECHANICAL ITEMS:

Refer to attached one page narrative from Kerr-Greulich Engineers, Inc.

ELECTRICAL ITEMS:

Refer to attached one page narrative from Kerr-Greulich Engineers, Inc.

END OF ADDENDUM
The following shall be included in Contract Drawings and Specifications on the above referenced project. Contractors shall acknowledge receipt of this revision.

**Fire Protection**

1. Reference Specification 211313 “WET-PIPE SPRINKLER SYSTEMS” and include the following:
   a. Revise paragraph 2.08 BACKFLOW PREVENTERS:
      i. Standard: ASSE 1013 and Marion County Water District requirements
      ii. Type: Stainless Steel Reduced Pressure Zone Assembly
      iii. Orientation: Horizontal

**Mechanical**

1. Reference Specification 238250 “VRV w/ Heat Recovery” and include the following:
   a. Revise acceptable manufacturers to include York, Carrier and Samsung.
2. Reference Specification 237433 “DEDICATED OUTDOOR-AIR UNITS” and include the following:
   a. Revise acceptable manufacturers to include Daikin and York.
   b. Revise paragraph 2.09 REFRIGERATION SYSTEM:
      i. Section 2.9.I.2 – revised curb type and height.
   c. Revise paragraph 2.10 INDIRECT GAS FURNACE:
      i. Section 2.10.D – revised warranty period to 25 years.
3. Reference sketch MSK11072017-1 – additional remarks/notes for the ERV schedule.
4. Reference sketch MSK11072017-2 – control panels for ERV units added to Mechanical Room.
5. Reference ERV units – the main supply and exhaust ductwork (and any branches within 12 feet) for each ERV shall be provided with 5/8” gypsum board sound cladding on all sides. Extend GWB twelve (12) feet from main duct drops, and include risers up to unit(s). Seal all seams.

**Electrical**

1. Reference sketch ESK11072017-1 – power connection for two (2) additional control panels for Dedicated Outside Air Units.
2. Reference sketch ESK11072017-1 – added two (2) additional tamper switches in Mech Room 113.

**END OF ADDENDUM**
**SITE RETAINING WALL SCHEDULE**

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<th>WALL GEOMETRY</th>
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**SITE SEAT WALL SCHEDULE**

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**RETAINING WALL**
N.T.S. RW C6

**SEAT WALL**
N.T.S. STW C6

PROPOSED HANDRAIL
SEE RAILING DETAIL BELOW

GROUT TO BE SLOPED
AWAY FROM POST
REMOVE ALL EXISTING ASPHALT AND CONCRETE WITHIN CROSS-HATCHED AREA

REMOVE EXISTING STORM PIPE AND STRUCTURES WITHIN LAWN AREA BETWEEN BLDG. AND MAIN ST.
SECTION 3/S3.01
SECTION 4/S3.01

CONT. BENT PLATE W/ 3" LEGS, F.V.
WIDTH: ATTACH TO EXIST. EDGE ANGLES W/ HILTI POWDER-ACTUATED PIN @ 12" O.C.
PROVIDE SHIMS AS NECESSARY FOR PROPER ATTACHMENT

EXIST. L3x3x1/4, F.V.

EXIST. JOIST

TEMP. SHORING BY CONTRACTOR

EXIST. CMU WALL TO BE DEMOLISHED

BEAM, SEE PLAN

ROOF 114'-0"
GLASS TYPES

GL-1 – INSULATED CLEAR: Low-e-coated, clear insulating glass.
   a. Provide fully tempered glass in locations required by code.
   b. Overall Unit Thickness: 1 inch (25 mm)
   c. Thickness of Each Glass Lite: ¼” (6.0 mm)
   d. Outdoor Lite: Float Glass
   e. Interspace Content: Air
   f. Indoor Lite: Float Glass
   g. Low-E Coating: Pyrolytic on third surface.
   h. Visible Light Transmittance: 45% minimum.
   i. Winter Nighttime U-Factor: 0.29 maximum.
   j. Summer Daytime U-Factor: .27 maximum
   k. Solar Heat Gain Coefficient: 0.32 maximum
   l. Provide safety glazing labeling
   m. Basis of Design: PPG Solorblue

GL-1S – INSULATED CLEAR SAFETY GLASS: GL-1, tempered.

   a. Thickness: ¼ inch (6.0 mm).
   b. Provide safety glazing labeling.
   c. To be used for interior applications.

GL-3 – INSULATED ‘FROSTED’ GLASS: GL-1 with interlayer.
   a. Interlayer Design Basis: Venceva “Artic Snow” (Sandblast)

GL-3S – INSULATED ‘FROSTED’ SAFETY GLASS: GL-1S with interlayer.
   a. Interlayer Design Basis: Venceva “Artic Snow” (Sandblast)

GL-4 – INSULATED COLORED GLASS (COLOR A): GL-1 with interlayers.
   a. Interlayer Design Basis: Venceva “Artic Snow” (Sandblast) with up to two “foundation” color layers.
GL-4S – INSULATED COLORED SAFETY GLASS (COLOR A): GL-1S with interlayers.
   a. Interlayer Design Basis: Vanceva “Artic Snow” (Sandblast) with up to two “foundation color” layers.


GL-6 – INSULATED COLORED GLASS (COLOR C): GL-1 with interlayers.

GL-6S – INSULATED COLORED SAFETY GLASS (COLOR C): GL-1S with interlayers.

GL-7 – INSULATED COLORED GLASS (COLOR D): GL-1 with interlayers.

GL-7S – INSULATED COLORED SAFETY GLASS (COLOR D): GL-1S with interlayers.

GL-8S – ONE-WAY MIRROR SAFETY GLASS: Transparent Mirror (one-way), fully tempered float glass.
   a. Provide fully tempered glass in locations required by code.
   b. Thickness: 1/4” inch (6.0 mm)
   c. Glass Substrate: Grey
   d. Visible Light Transmittance: 11%
   e. Visible Reflectance – Coated Side: 68%
   f. Visible Reflectance – Glass Side: 16%
   g. Provide safety glazing labeling
   h. Basis of Design: Pilkington “Mirrorpane”
WALL SECTION @ VEST #123

3/4" = 1'-0"

NOTE: ENTRY GRILLE IN VEST (RM # 100) IS NOT RECESSED INTO THE EXISTING SLAB.
PROVIDE SANITARY NAPKIN VENDOR ON THIS WALL IN WOMEN'S ROOM.

STAINLESS STEEL SHEET WITH EXPOSED STAINLESS STEEL FASTENERS @ 16" O.C.

D3

INT. ELEVATION - TYP RESTROOM

1/4" = 1'-0"

ADDENDUM NO. 2
MARION COUNTY PUBLIC LIBRARY
201 EAST MAIN ST
LEBANON, KENTUCKY

TYPICAL RESTROOM ELEVATION
Project # 1622.0
Date 11/07/17
A04
GARDEN SEAT WALL & RAIL DETAILS

3/4" = 1'-0"

NOTE: COORDINATE WITH CIVIL DETAILS
PLANTING BED (SEE CIVIL)

PAINTED STEEL RAILING & GATE

STONE SEAT WALL (SEE CIVIL) (SEE ADDENDUM NO. 2, SHEET A05)

ADDENDUM NO. 2
MARION COUNTY PUBLIC LIBRARY
201 East Main Street
Lebanon, KY

GARDEN WALL / RAIL PLAN
Project number 1622
Date 11/07/17

A06
COPYRIGHT 2017
ELEVATION - MONUMENT SIGN

1/4" = 1'-0"

8" TALL LETTERS, MATCH OWNER'S BRANDING FONT (SANS SERIF)

PLANTING BED AT BASE OF SIGN

CONTINUE STONE ONE COURSE BELOW GADE

POURED-IN-PLACE CONCRETE FOOTING

NEW BRICK OVER EXISTING CMU

MARION COUNTY PUBLIC LIBRARY
201 East Main Street
Lebanon, KY
SECTION 237433 - DEDICATED OUTDOOR-AIR UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS
   A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY
   A. Section includes

1.03 SUBMITTALS
   A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
   B. Shop Drawings: Include plans, elevations, sections, and attachment details. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection. Include diagrams for power, signal, and control wiring.
   C. Startup service reports.
   D. Sample Warranty: For special warranty.
   E. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

1.04 DELIVERY, STORAGE AND HANDLING
   A. Ship unit with doors fastened shut and openings closed-up to prevent damage during transport and during storage period.
   B. Follow unit manufacturer’s “Installation, Operation, and Maintenance Manual” instructions for rigging, moving, and unloading the unit to unit final location.
   C. Store unit in a clean, dry place protected from construction traffic and, in accordance with manufacturer’s “Installation, Operation, and Maintenance Manual.”
1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. Comply with NFPA 70.

B. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

C. AHRI Compliance:


D. ASHRAE Compliance:

1. Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

2. Capacity ratings for air-to-air energy recovery equipment shall comply with ASHRAE 84, "Method of Testing Air-to-Air Heat Exchangers."

3. ASHRAE/IESNA 90.1: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. UL Compliance:

1. Packaged heat recovery ventilators shall comply with requirements in UL 1812, "Ducted Heat Recovery Ventilators"; or UL 1815, "Nonducted Heat Recovery Ventilators."

1.06 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fan Belts: One set for each belt-driven fan.

2. Filters: One set for each unit.

1.07 WARRANTY

A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Basis-of-Design: AAON “RN Series”

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AAON.
2. Desert Aire.
3. Greenheck
4. LCSystems.
5. Daikin.
7. Munters Corporation, Dehumidification Division; Des Champs Products.
8. Thomas & Betts Corporation; Reznor HVAC Division.

