

SECTION 23 81 29
VARIABLE REFRIGERANT FLOW HVAC SYSTEM

PART 1 - GENERAL

1.01 SECTION INCLUDES

- A. Variable refrigerant flow HVAC system includes:
 - 1. Outdoor/Condensing unit(s):
 - a. Size Range: 8 to 14 Tons Nominal
 - b. YANMAR VRF Model Numbers:
 - NNCP096J-SB**
 - NNCP120J-SB**
 - NNCP144J-SB**
 - NNCP168J-SB**
 - 2. Indoor Units
 - a. *Input information as required

1.02 RELATED REQUIREMENTS

- A. *Input information as required

1.03 REFERENCES

- A. *Input information as required

1.04 SUBMITTALS

- A. *Input information as required

1.05 QUALITY ASSURANCE

- A. MANUFACTURER QUALIFICATIONS:
 - 1. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL) in accordance with CSA C22.2/UL 1995 – Heating and Cooling Equipment, ANSI Z21.40.2 - Gas-Fired, Work Activated Air-Conditioning and Head Pump Appliances (Internal Combustion), and bear the Listed Mark.
 - 2. All wiring shall be in accordance with the National Electrical Code (NEC).
 - 3. The system will be produced in an ISO 9001 and ISO 14001 facility, which are standards set by the International Standard Organization (ISO). The system shall be factory tested for safety and function.
 - 4. The condensing unit will be factory charged with R-410A.

1.06 DELIVERY, STORAGE AND HANDLING

- A. Unit shall be stored, handled and delivered according to the manufacturer's recommendations.

1.07 WARRANTY

- A. STANDARD LIMITED WARRANTY
 - 1. Complete warranty details are available through your authorized YANMAR VRF representative.
 - 2. YANMAR America Corporation warrants original owner of the non-residential building, multifamily residence or residence in which the YANMAR products are installed that under normal use and maintenance for comfort cooling and conditioning applications such products (the "Products") will be free from defects in material and workmanship. This warranty is limited in the durations listed below, starting from the "installation date" which is the date that the unit is originally commissioned.

- a. Condensing Unit
 - Parts: 5 Years / 20,000 Hours
 - Labor: 1 Year / 4,000 Hours
 - Compressor: 7 Years/ 28,000 Hours
- b. Fan Coil Unit and Indoor Accessories
 - Parts: 1 Year

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. DESIGN BASIS:

1. The HVAC equipment basis of design is YANMAR America Energy Systems. All bidders shall furnish the minimum system standards as defined by the base bid model numbers, model families or as otherwise specified herein (see Appendix A HVAC Equipment Alternate General Information). In any event, the contractor shall be responsible for all specified items and intents of this document without further compensation.

2.02 HVAC SYSTEM DESIGN

A. SYSTEM DESCRIPTION:

1. The variable capacity heat recovery air conditioning system shall be a YANMAR Variable Refrigerant Flow Series (heat and cool model) system as specified.
2. The system shall consist of multiple evaporators using PID control, Y style joints, a two-pipe refrigeration distribution system and YANMAR VRF condenser unit.
3. The condenser shall be a direct expansion (DX) air-cooled heat pump, multi-zone air-conditioning system with variable speed natural gas engine with belt-driven compressors using R-410A refrigerant
4. The condensing unit may connect an indoor evaporator capacity up to 130% of the condensing unit capacity. All zones are capable of operating separately with individual temperature control.
5. The YANMAR condensing unit shall be interconnected to Daikin indoor unit models FXAQ, FXDQ, FXFQ, FXHQ, FXLQ, FXMQ_P, FXMQ_M, FXNQ, FXTQ_T, and FXZQ, and shall range in capacity from 7,500 Btu/h to 96,000 Btu/h in accordance with Daikin's engineering data book detailing each available indoor unit.
 - a. The indoor units shall be connected to the condensing unit utilizing YANMAR specified piping joints to ensure correct refrigerant flow and balancing. T-style joints are not acceptable for a variable refrigerant system.
6. Operation of the system shall permit either cooling or heating of all of the indoor units simultaneously. Each indoor unit or group of indoor units shall be able to provide set temperatures independently via a local remote controller, a centralized controller or a BMS interface.
7. The NNCP condensing unit model numbers and the associated number of connectable indoor units per NNCP condensing unit is indicated in the following table. Each indoor unit or group of indoor units shall be independently controlled.