2.02 GENERAL REQUIREMENTS, SCOPE

A. Unit shall be fully assembled at the factory and consist of an insulated metal cabinet, louvered outdoor air intake with metal mesh filter assembly, condensate drain pan, P trap, Energy wheel, packaged cooling DX system with evaporator and hot gas reheat refrigerant coils, scroll compressors, indirect gas furnace, motorized outside and exhaust dampers, sensors, curb assembly (where units are to be roof-mounted), service receptacle, return air grate, filter assembly for intake air and exhaust air, supply air blower assembly, exhaust air blower and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point service voltage connection.

2.03 PERFORMANCE REQUIREMENTS

A. General: Provide dedicated outside air ventilation units with integral Indirect Gas-Fired furnace heating and packaged DX cooling for outdoor installation. Units shall include integral rotary air-to-air enthalpy wheel for exhaust air heat recovery. Provide horizontal configuration with additional features listed below. Comply with requirements of ASHRAE 62.1, Section 5 "Systems and Equipment," and Section 7 "Construction and System Start-up."

B. Cabinet Performance:

1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
2. Include effects of metal-to-metal contact and thermal bridges in the calculations.
3. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
4. Portions of cabinet located downstream from the cooling coil shall have a thermal break at each thermal bridge between the exterior and interior casing to prevent condensation from occurring on the interior and exterior surfaces.
5. Leakage: 1 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.
6. Cabinet Structural Performance: Walls, roof and floor deflections shall be within 1/240 of the span considering the design working pressure.

C. Electrical components, devices, and accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Capacities and Characteristics: Refer to HVAC Equipment Schedules on Drawings.

2.04 INDOOR CABINET

A. Construction: Provide double wall construction, galvanized steel with paint finish or stainless steel exterior casing, galvanized or stainless steel interior casing, factory-installed shipping skids and lifting lugs for lifting and handling, Galvanized-steel base rails for mounting.

B. Access for Inspection, Cleaning, and Maintenance: Comply with ASHRAE 62.1. Provide Hinged-access service doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.

C. Cabinet Insulation: 1” thick fibrous-glass duct lining complying with ASTM C 1071, Type II or flexible elastomeric insulation complying with ASTM C 534, Type II, sheet materials. Insulation adhesive complying with ASTM C 916, Type I. Mechanical fasteners shall be suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.

D. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

2.05 FANS

A. Supply and Exhaust Fans: Forward-curved, centrifugal or Backward-inclined, plenum centrifugal fan with spring isolators and insulated flexible duct connections.

1. Motor and Drive: Direct driven or Belt driven with adjustable sheaves, motor mounted on adjustable base.
2. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Spring isolators on each fan having 1-inch static deflection.
2.06 DAMBERS

A. Motorized dampers: Intake Air Motorized dampers of low leakage type shall be factory installed.

2.07 COILS

A. Cooling Coils: Rated according to ARI 410 and ASHRAE 33

1. Access: Fabricate coil section to allow removal and replacement of coil and to allow in-place access for service and maintenance of coil(s).
2. Casing: Manufacturer's standard material Aluminum, Galvanized or Stainless steel.
3. Tubes: Copper.
4. Fins: Aluminum or Copper.
5. Fin and Tube Joint: Mechanical bond.
6. Leak Test: Coils shall be leak tested with air under water.
7. Refrigerant Coils:
   a. Capacity Reduction: Circuit coils for interleaved control.
   b. Suction and Distributor: Seamless copper tube with brazed joints.

B. Cooling-Coil Condensate Drain Pans:

1. Fabricated from stainless-steel sheet and sloped in multiple planes to collect and drain condensate from cooling coils, coil piping connections, coil headers, and return bends.
2. Complying with requirements in ASHRAE 62.1.
3. Drain Connections: At low point of pan with threaded nipple.
4. Units with stacked coils shall have an intermediate drain pan to collect and drain condensate from top coil.

2.08 HEAT RECOVERY DEVICE

A. Energy recovery wheel shall be supplied with a fully factory programmed variable frequency drive. Outdoor air and return air sensors shall trigger wheel modulation for economizer mode. Outdoor air sensor and wheel pressure drop sensor shall trigger wheel modulation for frost control mode. Wheel shall modulate to target a discharge temperature of 55F during economizer. Wheel shall modulate during frost control to eliminate frost.

1. Wheel shall be of the enthalpy type for both sensible and latent heat recovery and be designed for laminar flow.
2. Energy transfer ratings shall be ARI Certified per Standard 1060 and bear the ARI certification symbol for ARI Air-to-Air Energy Recovery Ventilation Equipment Certification Program based on ARI 1060.
3. Desiccant shall be silica gel for maximum latent energy transfer. Silica gel desiccant shall be permanently bonded to wheel media to retain latent heat capability after cleaning. Wheels with sprayed on desiccant coatings are not acceptable. Wheels with desiccant applied after wheel formation are not acceptable.
4. Wheel shall be constructed of lightweight polymer media to minimize shaft and bearing loads.
5. Polymer media shall be mounted in a stainless steel rotor for corrosion resistance. Wheel design shall consist of removable segments (on diameters 36 inches and greater) for ease of service and/or cleaning.
6. Energy recovery device shall transfer moisture entirely in the vapor phase.
7. Energy recovery drive belt material shall be high strength urethane and shall be factory installed in a pre-tensioned state.

2.09 REFRIGERATION SYSTEM


B. Refrigerant Charge: Factory charged with refrigerant and filled with oil.

C. Compressors: Digital Scroll compressors with integral vibration isolators, internal overcurrent and overtemperature protection, internal pressure relief, and crankcase heater. Provide two-stages of cooling consisting of a regular scroll compressor and a digital scroll compressor for matching variable loads.

D. Refrigerant: R-410A.
   1. Classified as Safety Group A1 according to ASHRAE 34.
   2. Provide unit with operating charge of refrigerant.

E. Capacity Control:
   1. Hot-gas bypass refrigerant valve control for dehumidification.

F. Refrigerant condenser and reheat condenser coils:
   2. Tube Material: Copper.
   3. Fin Material: Aluminum.
   5. Leak Test: Coils shall be leak tested with air underwater.

G. Condenser Fan Assembly:
   1. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades.
   2. Fan Motors: Premium efficient, Cast iron, aluminum or rolled steel, Open drip-proof or TEFC, 1.15 Service Factor. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
   3. Fan Safety Guards: Steel with corrosion-resistant coating.

H. Safety Controls:
1. Compressor motor and condenser coil fan motor low ambient lockout.
2. Overcurrent protection for compressor motor.

I. Accessories:
   1. Hail Guard: Provide hail guards for protection of condenser coils in extreme weather conditions.
   2. Roof Curb: Vibration Isolation with corrosion-protection coating, gasketing, and factory-installed wood nailer; complying with NRCA standards; minimum height of 14 inches (intake must be kept at 36” above roof level.)

2.10 INDIRECT GAS FURNACE

A. General: ETL Certified as a component of the unit and ETL Certified for installation downstream of a cooling coil.. Provide integral combustion gas blower.

B. Shall have fault sensors to provide fault conditions to microprocessor controller or BAS as specified in Division 23 section 230993.

C. Heat Exchanger: Provide 4-pass tubular heat exchangers, constructed of type 409 stainless steel. Install tubes shall on vest plate using swaged assembly (welded connections are not acceptable.) Support tubes with fabricated assemblies which permit expansion and contraction of the tubes.

D. Warranty: Provide 25 year extended warranty for Heat exchanger.

E. Furnace gas valve control shall be Modulating-type with 10:1 turn-down.

F. Casing: Encase in weather-tight metal housing with intake air vents, with metal lift-off access door which shall provide access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower.

G. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.

H. Provide solid state stand-alone controls.

I. Provide kit for indoor venting separated 2 pipe venting.

2.11 FILTERS

A. Extended-Surface, Disposable Panel Filters:
   1. Comply with NFPA 90A.
   2. Factory-fabricated, dry, extended-surface type.
   3. Thickness: 2 inch.
   4. Minimum Arrestance: 90, according to ASHRAE 52.1.
   5. Minimum Merv: 8, according to ASHRAE 52.2.

DEDICATED OUTDOOR-AIR UNITS

237433
6. Media: Fibrous material formed into deep-V-shaped pleats with antimicrobial agent and held by self-supporting wire grid.
7. Extended surface filters arranged for flat orientation, removable from access plenum.
8. Galvanized or stainless steel with gaskets and fasteners, suitable for bolting together into built-up filter banks.

2.12 ELECTRICAL POWER CONNECTIONS

A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to Indoor unit and single point field power connection to Outdoor unit.

B. Piping and Wiring: Fabricate units with space within housing for piping and electrical conduits. Wire motors and controls so only external connections are required during installation.

1. Indoor Enclosure: NEMA 250, Type 12 enclosure contains relays, starters, and terminal strip.
2. Outdoor Enclosure: NEMA 250, Type 3R enclosure contains relays, starters, and terminal strip.
3. Include fused nonfused disconnect switches.
4. Variable-speed controller to vary fan capacity from 100 to approximately 50 percent.

2.13 VARIABLE FREQUENCY DRIVE

A. Variable Frequency Controllers, General Description: NEMA ICS 2, IGBT, PWM, VFC; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.

1. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range.
2. Unit Operating Requirements:
   a. Input ac voltage tolerance of plus or minus 10 percent.
   b. Input frequency tolerance of 03/11 Hz, plus or minus 6 percent.
   c. Minimum Efficiency: 96 percent at 60 Hz, full load.
   d. Minimum Displacement Primary-Side Power Factor: 96 percent.
   e. Overload Capability: 1.1 times the base load current for 60 seconds; 2.0 times the base load current for 3 seconds.
   f. Starting Torque: 100 percent of rated torque or as indicated.
   g. Speed Regulation: Plus or minus 1 percent.

3. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
4. Internal Adjustability Capabilities:
   a. Minimum Speed: 5 to 25 percent of maximum rpm.
   b. Maximum Speed: 80 to 100 percent of maximum rpm.
   c. Acceleration: 2 to a minimum of 22 seconds.
d. Deceleration: 2 to a minimum of 22 seconds.

e. Current Limit: 50 to a minimum of 110 percent of maximum rating.

5. Self-Protection and Reliability Features:

a. Input transient protection by means of surge suppressors.
b. Undervoltage and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
c. Adjustable motor overload relays capable of NEMA ICS 2, Class 10 performance.
d. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
e. Instantaneous line-to-line and line-to-ground overcurrent trips.
f. Loss-of-phase protection.
g. Reverse-phase protection.
h. Short-circuit protection.
i. Motor overtemperature fault.

6. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

7. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

8. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

9. Door-mounted LED status lights shall indicate the following conditions:

a. Power on.
b. Run.
c. Overvoltage.
d. Line fault.
e. Overcurrent.
f. External fault.


11. Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:

a. Output frequency (Hertz).
b. Motor speed (rpm).
c. Motor status (running, stop, fault).
d. Motor current (amperes).
e. Motor torque (percent).
f. Fault or alarming status (code).
g. Proportional-integral-derivative (PID) feedback signal (percent).
h. DC-link voltage (volts direct current).
i. Set-point frequency (Hertz).
j. Motor output voltage (volts).
12. Control Signal Interface:
   a. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
   b. Remote signal inputs capable of accepting any of the following speed-setting input signals from the control system:
      1) 0 to 10-V dc.
      2) 0-20 or 4-20 mA.
      3) Potentiometer using up/down digital inputs.
      4) Fixed frequencies using digital inputs.
      5) RS485.
      6) Keypad display for local hand operation.
   c. Output signal interface with a minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hertz).
      2) Output current (load).
      3) DC-link voltage (volts direct current).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hertz).
   d. Remote indication interface with a minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
      1) Motor running.
      2) Set-point speed reached.
      3) Fault and warning indication (overtemperature or overcurrent).
      4) High- or low-speed limits reached.

13. Communications: RS485 interface allows VFC to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFC to be programmed via BMS control. Provide capability for VFC to retain these settings within the nonvolatile memory.


15. Accessories:
   a. Devices shall be factory installed in Rooftop Unit Control (NEMA-3R type) weather-proof enclosure.
   c. Standard Displays:
      1) Output frequency (Hertz).
      2) Set-point frequency (Hertz).
      3) Motor current (amperes).
      4) DC-link voltage (volts direct current).
      5) Motor torque (percent).
      6) Motor speed (rpm).
2.14 CONTROLS

A. Control sequence of operation is specified in Section 230993 "Sequence of Operation for HVAC Control."

B. Control Wiring: Factory wire connection for controls' power supply.

C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.

D. Controller: Unit shall be controlled by a factory-installed microprocessor programmable controller that is connected to various sensors. Unit shall incorporate a controller with integral LCD screen that provides text readouts of status, operating settings and alarm conditions. DDC controller shall have a built-in keypad to permit operator to access read-out screens and change settings without the use of ancillary equipment, devices or software. Provide means for Owner-specified ventilating conditions input by using pushbuttons. Operating protocol: The DDC shall be factory-programmed for BACnet MSTP.

E. Sensors: Provide the following sensors:

1. Dirty Filter Sensor
2. Temperature Sensors- Outside Air Intake and Discharge
3. Current Sensor- Fan

PART 3 - EXECUTION

3.01 EXAMINATION

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

B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.

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

3.02 COORDINATION

A. Coordination: Coordinate installation of units with other work of other trades, including ductwork, roofing work, structural, lighting fixtures, smoke detectors, intercom speakers, projectors and screens, piping, sprinklers, and similar items of work, as necessary to interface installation with other work.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases.
3.03 INSTALLATION

A. General: Install HVAC equipment in accordance with all applicable codes, manufacturer’s printed instructions and industry practices to provide complete and fully operational systems. Install units level and plumb, maintaining manufacturer's recommended clearances. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.

B. Equipment Mounting: Install floor or on-grade mounted units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases specified in Division 03 Concrete Sections.

1. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases.
2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
3. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install on 4-inch-high concrete base.

C. Install wall- and duct-mounted sensors furnished by manufacturer for field installation. Install control wiring and make final connections to control devices and unit control panel.

D. Install separate devices furnished by manufacturer and not factory installed.

E. Install new filters at completion of equipment installation and before testing, adjusting, and balancing.

F. Install drain pipes from unit drain pans to sanitary drain.

1. Drain Piping: Drawn-temper copper water tubing complying with ASTM B 88, Type L or M, with soldered joints or schedule 40 PVC pipe complying with ASTM D 1785, with solvent-welded fittings.
2. Pipe Size: Same size as condensate drain pan connection except 1” minimum.

G. Refrigerant Specialties: Install refrigerant specialties and devices shipped loose for field installation. Provide any additional piping, refrigerant specialties, filter/driers, site glasses, fittings, traps, and similar devices not furnished by the manufacturer but, required for a complete installation. Refer to Division 23 Refrigerant Piping Section.

3.04 CONNECTIONS

A. Gas piping installation requirements are specified in "Facility Natural-Gas Piping." Drawings indicate general arrangement of piping, fittings, and specialties. Connect gas piping full size of gas train inlet with union or flange, appliance connector and shut-off valve. Install piping adjacent to equipment to allow service and maintenance.
B. Where installing piping adjacent to units, allow space for service and maintenance.

C. Duct Connections:
   1. Comply with requirements in Division 23 Metal Ducts Section.
   2. Drawings indicate the general arrangement of ducts.
   3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."

D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections. Install electrical devices furnished by unit manufacturer but not factory mounted.

3.05 STARTUP SERVICE

A. Perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Verify operation, failure modes and alarms.
   3. Inspect units for any visible damage to refrigerant compressor, condenser and evaporator coils, and fans.
   4. Inspect for visible damage to furnace combustion chamber.
   5. Verify that labels are clearly visible.
   6. Inspect casing insulation for seal integrity, moisture content, and adhesion.
   7. Verify that clearances have been provided for servicing.
   8. Verify that controls are connected and operable.
   9. Verify that clean filters are installed.
  10. Inspect and adjust vibration isolators.
  11. Verify bearing lubrication.
  12. Adjust fan belts to proper alignment and tension.
  13. Connect and purge gas line.
  15. Clean furnace flue and inspect for construction debris.
  16. Clean coils and inspect for construction debris.
  17. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  18. Start unit.
  19. Start refrigeration system when outdoor-air temperature is within normal operating limits and measure and record the following:
      a. Cooling coil leaving-air, dry- and wet-bulb temperatures.
      b. Cooling coil entering-air, dry- and wet-bulb temperatures.
      c. Hot-gas reheat coil entering-air dry-bulb temperature.
      d. Hot-gas reheat coil leaving-air dry-bulb temperature.
      e. Condenser coil entering-air dry-bulb temperature.
      f. Condenser coil leaving-air dry-bulb temperature.
  20. Simulate maximum cooling demand and inspect the following:
      a. Compressor refrigerant suction and hot-gas pressures.
b. Short-circuiting of air through or around coils.

21. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm, where provided.

22. Operate unit for run-in period.

23. Heating checks: Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency. Adjust pilot to stable flame.

a. Measure gas pressure on manifold.
b. Measure combustion-air temperature at inlet to combustion chamber.
c. Measure flue-gas temperature at furnace discharge.
e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.


25. Inspect outdoor-air dampers for proper stroke and interlock with exhaust-air dampers.

26. Verify operational sequence of controls.

27. Measure and record the following airflows. Plot fan volumes on fan curve.

a. Exhaust-air flow.
b. Outdoor-air flow.

28. After startup and performance testing, vacuum heat exchanger and cooling and outside coils, change filters, verify bearing lubrication, adjust belt tension and inspect operation of power vents.

B. Remove and replace components that do not properly operate and repeat startup procedures as specified above.

C. Prepare written report of the results of startup services.

3.06 ADJUSTING

A. Adjust initial temperature and humidity set points.

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

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

3.07 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.
SECTION 238250 – VARIABLE REFRIGERANT VOLUME SYSTEM WITH HEAT RECOVERY

PART 1 - GENERAL

1.01 RELATED DOCUMENT

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

1.02 SUMMARY

A. This Section Includes:

1. Indoor Fan Coil Units
2. Outdoor Heat Pump Unit
3. Branch Selector Unit
4. Outdoor Unit Multiple Connection Component
5. Controls and Operating System

1.03 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Operation and maintenance data.

1.01 DELIVERY, STORAGE AND HANDLING

A. Store and handle units according to the VRV unit manufacturer’s recommendations.

1.02 WARRANTY

A. Special warranty: Provide extended warranty for VRV system where manufacturer agrees to repair or replace the following components that fail within the specialized warranty period.