Model Number	Nominal Capacity (Tons)	Maximum Number of Indoor Units
NNCP096J-SB	8	16
NNCP120J-SB	10	20
NNCP144J-SB	12	24
NNCP168J-SB	14	29

2.03 NNCP VRF FEATURES AND BENEFITS

- A. Voltage Platform –Variable Refrigerant Flow (VRF) condensing units shall be available with a 208-240V/1 ϕ /60Hz power supply.
- B. Advanced Zoning – A single outdoor unit shall provide for up to twenty-nine (29) zones (see table from 2.02)
- C. Independent Control – Each indoor unit shall use a dedicated electronic expansion valve with 2000 positions for independent control.
- D. Variable Refrigerant Temperature – Each condensing unit shall use high efficiency, variable speed belt-driven compressor(s) coupled with variable speed fan motors to optimize part load performance. The system capacity and refrigerant temperatures shall be modulated automatically to set suction and condensing pressures while varying the refrigerant volume for the needs of the cooling or heating loads. The control will be automatic and customizable depending on load and weather conditions
- E. Heat Recovery – Engine exhaust heat recovery will be built in to increase heat output.
- F. Indoor units shall use PID to control superheat to deliver a comfortable room temperature conditions and optimize efficiency.
- G. Flexible Design –
 - 1. Systems shall be capable of up to 557 ft. (656 ft. equivalent) of linear piping between the condensing unit and furthest located indoor unit.
 - 2. Systems shall be capable of up to 2100 ft. total “one-way” piping in the piping network.
 - 3. Systems shall have a vertical (height) separation of up to 164 ft. between the condensing unit and the indoor units
 - 4. Systems shall be capable of operating up to 295 ft. from the first Y branch point.
 - 5. The condensing unit shall have the ability to connect an indoor unit evaporator capacity of up to 130% of the condensing unit capacity.
 - 6. Systems shall be capable of 49 ft. of vertical separation between indoor units.
 - 7. VRF condensing units can be combined to a maximum of sixteen (16) outdoor units per one (1) Remote Monitoring System.
- H. Oil Return – Each system shall be furnished with a centrifugal oil separator and active oil recovery cycle.
- I. Simple Wiring – Systems shall use 16/18 AWG, 2 wire, multi-stranded, non-shielded and non-polarized daisy chain control wiring.
- J. Space Saving – Each system shall have a condensing unit module footprint of 86 x 67 x 32 (H x W x D) inches or smaller.
- K. Advanced Diagnostics – Systems shall include a self-diagnostic auto-check function to detect malfunctions and display the type and location.
- L. Advanced Controls – Each system shall have at least one (1) remote controller capable of controlling up to sixteen (16) indoor units.
- M. Each system shall be capable of integrating with open protocol BACnet and LonWorks building management systems.
- N. Low Sound Levels – Each system shall have quiet operation mode of 55 dB(A) or lower measured at a distance of 3.3 ft. from condensing unit.
- O. System shall have remote monitoring capabilities.

2.04 PERFORMANCE

- A. The VRF system rated performance shall be based on below conditions.

1. Performance Conditions:

Cooling: Indoor temperature of 80°F DB, 67°F WB
Outdoor temperature of 95°F DB, 75°F WB

Heating: Indoor temperature of 70°F DB, 60°F WB
Outdoor temperature of 47°F DB, 43°F WB

External piping: 100 ft. equivalent piping length and 0 ft. level difference.