B. Warranty period commences on date of substantial completion (after factory start-up) for the following:

1. Outdoor Sections excluding compressors (1 year parts and labor).
2. Outdoor Compressors (10 years parts and labor).
3. Indoor Fan Coil Units (1 year parts and labor).
4. Refrigerant Piping Branch Selector and Controls (2 years parts, 1 year labor).

C. Refer to Refrigerant piping specification for warranty required for refrigerant piping connections.
1.03 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. All unit wiring shall be in accordance with the National Electric Code (NEC).

B. NRTL listing: The units shall be listed by United Laboratories (UL) or Electrical Testing Laboratories (ETL) and bear the UL or ETL label.

C. VRV Installer Qualifications: VRV systems shall be installed by qualified refrigeration technicians who have successfully completed VRV Equipment Training from the manufacturer of the equipment furnished for this project. Installer shall furnish verification that each qualified refrigeration technician installing VRV system components has successfully completed this training.

1.04 SYSTEM DESCRIPTION

A. General: Provide a complete split, heat-recovery type Variable Refrigerant Volume air conditioning system as indicated on the drawings and as specified. The system shall consist of multiple evaporators, branch selectors, headers, three pipe refrigeration distribution system using PID control, and outdoor units.

B. Outdoor Units: The outdoor units shall consist of a direct expansion (DX), air-cooled heat recovery, multi-zone air-conditioners with variable speed driven compressors using R-410A refrigerant. The outdoor unit shall be factory charged with R-410A. The outdoor units shall be interconnected to indoor units and shall range in capacity as listed on the equipment schedule.

C. Operation of the system shall permit either individual cooling or heating of each fan coil simultaneously or all of the fan coil units associated with one branch cool/heat selector. Each fan coil or group of fan coils shall be able to provide set temperature independently via a local remote controller, and DDC controls with BACNET.

D. Branch Selector: The selector shall have the capacity to control up to 60 MBH (cooling) downstream. The selector shall consist of five electronic expansion valves, refrigerant control piping and electronics to facilitate communications between components. This shall control the operational mode of the subordinate fan coils.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. LG
2. Trane
3. Daikin
5. Samsung.
6. Carrier.

B. Basis-of-Design: LG – Multi V

2.2 OUTDOOR UNIT

A. Performance: The outdoor units shall meet or exceed the heating and cooling design capacities listed in the equipment schedule at the design outdoor ambient temperature, performance shall be corrected for defrost, no exceptions.

B. General: The outdoor unit shall be designed specifically for use with VRV heat recovery system components.

1. The outdoor unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of scroll compressors, motors, fans, condenser coil, electronic expansion valves, solenoid valves, 4-way valve, distribution headers, capillaries, filters, shut-off valves, oil separators, service ports and refrigerant regulator.

2. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.

3. The outdoor unit can be wired and piped with outdoor unit access from the left, right, rear or bottom.

4. The sound pressure level shall not exceed values listed on the schedule.

5. The system will automatically restart operation after a power failure and will not cause any settings to be lost.

6. The unit shall incorporate an auto-charging feature and a refrigerant charge check function.

7. The following safety devices shall be included on the condensing unit; high pressure switch, control circuit fuses, crankcase heaters, fusible plug, high pressure switch, overload relay, inverter overload protector, thermal protectors for compressor and fan motors, over current protection for the inverter and anti-recycling timers.

8. To ensure the liquid refrigerant does not flash when supplying to the various fan coil units, the circuit shall be provided with a sub-cooling feature.

9. Oil recovery cycle shall be automatic occurring 2 hours after start of operation and then every 8 hours of operation.

10. The outdoor unit shall be capable of heating operation at 0°F dry bulb ambient temperature without additional low ambient controls.

11. The system shall continue to provide heat to the indoor units in heating operation while in the defrost mode.

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

D. Fan: The outdoor unit shall be vertical discharge configuration and have one or more propeller type, direct-drive 350 and 750 W fan motors that have multiple speed operation via a digitally commutating inverter designed for high external static pressure. Provide inherently protected fan motor with permanently lubricated bearings and fan guard to prevent contact with moving parts.
E. Condenser Coil:

1. The condenser coil shall be manufactured from seamless copper tubes expanded and mechanically bonded to aluminum fins to an e-Pass Design. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance. Cover fins with an anti-corrosion acrylic resin and hydrophilic film type E1. The pipe plates shall be treated with powdered polyester resin coating 2.0 to 3.0 microns in thickness, for corrosion prevention.

F. Compressor:

1. The scroll compressors shall be variable speed controlled. Samplings of evaporator and condenser temperatures shall be made so that the high/low pressures detected are read every 20 seconds and calculated. The capacity control range shall be 6% to 100%. Each compressor shall be hermetically sealed scroll type. Each compressor shall be equipped with a crankcase heater, high pressure safety switch, and internal thermal overload protector. Oil separators shall be standard with the equipment. The compressor shall be isolated to avoid the transmission of vibration.

2. In the event of compressor failure the remaining compressors shall continue to operate and provide heating or cooling as required at a proportionally reduced capacity. The microprocessor and associated controls shall be designed to specifically address this condition.

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<tr>
<th>Number of Compressors</th>
<th>Compressor Types</th>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>1 inverter + 1 fixed</td>
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<td>2</td>
<td>1 inverter + 1 fixed</td>
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</table>

G. Multiple condenser modules: In the case of multiple condenser modules, conjoined operation hours of the compressors shall be balanced by means of the Duty Cycling Function, ensuring sequential starting of each module at each start/stop cycle, completion of oil return, completion of defrost or every 8 hours.

2.3 INDOOR UNITS:

1. Wall-mounted units:

Casing
Units are designed to mount on a vertical surface and come complete with an installation mounting template guide and a separate hanging bracket. The unit case is manufactured with coated metal. Cold surfaces are covered with a coated polystyrene insulating material.

Finish
The unit case is manufactured using ABS polymeric resin and has a pearl white finish.
Fan Assembly and Control
The unit has a single, direct-drive, crossflow tangential Sirocco fan made of high strength ABS BSN-7530 polymeric resin. The fan motor is a Brushless Digitally-Controlled, (BLDC) design with permanently lubricated and sealed ball bearings. The fan/motor assembly is mounted on vibration attenuating rubber grommets. The fan speed is controlled using a microprocessor-based direct digital control algorithm that provides a minimum of three pre-programmed fan speeds in the Heating and Fan Only modes and four speeds in the Cooling mode. Fan settings are high, medium, and low. The fourth speed in the Cooling mode is a fan power cooling cycle that runs for 30 minutes at high fan speed. A chaos setting provides a simultaneous and random change in fan speed and flow direction at the supplied air flow. The fan speed algorithm provides a field selectable fixed-speed or auto-speed setting that changes the fan speed based on the difference between the controller setpoint and space temperature.

Air Filter
Return air is filtered with a removable, washable filter. The unit is also equipped with a plasma filter. Filter access is from the front of the unit without the use of tools.

Airflow Guide Vanes
7–15 MBh
The indoor unit is provided with a motorized oscillating guide vane that automatically changes the direction of up-and-down airflow. The indoor unit includes factory installed, manually adjustable guide vanes that control the side-to-side direction of supplied airflow.

Microprocessor Control
The unit is provided with an integrated microprocessor controller capable of performing functions necessary to operate the system without the use of a wall-mounted controller. A temperature thermistor is factory mounted in the return air stream. All unit operation parameters, excluding the operating schedule, are stored in non-volatile memory resident on the unit microprocessor. Operating schedules are stored in select models of the optional, wall-mounted, local or central controllers. The field-supplied communication cable between the indoor unit(s) and outdoor unit is to be a minimum of 18 AWG, 2 conductor, stranded, and shielded cable (RS485), terminated via screw terminals on the control boards. The microprocessor control provides the following functions: selfdiagnostics, auto restart following power restoration, test run, and will operate the indoor unit using one of five operation modes:
1. Auto Changeover (Heat Recovery only)
2. Heating
3. Cooling
4. Dry
5. Fan Only
For Heat Recovery systems the Auto Changeover setting automatically switches control of the indoor unit between Cooling and Heating modes based on space temperature conditions. For Heat Pump systems, heated or cooled air delivery is dependent upon outdoor unit operating mode. In Heating mode, the microprocessor control will activate indoor unit operation when the indoor room temperature falls below setpoint temperature. At which point, a signal is sent to the outdoor unit to begin the heating cycle. The indoor unit fan operation is delayed until coil pipe temperature reaches 76°F. Significant airflow is generated when pipe temperature reaches 80°F. A field-selectable option maintains fan operation for 30 minutes following cooling cycle operations. The unit is equipped with an infrared receiver designed to communicate with a hand-held remote controller. In lieu of wireless remote or factory return air thermistor, pluggable connection sockets on the microprocessor circuit board
accommodates various models of wall-mounted local controllers. The unit microprocessor is capable of accepting space temperature readings concurrently or individually from either:
  1. Wall-mounted wired controller(s)
  2. Factory-mounted return air thermistor
A single indoor unit has the capability of being controlled by up to two local wired controllers. The microprocessor controls space temperature using the value provided by the temperature sensor sensing a space temperature that is farthest away from the temperature set-point. The microprocessor control provides a cooling mode test cycle that operates the unit for 18 minutes without regard to the space temperature. If the system is provided with an optional wall-mounted local or central controller, displayed diagnostic codes are specific, alpha-numeric, and provide the service technician with a reason for the code displayed.

**Handling Condensate**
The unit is designed for gravity draining of condensate. Unit shall be provided with a factory insulated flexible drain hose. If condensate lift/pumps are needed for the application, they are to be field provided. The lift pump comes with a safety switch that shuts off the indoor unit if condensate rises too high in the drain pan.

**Controls Features**
- Auto changeover (Heat Recovery only)
- Auto operation
- Auto clean (coil dry)1
- Child lock
- Dual themistor control
- Group control
- Forced operation
- Hot start
- Self diagnostics
- Sleep mode
- Timer (on/off)
- Weekly schedule
- Soft dry (dehumidification)
- Auto direction/swing (up/down)
- Auto direction (left/right)2
- Manual direction (left/right)3
- Fan speed control
- Chaos swing (random louver swing)
- Chaos wind (random fan speed)

2. 4-Way Ceiling Cassette:

**Casing**
The case is designed to mount recessed in the ceiling and has a surface-mounted concentric grille on the bottom of the unit. The unit case is manufactured with coated metal. Cold surfaces are covered with a coated polystyrene insulating material. The case is provided with metal ears designed to support the unit weight on four corners. Ears have pre-punched holes designed to accept field-supplied all-thread rod hangers.

**Architectural Filter/Grille**
The ceiling cassette assembly is provided with an off-white ABS polymeric resin architectural grille equipped with a tapered trim edge and a hinged, spring clip (screwless) return air filter-grille door.

**TM, TN, TP Chassis**
The unit case allows access to hanger rods and the inspection of piping through corner access panels on the architectural grille. The optional auto-elevating grille kit is designed to provide motorized ascent/descent of the return air grille/pre-filter assembly a distance of up to 14-3/4 feet allowing easy access to remove and clean the filter.

The kit consists of two lifting mechanisms comprised of an electric motor driven winch with braided steel lifting cables. The winch kit is mounted behind the grille and is not visible during normal unit operation. The auto-elevating return air grille appearance and finish matches that of the architectural grille on similar indoor unit models equipped with the standard hinged filter grilles. The auto-elevating grille control algorithm accepts up, down, and stop control commands from either a wall-mounted or the lift remote controller. The algorithm does not permit the lowering of the grille while the indoor unit fan is operating. The pair of winch controllers work in unison to keep the return air grille level during lift and descent operations and will automatically stop the descent of the return air grille/filter if contact is made with any obstacle.

**Fan Assembly and Control**
The indoor unit has a single, direct-drive, turbo fan. The fan wheel is made of high strength ABS HT-700 polymeric resin. The fan motor is a Brushless Digitally-Controlled (BLDC) design with permanently lubricated and sealed ball bearings. The fan/motor assembly is mounted on vibration attenuating rubber grommets. The fan speed is controlled using a microprocessor-based, direct digital control algorithm that provides a minimum of four pre-programmed fan speeds in the Heating and Fan Only modes and five speeds in the Cooling mode. Fan settings are super high, high, medium, and low. Each setting can be field adjusted from the factory speed setting (RPM/ESP) to compensate for a limited amount of additional resistance to airflow caused by field connected ductwork or other airflow restricting devices. The fifth speed in the Cooling mode is a fan power cooling cycle that runs for 30 minutes at high fan speed. A chaos setting provides a random change in fan speed. The fan speed algorithm provides a field selectable, fixed-speed or autospeed setting that adjusts the fan speed based on the difference between the controller set-point and space temperature.

**Air Filter**
Return air is filtered with a removable, washable filter. The unit may also be equipped with a plasma filter.

**Airflow Guide Vanes**
The architectural grille has four-directional slot diffusers each equipped with independent oscillating motorized guide vanes designed to change the angle airflow is discharged. Discharge range of motion is 40° in an up/down direction. The unit has a guide vane control algorithm designed to sequentially change the predominant discharge airflow direction in a counterclockwise pattern. The control algorithm also provides the capability of locking each guide vane independently in a field adjusted fixed position. Guide vanes provide airflow in all directions. The ends of each vane are tapered to provide airflow to the space in the direction of the four corners of the architectural grille.

**Microprocessor Controls**
The unit is provided with an integrated microprocessor controller capable of performing functions necessary to operate the system without the use of a wall-mounted controller. A temperature thermistor is factory-mounted in the return air stream. All unit operation parameters, excluding the unit operating schedule, are stored in non-volatile memory resident on the unit microprocessor. Operating schedules are stored in select models of the optional, wall-mounted, local, or central controller. The field-supplied communication cable between the indoor unit(s) and outdoor unit is to be a minimum of 18 AWG, 2 conductor, stranded, and shielded cable (RS485), terminated via screw terminals on the control boards. The microprocessor control algorithms provide the following functions: self-diagnostics, auto restart following power restoration, test run, and will operate the indoor unit using one of five operating modes:

1. Auto Changeover (Heat Recovery only)
2. Heating
3. Cooling
4. Dry
5. Fan Only

For Heat Recovery systems the Auto Changeover setting automatically switches control of the indoor unit between cooling and heating modes based on space temperature conditions. For Heat Pump systems, heated or cooled air delivery is dependent upon outdoor unit operating mode. In Heating mode, the microprocessor control will activate indoor unit operation when the indoor room temperature falls below setpoint temperature. At which point, a signal is sent to the outdoor unit to begin the heating cycle. The indoor unit fan operation is delayed until coil pipe temperature reaches 76ºF. Significant airflow is generated when pipe temperature reaches 80°F. The unit is equipped with an infrared receiver designed to communicate with a hand-held remote controller. In lieu of wireless remote or factory return air thermistor, pluggable connection sockets on the microprocessor circuit board accommodate various models of wall-mounted local controllers and/or a wall-mounted remote temperature sensor. The unit microprocessor is capable of accepting space temperature readings concurrently or individually from either:
1. Wall-mounted wired controller(s)
2. Factory mounted return air thermistor or the optional wall-mounted wired remote temperature sensor. A single indoor unit has the capability of being controlled by up to two local wired controllers. The microprocessor controls space temperature using the value provided by the temperature sensor sensing a space temperature that is farthest away from the temperature set-point. The microprocessor control provides a cooling mode test cycle that operates the unit for 18 minutes without regard to the space temperature. If the system is provided with an optional wall-mounted, local, or central controller, displayed diagnostic codes are specific, alpha numeric, and provide the service technician with the reason for the code displayed.

**Condensate Lift/Pump**

The indoor unit is provided with a factory installed and wired condensate lift/pump capable of providing a minimum 27.5 inch lift from the bottom surface of the unit. The lift pump comes with a safety switch that shuts off the indoor unit if condensate rises too high in the drain pan.

**Controls Features**

- Auto changeover (Heat Recovery only)
- Auto operation
- Auto restart
- Child lock
- Dual thermistor control
- Forced operation
- Group control
• High ceiling
• Hot start
• Self diagnostics
• Sleep mode
• Timer (on/off)
• Weekly schedule
• Soft dry (dehumidification)
• Auto direction/swing (up/down)
• Fan speed control
• Chaos wind (random fan speed)
• Swirl wind (alternating vanes)
• Jet cool (fast cooling)

3. Vertical/Horizontal Air Handling Units:

Casing
The unit is designed to operate in the vertical up flow configuration or horizontal left end supply air. Return air opening is on the bottom in the vertical position or right end in the horizontal position. Return air plenum subbase is to be field-provided. The supply air connection is male flange. The unit case is made of 22-gauge coated metal and the external surfaces are finished with a high gloss baked enamel finish. Finish color is “morning fog” (medium beige). Cold surfaces are galvanized steel. The cold surfaces of the case are internally insulated with ½ inch foil faced, polystyrene fiber insulation. The inside surface of the fan assembly door access panel is treated with ½ inch polystyrene fiber insulation, encapsulated on both sides, and sealed along the edges with a reinforced foil-faced covering to prevent deterioration caused by panel removal. All access panels are provided with gasket seals to minimize air leakage. The unit case is designed to accept an internal, optional, electric strip heater. The unit bears the ETL label. Unit breaker, fuses, and/or disconnect are provided by others.

Fan Assembly and Control
The indoor unit has an integral fan assembly consisting of a galvanized steel housing and a forward-curved fan wheel. The direct drive fan/motor assembly is mounted on rubber grommets isolating the rotating assembly from the fan housing. The fan motor is a Brushless Digitally-Controlled design (BLDC), having permanently lubricated and sealed ball bearings. The fan/motor assembly is mounted on vibration attenuating rubber grommets. Fan speed is controlled using a microprocessor-based direct digital control algorithm that provides a minimum of three pre-programmed fan speeds. Fan speeds are high, medium, and low. Each setting can be field adjusted from the factory setting (RPM/ESP). The setting provides delivery of the high speed air volume against an external static pressure of up to 0.8 in-wg and up to 85% of the high speed air volume against an external static pressure of 1.0 in-wg.

Air Filter
The unit comes with a filter rack capable of accepting a field provided 16” x 20” x 1” (NJ chassis) or 24” x 20” x 1” (NK chassis) filter cartridge. The filter rack is equipped with guides that keep the filter centered in the rack. Filter service access is from the front of the unit without removing the coil or fan area access panels. Filter access door is provided with thumb screws that are removal.