B. Operating Range

1. The operating range in cooling will be 32 to 115°F DB (14 to 115°F DB with optional air guard) intake air temperature for outdoor unit.
2. The indoor temperature and humidity range in cooling will be 61 to 88°F DB at 80% RH or less.
3. The operating range in heating will be -4 to 95°F DB intake air temperature for the outdoor unit.
4. The indoor temperature range in heating will be 61 to 88°F DB

2.05 REFRIGERANT PIPING

- A. The system shall be capable of refrigerant piping up to 557 actual ft. or 656 equivalent ft. from the condensing unit to the furthest indoor unit, and a total combined liquid line length of 2100 ft. of piping between the condensing and indoor units with 164 ft. maximum vertical difference without any oil traps or additional components.
- B. YANMAR piping joints shall be used to ensure proper refrigerant balance and flow for optimum system capacity and performance. T style joints shall not be acceptable as this will negatively impact proper refrigerant balance and flow for optimum system capacity and performance.

2.06 CONDENSING UNIT

- A. General: The condensing unit is designed specifically for use with YANMAR VRF series components.
 1. The condensing unit shall be factory assembled and pre-wired with all necessary electronic and refrigerant controls. The refrigeration circuit of the condensing unit shall consist of YANMAR belt-driven scroll compressors, motors, fans, condenser coils, electronic expansion valves, solenoid valves, 4-way valves, distribution headers and capillaries, filters, shut off valves, oil coolers, service ports, refrigerant receivers and refrigerant accumulators.
 2. Liquid and suction lines must be individually insulated between the condensing and indoor units.
 3. The condensing unit can be wired and piped with access from the left, right, rear or bottom.
 4. The connection ratio of indoor units to condensing unit shall be permitted up to 130%.
 5. Each condensing unit shall be able to support the connection of a maximum of twenty-nine (29) indoor units depending on the model of the condensing unit.
 6. The sound pressure level standard shall be that value as listed in the YANMAR engineering manual for the specified models at 3.3 ft. from the front of the unit. The condensing unit shall be capable of operating automatically at further reduced noise during night time or via an external input
 7. The condensing unit shall be modular in design, and should allow for side-by-side installation with minimum spacing.

8. The following safety devices shall be included on the condensing unit: high pressure sensor and switch, low pressure sensor, control circuit fuses, crankcase heaters and fan motors and over current protection.
 9. To ensure the liquid refrigerant does not flash when supplying to the various indoor units, the circuit shall be provided with a sub-cooling feature.
 10. The oil recovery cycle shall automatically occur one (1) hour after the start of operation.
 11. The condensing unit shall be capable of heating operation at -4°F DB ambient temperature without additional low ambient controls or air guard.
- B. Unit Cabinet:**
1. The condensing unit shall be completely weatherproof and corrosion resistant. The unit shall be constructed from rust-proofed mild steel panels coated with a baked enamel finish.
- C. Fan:**
1. Each condensing unit shall consist of two (2) propeller type, direct-drive fan motors that have multiple speed operation.
 2. The fan shall be a vertical discharge configuration with a nominal airflow up to 13,400 CFM depending on model specified.
 3. Nominal sound pressure levels shall be as shown in the table below or less, when measured at a distance of 3.3 ft.

Model Number	Sound Pressure Level dB(A)
NNCP096J-SB	54
NNCP120J-SB	55
NNCP144J-SB	57
NNCP168J-SB	58

4. The fan motor shall have inherent protection and permanently lubricated bearings.
 5. The fan motor shall be provided with a fan guard to prevent contact with moving parts.
 6. Quiet control of the fan motor for low noise operation by way of automatically limiting the maximum speed shall be a standard feature. Operation sound level shall be selectable from two (2) steps.
- D. Condenser Coil:**
1. The condenser coil shall be manufactured from copper tubes expanded into aluminum fins to form a mechanical bond.
 2. The heat exchanger coil shall be of a waffle louver fin and rifled bore tube design to ensure high efficiency performance.
 3. The heat exchanger on the condensing units shall be installed for engine heat recovery.
 4. The fins and side plates shall be covered with an anti-corrosion, anti-salt coating as standard with a salt spray test rating of 480 hours (JRA 9002).
- E. Compressor:**
1. The YANMAR belt-driven scroll compressors shall be variable speed controlled and capable of changing the speed to follow the variations in total cooling and heating load as determined by the suction gas pressure as measured in the condensing unit. The target suction pressure should be capable of automatic reset based on outdoor temperatures and system load to improve efficiency. In addition, samplings of evaporator and condenser temperatures shall be made so that the high/low pressures always detect and calculate. With each reading, the

compressor capacity shall be controlled by the YANMAR gas engine to eliminate deviation from target value.

2. The compressors in the condensing unit shall be of highly efficient reluctance hermetically sealed scroll compressors.
3. The capacity control range shall be as low as 10% to 100%.
4. Each compressor shall be equipped with a crankcase heater, high pressure safety switch.
5. The oil cooler shall be standard with the equipment together with an intelligent oil management system.
6. The compressor shall be bracket mounted to avoid the transmission of vibration.
7. Each condensing unit shall consist of two (2) belt-driven controlled compressors

F. Electrical:

1. The power supply to the condensing unit shall be:

Power Supply Voltage	Voltage Range
208-240V/1 ϕ /60Hz	187V-264V

Model	MCA	MOP
NNCP096J-SB	15.7	22.7
NNCP120J-SB	15.7	22.7
NNCP144J-SB	15.7	22.7
NNCP168J-SB	16.1	23.2

2. The control voltage between the indoor and condensing units shall be 16VDC non-shielded, stranded 2 conductor cable.
3. The control wiring shall be a two-wire multiplex transmission system, making it possible to connect multiple indoor units to one (1) condensing unit with one (1) 2-cable wire, thus simplifying the wiring installation
4. The control wiring shall be 16/18 AWG, two-wire, non-polarity, non-shielded, stranded and have maximum lengths as shown in the table below.

Max. Total Comm. Wiring	Max. Condenser to Indoor Units Wiring	Max. Indoor Unit to Remote Control
6,562 ft.	3,281 ft.	1,640 ft.

2.07 VARIABLE REFRIGERANT FLOW INDOOR UNITS

* INSERT AS REQUIRED

PART 3 - EXECUTION

* INSERT AS REQUIRED

END OF SECTION

APPENDIX A**HVAC EQUIPMENT ALTERNATE (GENERAL INFORMATION)**

- I. The alternate equipment supplier shall provide to the bidding mechanical contractor a complete equipment data package.
 - a) This package shall include, but is not limited to, equipment capacities at the design condition, power requirements, indoor units CFM/static pressures, fan curves, installation requirements, and physical dimensions. Nominal performance data is not acceptable.
 - b) The mechanical contractor shall request and receive the equipment data package 15 days prior to bid date and submit this package with the alternate bid.
 - c) The mechanical contractor shall list the equipment supplier and submit the required data package with the bid detailing a complete comparison of the proposed alternate equipment to the specified equipment and the associated cost reduction of the alternate equipment. The contractor bids an alternate manufacturer with full knowledge that that manufactures product may not be acceptable or approved.
 - d) All equipment must have visible and permanent label clearly identifying the original manufacturer of the equipment. These labels shall have original manufacturer's name and contact information and be located both inside and outside the equipment and on all equipment-related literature. Submittals shall include the above statement as confirmation by supplier that all conditions are agreed to and complied to. Failure to comply with these requirements shall be sufficient cause for rejection of the submittal and product with no further consideration.