Microprocessor Controls
The unit is equipped with an integrated microprocessor-based controller capable of performing functions necessary to operate the system without the use of a wall-mounted controller. A temperature thermistor is mounted in the return air stream. All unit operating parameters, excluding the operation schedule, are stored in nonvolatile memory resident on the unit microprocessor. Operating schedules are stored in select models of the optional wall-mounted local or central controller. The field-supplied communication cable between the indoor unit(s) and outdoor unit is to be a minimum of 18 AWG, 2 conductor, stranded, and shielded (RS485). The microprocessor control provides the following functions: self-diagnostics, auto restart following power restoration, and will operate the indoor unit using one of the following five operation modes:

1. Auto Changeover (Heat Recovery only)
2. Heating
3. Cooling
4. Dry
5. Fan Only

For Heat Recovery systems the Auto Changeover setting automatically switches control of the indoor unit between cooling and heating modes based on space temperature conditions. For Heat Pump systems, heated or cooled air delivery is dependent upon outdoor unit operating mode. In Heating mode, the microprocessor control does not begin fan operation until coil pipe temperature reaches 76°F. Significant airflow is generated when pipe temperature reaches 80°F. A field selectable option maintains fan operation for 30 minutes following cooling cycle operations. The controller is capable of monitoring space temperature using any of the three sensors individually or any two of the three concurrently.

1. Wall-mounted wire controller
2. Factory-mounted return air thermistor or the optional wall mounted wired remote temperature sensor.

The microprocessor controls space temperature using the value provided by the temperature sensor sensing a space temperature that is farthest away from the temperature setpoint. A single indoor unit has the capability of being controlled by up to two local wired controllers. The microprocessor control provides a Cooling mode test cycle that operates the unit for 18 minutes without regard to the space temperature. If the system is provided with an optional local or central controller, displayed diagnostic codes are specific and provide the service technician with the reason for the code displayed.

Handling Condensate
The drain pan is designed to work with a gravity building drain system. If condensate lifts/pumps are needed, they are to be field provided. A secondary drain port plug is provided allowing the pan to be drained for service.

Controls Features
- Auto changeover (Heat Recovery only)
- Auto operation
- Auto restart
- Child lock
- Dual thermistor control
- E.S.P control
- Group control
- Forced operation
• Hot start
• Self diagnostics
• Sleep mode
• Timer (on/off)
• Weekly schedule
• Soft dry (dehumidification)
• Fan speed control

4. Ceiling Suspended Units:

**Casing**
The case is designed to mount against the ceiling surface in a horizontal supply air configuration. The return air is from the bottom and supply air is from a single slot on the front of the unit. The unit is manufactured using a coated metal frame covered with an off-white ABS architectural polymeric resin exterior case. Cold surfaces are covered with a coated polystyrene insulating material.

**Fan Assembly and Control**
The unit has a single, direct driven, Sirocco fan made of high strength ABS HR-2407 polymeric resin. The fan motor is a Brushless Digitally-Controlled (BLDC) design with permanently lubricated and sealed ball bearings. The fan/motor assembly is mounted on vibration attenuating rubber grommets. The fan speed is controlled using a microprocessor-based direct digital control algorithm that provides a minimum of three pre-programmed fan speeds in the Heating and Fan Only modes and four speeds in the Cooling mode. Fan settings are high, medium, and low. The fourth speed in the Cooling mode is a super high setting that runs for 30 minutes at high fan speed. A chaos wind setting provides random change in fan speed. The fan speed algorithm provides a field selectable fixed or auto-speed setting that changes fan speed based on the difference between controller set-point and space temperature.

**Air Filter**
Return air is filtered with a removable, washable filter. Access to the filter media is through a hinged, spring clip (screwless) return air grille located on the bottom of the unit.

**Airflow Guide Vanes**
The supply air opening has a single directional slot diffuser with an oscillating motorized guide vane designed to change the angle airflow is supplied. The supply air range of motion is 40° in an up/ down direction with the capability of locking the valve in a fixed position. Manually adjustable guide vanes are provided to set the airflow supply air direction from side-to-side.

**Microprocessor Controls**
The unit is provided with an integrated microprocessor-based controller. The controller is capable of performing functions necessary to operate the system without the use of a wall-mounted controller. A temperature thermistor is factory-mounted in the return air stream. All unit operation parameters, excluding the operating schedule, are stored in non-volatile memory resident on the unit microprocessor. Operating schedules are stored in select models of the optional, wall-mounted, local or central controller. The field-supplied communication cable between the indoor unit(s) and outdoor unit is to be a minimum of 18 AWG, 2 conductor, stranded, and shielded cable (RS485), terminated via screw terminals on the control boards. The microprocessor control provides the following functions: self-diagnostics, auto restart following power restoration, test run, and will operate the indoor unit using one of five operating modes:
1. Auto Changeover (Heat Recovery only)
2. Heating  
3. Cooling  
4. Dry  
5. Fan Only

For Heat Recovery systems the Auto Changeover setting automatically switches between cooling and heating modes based on room temperature conditions. For Heat Pump systems, heated or cooled air delivery is dependent upon outdoor unit operating mode. In Heating mode, the microprocessor control will activate the indoor unit when indoor room temperature falls below setpoint temperature and signals the outdoor unit to begin the heating cycle. The indoor unit fan operation is delayed until coil pipe temperature reaches 76°F. Significant airflow is generated when pipe temperature reaches 80°F. The unit is equipped with an infrared receiver designed to communicate with a hand-held remote controller. Pluggable connection sockets on the microprocessor circuit board accommodate various models of wall-mounted local controllers and/or a wall-mounted remote temperature sensor. The unit microprocessor is capable of accepting space temperature readings concurrently or individually from either:
1. Wall-mounted wired controller(s)  
2. Factory mounted return air thermistor or the optional wall-mounted wired remote temperature sensor

A single indoor unit has the capability of being controlled by up to two local wired controllers. The microprocessor controls space temperature using the value provided by the temperature sensor sensing a space temperature that is farthest away from the temperature set-point. The microprocessor control provides a Cooling mode test cycle that operates the unit in full Cooling mode for 18 minutes without regard to space temperature. If the system is provided with an optional wall-mounted or central controller, displayed diagnostic codes are specific, alpha numeric, and provide the service technician with a reason for the code displayed.

Handling Condensate

The unit is designed for gravity draining of condensate. Provide a factory insulated flexible drain hose. If condensate lift/pumps are needed for the application, they are to be field-provided.

Controls Features
- Auto changeover (Heat Recovery only)  
- Auto operation  
- Auto restart  
- Child lock  
- Dual themistor control  
- E.S.P control  
- Group control  
- Forced operation  
- Hot start  
- Self diagnostics  
- Sleep mode  
- Timer (on/off)  
- Weekly schedule  
- Soft dry (dehumidification)  
- Fan speed control
**High Static Casing**

The case is designed to mount concealed above a finished ceiling. Fan supply air is front horizontal with a dedicated rear horizontal return. The unit is manufactured with coated metal. Cold surfaces are covered with a coated polystyrene insulating material. The cold surface areas of the case are covered externally with sheet insulation made of Ethylene Propylene Diene Monomer (M-Class) (EPDM) conforming to ASTM Standard D-1418. The case is provided with hanger brackets designed to support the unit weight on four corners. Hanger brackets have pre-punched holes designed to accept field supplied, allthread rod hangers.

**Fan Assembly and Control**

The unit has Sirocco fans made of high strength ABS GP-2200 polymeric resin. Fans are directly driven and mounted on a common shaft. The fan motor is a Brushless Digitally-Controlled (BLDC) design with permanently lubricated and sealed ball bearings. The fan/motor assembly is mounted on vibration attenuating rubber grommets. The fan speed is controlled using a microprocessor based, direct digital control algorithm that provides a minimum of three pre-programmed fan speeds. Fan settings are high, medium, and low. Each setting can be field adjusted from the factory setting (RPM/ESP) to compensate for a limited amount of additional resistance to airflow caused by field connected ductwork or other airflow restricting devices.

**Air Filter**

Return air is filtered with a removable, washable filter. MERV 13 filter modules with plenums available.

**Microprocessor Controls**

The unit is provided with an integrated microprocessor-based controller. The controller is capable of performing functions necessary to operate the system without the use of a wall-mounted controller. A temperature thermistor is factory-mounted in the return air stream. All unit operation parameters, excluding the unit operating schedule, are stored in non-volatile memory resident on the unit microprocessor. Operating schedules are stored in select models of the optional, wall-mounted, local, or central controller. The field supplied communication cable between the indoor unit(s) and outdoor unit is to be a minimum of 18 AWG, 2-conductor, stranded, and shielded cable (RS485), terminated via screw terminals on the control boards. The microprocessor control provides the following functions: self-diagnostics, auto restart following power restoration, test run, and will operate the indoor unit using one of five operating modes:

1. Auto Changeover (Heat Recovery only)
2. Heating
3. Cooling
4. Dry
5. Fan Only

For Heat Recovery systems the Auto Changeover setting automatically switches control of the indoor unit between cooling and heating modes based on space temperature conditions. For Heat Pump systems, heated or cooled air delivery is dependent upon outdoor unit operating mode. In Heating mode, the microprocessor control will activate the indoor unit when indoor room temperature falls below setpoint temperature and signals the outdoor unit to begin heating cycle. The indoor unit fan operation is delayed until coil pipe temperature reaches 76ºF. Significant airflow is generated when pipe temperature reaches 80ºF. In lieu of factory return air thermistor, pluggable connection sockets on the microprocessor circuit board accommodate various models of wall-mounted local controllers and/or a wall-mounted remote temperature sensor.
The unit microprocessor is capable of accepting space temperature readings concurrently or individually from either:
1. Wall-mounted wired controller(s)
2. Factory mounted return air thermistor or the optional wall-mounted wired remote temperature sensor.

A single indoor unit has the capability of being controlled by up to two local wired controllers. The microprocessor controls space temperature using the value provided by the temperature sensor sensing a space temperature that is farthest away from the temperature set-point. If the system is provided with an optional wall-mounted local or central controller, displayed diagnostic codes are specific, alpha numeric, and provide the service technician with a reason for the code displayed.

**Condensate Lift/Pump**
The indoor unit is provided with a factory installed and wired condensate lift/pump capable of providing a minimum 27.5 inch lift from the bottom exterior surface of the unit casing. The unit drain pan is provided with a secondary drain port/plug allowing the pan to be drained for service. The lift pump comes with a safety switch that will shut off indoor unit if condensate rises too high in the drain pan.

**Controls Features**
- Auto changeover (Heat Recovery only)
- Auto operation
- Auto restart
- Child lock
- Dual themistor control
- Group control
- E.S.P. control
- Hot start
- Self diagnostics
- Sleep mode
- Timer (on/off)
- Weekly schedule
- Soft dry (dehumidification)
- Fan speed control
- Ventilation (outside air)

2.4 CONTROLS

A. Electrical:
   1. The control voltage between the indoor and outdoor unit shall be furnished and installed by BAS contractor per manufacturer recommendations. Refer to Division 23 Controls Sections.

B. Control:
   1. Provide control wiring and components per manufacturers recommendations.
   2. Units shall have controls provided by VRV Equipment manufacturer to perform input functions necessary to operate the system.
3. The unit shall be compatible with interfacing connection to BACnet network or interfacing connection to BMS system. Consult with manufacturer prior to applying controls.

4. All indoor units shall maintain the settings for: temperature setpoint, start/stop status, operating mode, fan speed, air flow direction in non-volatile memory each time they are changed. These settings shall not be lost upon a power loss event.

5. All indoor unit settings shall be adjusted through the BMS system using the BACnet interface.

6. The entire system shall automatically re-start upon a power loss event. All indoor units shall be auto addressing. Manual addressing of the indoor unit shall not be acceptable.

7. Control Wiring Requirements:
   a. All control wiring shall be done per the control wiring drawings provided on the drawings.
   b. All control wiring shall be 18 AWG, 2 conductor, stranded non-shielded cable.
   c. In all zones a wall mounted space temperature sensor shall be mounted 48” above the finished floor and next to the Siemen’s unit controller.
   d. This remote sensor shall wire to the indoor unit that serves this space.
   e. The system shall be supplied with an LCD touch screen Centralized Controller. This controller will allow for onsite setpoint changes if the BMS ever fails. Each centralized remote controller shall be able to control all VRF units with 10% spare capacity.
   f. The I touch controller, BAS system shall provide e-mail and mobile phone malfunction reporting.
   g. The centralized remote controller shall have the following features:
      1) Change Operation: Start/stop, operation mode, temperature setting, fan speed, airflow direction.
      2) Monitoring: Status, malfunction identification, malfunction code, filter sigh, operation mode, temperature setting, fan speed, airflow direction.

8. BACnet Interface:
   a. The system shall be supplied with a BACnet IP interface. This interface shall allow the BMS to monitor and change certain values of the system.
   b. The BACnet interface shall be a hardware based device and shall mount in the BMS control panel.
   c. The BACnet interface shall be capable of interfacing to all VRF units with 10% spare capacity.
   d. The interface shall provide as a minimum the following points:
      1) Monitoring points: indoor unit Start/stop status, all indoor unit alarms, all outdoor unit alarms, indoor unit malfunction codes, outdoor unit malfunction codes, indoor unit mode of operation, return air or space temperature, indoor unit filter inspection required, outdoor unit compressor status, indoor unit fan status.
      2) Writable points: indoor unit start/stop operation, indoor unit mode of operation, room temperature setting, indoor unit filter inspection reset, remote controller enable/disable, indoor unit fan speed setting, indoor unit air direction setting, forced system stop, forced thermostat disable.

9. Capacity and performance criteria is listed on the drawings.
2.5 Sequence, Add’l Controls, Etc.

a. **Compressor control**: Fuzzy control logic shall establish and maintain target evaporating temperature (Te) to be constant on cooling mode and condensing temperature (Tc) constant on heating mode by Fuzzy control logic to ensure the stable system performance. Other compressor control capabilities shall be available via special function controls as noted elsewhere in this specification.

b. **Flexible Capacity Control**: (Demand limiting) The system shall allow for up to 5 steps of flexible capacity control using an I/O controller or up to 8 steps of flexible capacity control using a BMS control by others. This FCC shall be employed when electrical demand limiting, night time noise reduction or any other flexible capacity control requirement based on any other requirement using contact closures or 0-10vdc to engage.

c. **Initial Test Run (ITR) (Heating) / Fault Detection Diagnosis (FDD) Code**: This control mode shall monitor and display positive or negative results of system initial startup and commissioning. It shall monitor the following, but not be limited to, refrigerant quantity charge, auto-charge, stable operations, connection ratios, indoor unit status, error status, and number of indoor units connected. This control mode shall not replace the system error monitoring control system.

d. **Integration**: Each system shall be able to integrate 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 more detailed description of integration and points to be controlled and monitored.

e. **Smart Load control**: Smart load control operation shall be available at any time during or after system Commissioning. Smart Load Control shall be initiated by outdoor air temperature and or relativity humidity as sensed at the outdoor and or the indoor unit controller and shall automatically adjust the evaporator target (condenser target for heat) pressure/temperature that the system will operate to in order to precisely load match the system to the building load as the outdoor and/or the indoor ambient temperature and or humidity increases or decreases. By varying the compression ratios of the system and increasing the operating efficiencies, comfort and reducing energy consumption by adjusting the compressor lifts, the system shall poll all indoor units’ data, dry bulb temperature and or relative humidity, in real time and apply its algorithm to determine the optimal evaporating temperature to satisfy varying loads. Systems that rely on the worst performing zone to reset the system conditions shall not be sufficient and shall not be allowed. Use of an zone controller CRC1+ required for indoor zone humidity sensing capabilities for Smart Load Control.

f. **Wi-Fi communication**: The outdoor unit shall be Wi-Fi enabled and capable. 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.
g. **Indoor unit connectivity:** 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.

h. **Power and communication interruption:** 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. Systems that alarm and/or shut down because of a lack of power to any number of indoor units shall not be acceptable or allowed.

### Connection ratios

The maximum allowable system combination ratio shall be 130%. Systems designed with combination ratio above 130% are not acceptable. The total nominal capacity of all indoor units shall be no less than 50% and no more than 130% of outdoor unit’s nominal capacity.

i. **Intelligent Heat Mode:** Intelligent heating shall be initiated via a field setting at the outdoor unit. Intelligent heating shall extend the heating operation by calculating the dew point of the outdoor coil surface using the outdoor units’ temperature and humidity sensors to maintain the coil surface temperature above the ambient dew point minimizing frost build-up and delaying a defrost operation while maintaining indoor space temperature. This feature shall be capable of eliminating several defrost actions per day based on outdoor air temperature and humidity conditions.

j. **Comfort cooling mode:** 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 zones on a system to adjust automatically their evaporator temperatures, independent of other zones, based on the impending total loads of that zone determined by using the zone controller temperature sensor.

k. The outdoor unit refrigerant circuit shall employ for safety a threaded fusible plug.

l. 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.

m. 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)
   (viii) Vapor injection valve(s)
   (ix) Variable path heat exchanger control valve(s)
   (x) Oil balancing control
   (xi) Oil Level sensor(s)
   (xii) Electronic expansion valve(s)
   (xiii) Sub-cooler(s)
   (xiv) Vapor Injection Valve(s)
   (xv) High and low side Schrader valve service ports with caps
   (xvi) Service valves
   (xvii) Factory supplied refrigerant charge, pounds.
### Variable Refrigerant Flow Control

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<th>Outdoor Unit Size (Tons)</th>
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<th>Frame 2 Charge</th>
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#### 2.6 Refrigerant Flow Control

a) 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 efficiency and minimize or maximize the circulating volume of the operating fluids of the system.

b) 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.

c) System shall have an active refrigerant control and multi section accumulator-receiver that dynamically changes the volume of refrigerant circulating in the system.
based on operating mode and operating conditions to ensure maximum system performance and efficiency.

d) 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 15Hz to 150 Hz.

e) 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.

f) System shall have following frame configurations vs. capacity.

2.6.1 6 to 20 ton units shall be a single frame only.
2.6.2 22 to 34 ton units shall be dual frame only.
2.6.3 36 to 42 ton heat recovery units shall be triple frame only

*VRF Systems with Onboard Alternate Operating Mode Selection capability.

a) All VRF systems which provide field selectable Alternate Operating Modes, for example, High Heat or High Ambient Cooling, published data tables must be available to the public for all modes offered. Table format must comply with section 2.03.

g) 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.

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

i) 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 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.

2.7 Field Supplied Refrigerant Piping Design Parameters

a) 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.

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

c) 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.
d) 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.

e) 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.

2.8 Defrost Operations

a) The outdoor unit(s) shall be capable of Intelligent defrost operation to melt accumulated frost, snow and ice that may have accumulated on 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.

b) Defrost Mode Selection: The outdoor unit shall be provided with a minimum of three field selectable defrost operation modes; Normal, Fast, or Forced.

1. 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.

2. 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; 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.

3. 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.

c) 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.

1. 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.

2. 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 addi-
tional three minutes to remove any frozen water that may have dripped onto the lower coil during the top coil defrost operation.