- II. The alternate equipment supplier shall furnish a complete drawing package to the mechanical contractor 15 days prior to bid day for bidding and installation.
 - a) The drawing format shall be .dxf or equivalent, on 30"x42" sheets.
 - b) The HVAC and electrical series design documents will be made available in electronic format for use by the equipment supplier in preparing their drawings.
 - c) The alternate equipment supplier shall prepare the following drawings:
 - i) XXX HVAC Floor Plan
 - ii) XXX HVAC Refrigerant Piping Plan
 - iii) XXX HVAC Refrigerant Piping/Controls Details
 - iv) XXX HVAC Details
 - v) XXX HVAC Schedules
 - d) The alternate equipment supplier shall draft all piping circuits, components, overall building control schematic, detailed control wiring diagrams, system details and schedules for their system. The drawings shall convey all requirements to successfully install the alternate equipment supplier's system.
 - e) Provide (2) drawing package sets plotted on 20 lb. vellum. Provide (1) drawing package in electronic format (.dxf files) on CD.
 - f) The submitted documents shall be complete system designs and show no less information than the HVAC equipment/controls contract bid documents.

- III. The equipment supplier shall submit, as part of the equipment data package, condensing unit data sheets. Data sheets to include the following:
- a) COOLING capacities at project design conditions:
 - i) Cooling (Btu/h)
 - ii) Cooling Input Power:
 - (1) Ducted (kW)
 - (2) Ductless (kW)
 - (3) Mixed (kW)
 - iii) Part Load IEER:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
 - iv) SCHE
 - v) Full Load EER:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
 - b) HEATING capacities at project design conditions:
 - i) Heating (Btu/h)
 - ii) Heating Input Power:
 - (1) Ducted (kW)
 - (2) Ductless (kW)
 - (3) Mixed (kW)
 - iii) Full Load COP @ 47°F:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
 - iv) Full Load COP @ 17°F:
 - (1) Ducted
 - (2) Ductless
 - (3) Mixed
 - c) The submitted capacity and efficiency performance must meet or exceed the listed performance on the schedule at the designed space conditions including de-rate factors for defrost if applicable and refrigerant piping losses.
 - i) OPERATING TEMPERATURE RANGE:
 - (1) Cooling
 - (2) Heating
 - ii) POWER SUPPLY:
 - (1) Maximum Circuit Amps (MCA)
 - (2) Maximum Overcurrent Protection Amps (MOP)
 - (3) Maximum Starting Current (MSC)
 - (4) Condenser Fan Motor
 - iii) REFRIGERANT:
 - (1) Refrigerant type and charge details including field charge for piping to ensure code compliance.
 - (2) Control of refrigerant temperature based on weather and load or alternative function.
 - iv) UNIT DATA:

- (1) Max. number of indoor units
 - (2) Sound pressure level at 3.3 ft. dB(A)
 - (3) Weight (lbs.)
 - (4) Dimensions
 - (5) Demand limit function description
 - (6) Details on sequential start functionality
 - (7) Coil anticorrosion data
- IV. The equipment supplier shall guarantee the performance of their system and all published data submitted. Performance shall be based on the design criteria below.
- a) Room Temperature (Cooling)
 - b) Room Temperature (Heating)
 - c) Ambient Temperature (Summer)
 - d) Ambient Temperature (Winter)
 - e) Defrost De-rate Factor
 - f) Refrigerant Piping Loss
- V. The alternate equipment supplier shall submit with bid, indoor unit data sheets. Data sheets to include the following:
- a) Capacities at project design conditions:
 - i) Cooling (Btu/h)
 - ii) Cooling Input Power (kW)
 - iii) Part Load IEER
 - iv) SCHE
 - v) Full Load EER
 - vi) Heating (Btu/h)
 - vii) Heating Input Power (kW)
 - viii) Full Load COP@47°F
 - ix) Full Load COP@17°F
 - x) Air Flow (CFM)
 - b) External Static Pressure (ESP)
 - c) Electrical Data (MAC, MOP, MSC, RLA)
 - d) Weight (lbs.)
 - e) Dimensions
- VI. The equipment supplier shall provide a certificate which states that the equipment has a minimum salt spray resistance of 480 hours.
- VII. The equipment supplier shall submit the warranty certificate to the mechanical contractor.