3. 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.

4. 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.

d) Indoor Unit Fan Operation During Defrost

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

2. 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.

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

2.9 Oil Management

a) 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.

b) 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.

c) 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.

d) 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.

e) 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.

f) Timed oil return operations or systems that do not directly monitor compressor oil level shall not be permitted.

e) Indoor Unit Fan Operation During Oil Return Cycle

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

2. 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.

3. During oil return cycle indoor unit fans will cycle off and remain off during oil return cycle while operating in all modes except 2.11.e.1 and 2.

2.12 Heat Recovery Boxes
a) Heat recovery unit shall be designed and manufactured by the same manufacturer of VRF indoor unit(s) and outdoor unit(s).

b) Heat recovery unit casing shall be constructed with galvanized steel.

c) Heat recovery unit shall require 208-230V/1-phase/60Hz power supply.

d) 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.

e) Heat recovery unit shall be engineered to work with a three pipe VRF system comprising of
   (i) High Pressure Vapor Pipe
   (ii) Low Pressure Vapor Pipe
   (iii) Liquid Pipe

f) Heat recovery units’ main 3 pipe connections shall be capable of series or parallel pipe configuration.

 g) The quantity of heat recovery units that can be piped in series shall be limited to 16.

h) 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 192MBh.

i) Heat recovery unit shall have 2, 3 or 4 ports, each port supporting one or more indoor units with a maximum connected capacity of 54 MBH.

j) 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.

k) Each port shall be capable of connecting from 1 to 8 indoor units.

l) Connection to Indoor units totaling greater than 54MBh nominal capacity shall be twinned to two adjacent ports of the heat recovery unit using a reverse Y-branch connector supplied by manufacture.

m) Heat recovery unit shall be internally piped, wired, assembled and run tested at the factory.

n) Heat recovery unit shall be designed for installation in a conditioned environment per specifications.

o) Heat recovery unit shall employ a liquid bypass valve.

p) Heat recovery unit shall have (2) two-position refrigerant valves per port.

q) 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 changeover pressure related sounds.

r) Heat recovery unit shall employ an electronic expansion valve to ensure proper subcooling of the refrigerant.

s) Heat recovery unit shall contain one double spiral sub-cooling heat exchanger per port.

t) Heat recovery unit shall not require a condensate drain or connection.

u) Heat recovery unit shall be internally factory insulated.

v) 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.

w) The heat recovery unit shall not exceed a net weight of 50 lbs.

x) Heat recovery units, for line length and pressure drop calculations, shall not exceed a maximum equivalent pipe length value of 8.2 feet.

y) 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.

Piping Capabilities
a) The elevation difference between indoor units on heat pump systems shall be 131 feet.
b) The elevation differences for heat recovery systems shall be:
   (i) Heat recovery unit to connected indoor unit shall be 49 feet
   (ii) heat recovery unit to heat recovery unit shall be 49 feet
   (iii) Indoor unit to indoor unit connected to same heat recovery unit shall be 49 feet
   (iv) Indoor unit to indoor unit connected to separate parallel piped heat recovery units shall be 131 feet.
c) The acceptable elevation difference between two series connected heat recovery units shall be 16 feet.

Controls
a) Heat recovery unit(s) shall have factory installed unit mounted control boards and integral microprocessor to communicate with other devices in the VRF system.
b) Heat recovery unit shall communicate with the indoor units via a 2-conductor stranded communications cable terminated using a daisy chain configuration.
c) 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.

PART 3 - EXECUTION

3.01 EXAMINATION

A. The outdoor units shall provide at a minimum the listed cooling and heating capacities on the equipment schedule at the listed outdoor temperatures. Equipment that does not meet the listed capacities will not be accepted.

3.02 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section “Roof Accessories.”

3.03 OPERATING RANGE

A. The operating range in cooling shall be 23°F DB - 110°F DB.

B. The operating range in heating will be 0°F DB – 64°F DB / -4°F WB – 60°F WB. Simultaneous cooling/heating operating range will be 22°F WB - 60°F WB.
3.04 REFRIGERANT PIPING

A. The system shall be capable of refrigerant piping up to 540 actual feet or 620 equivalent feet from the outdoor unit to the furthest indoor unit, a total combined liquid line length of 3,280 feet of piping between the condensing and fan coil units with 295 feet maximum vertical difference, without any oil traps.

3.05 INSTALLATION

A. VRV System Installer Qualifications: Refer to QUALITY ASSURANCE article in Part 1 for requirements.

B. Suspended Units: Suspend from structure using threaded rods, spring hangers, and building attachments. Secure rods to unit hanger attachments. Adjust hangers so unit is level and plumb.

C. Base-Mounted Units: Secure units to substrate. Provide optional bottom closure base if required by installation conditions.

D. Controls: Install thermostats and humidistats at mounting height of 48 inches above floor.

E. Wiring Method: Install control wiring in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal control wiring except in unfinished spaces.

F. Install ground-mounted, compressor-condenser components on poured-in-place concrete pad.

G. Install roof-mounted, compressor-condenser components on equipment supports specified. Anchor units to supports with removable, cadmium-plated fasteners.

H. Refer to Refrigerant piping specification for testing requirements.

3.06 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Perform electrical test and visual and mechanical inspection.
   2. Leak Test: After installation, charge systems with refrigerant and oil and test for leaks. Refer to refrigerant piping specification for testing requirements. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
   3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation, product capability, and compliance with requirements.
   4. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
   5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Verify that vibration isolation and flexible connections properly dampen vibration transmission to structure.
3.07 STARTUP SERVICE

A. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Inspect for physical damage to unit casings.
2. Verify that access doors move freely and are weathertight.
3. Clean units and inspect for construction debris.
4. Verify that all bolts and screws are tight.
5. Adjust vibration isolation and flexible connections.
6. Verify that controls are connected and operational.

B. Adjust fan belts to proper alignment and tension.

C. Start unit according to manufacturer's written instructions and complete manufacturer's operational checklist.

D. Measure and record airflows.

E. Verify proper operation of capacity control device.

F. After startup and performance test, lubricate bearings and adjust belt tension (belt-driven units.)

3.08 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set controls, burner, and other adjustments for optimum heating performance and efficiency. Adjust heat-distribution features, including shutters, dampers, and relays, to provide optimum heating performance and system efficiency.

3.09 CLEANING

A. After completing installation, clean furnaces internally according to manufacturer's written instructions.

B. Install new filters in each furnace within 14 days after Substantial Completion.

3.10 DEMONSTRATION AND TRAINING

A. Owner Training: Train Owner’s maintenance personnel to adjust, operate, and maintain system(s).

B. Training Sessions: The VRV System Installer shall develop an overall training plan and present training session(s) with the Owner’s Staff. Coordinate and schedule training sessions with the General Contractor.

C. Video Recording: Provide video recording of training session(s) for inclusion with submission of Operation and Maintenance Manuals in accordance with requirements of Division 1 Sections.

D. The VRV System Installer shall develop an overall training plan and session and shall coordinate and schedule with CxA and General Contractor. The CxA shall identify whether a
Factory Representative or VRV System Installer will perform the training. The CxA shall determine that the training was satisfactorily completed. The CxA shall recommend approval of the training to the General Contractor. Video recording of the training session(s) shall be provided by the VRV System Installer and shall be submitted as part of the Operation and Maintenance submission in accordance with requirements of Division 1 Sections.

END OF SECTION 238250
ADDENDUM 2
MARION COUNTY PUBLIC LIBRARY

REFERENCE DRAWING: E201
DATE: 11/07/2017
PROJECT NO: 2017-7545
SKETCH NO: ESK11072017-01

Partial Power Floor Plan
1/8" = 1'-0"
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**GENERAL NOTES:**
- Design conditions based on:
  - Winter: Outside 0°F, Inside 72°F and 50% RH +/- 10%
  - Summer: Outside 93°F DB/76°F WB, Inside 75°F DB/50% RH +/- 10%
- Single point electrical connection
- Cooling coil of aluminum fins and copper tubes.
- Weatherproof baked enamel cabinet.
- UL listed electrical in NEMA enclosure and factory wired units rated in accordance with ARI 210, 340.
- Units to have high/low pressure switches, anti-short cycling device and overload protection.
- Refrigerant to be factory tested and charged.
- Duct, plenum, plenum and A.G.A. approved and rated.
- 100% safety shut-off and fan limit control.
- 25-year heat exchanger/burner warranty.

**REMARKS:**
- Units shall be furnished with:
  1. Vibration isolation roof curb.
  2. Interface/Integrate with new BAS/CONTROL PANEL.
  3. Integral door interlock disconnect, 24 volt transformer and motor starters.
  4. Control accessories:
     - Low temperature cut-off switch.
     - Defrost control.
     - Dirty filter switch.
     - Modulating wheel with rotation sensor.
     - CO₂ sensor in exhaust air stream.
     - Stoplog econo-winder.
- Weatherhood.
- Exhaust supply fans shall have VFDs.
- Units shall have 10:1 turndown modulating gas heat.
- Modulating hot gas reheat.
- Units shall be provided with compressor sound blanket.
- Units shall be provided with variable frequency drive.
- Unit shall be provided with variable frequency drive.

**PROJECT NO:** 2017-7545

**REFERENCE DRAWING:** M002

**DATE:** 11/07/2017

**ADDENDUM 2**

**MARION COUNTY PUBLIC LIBRARY**

**SKETCH NO.:** MSK11072017-1
MECHANICAL ROOM ADDENDUM

1/8" = 1'-0"