UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
****

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DIVISION 23 - HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 81 29

VARIABLE REFRIGERANT FLOW HVAC SYSTEMS

02/20

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SECTION 23 81 29

VARIABLE REFRIGERANT FLOW HVAC SYSTEMS
02/20

****
NOTE: This guide specification covers the requirements for variable refrigerant flow (VRF) type air conditioning and heat pumps systems and accessories.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: This specification uses tailoring options to select the required protocol for control system interfaces for equipment. These tailoring options are:
1. BACnet Only
2. LonWorks Only

You have currently SELECTED the following options:

BACnet Only
LonWorks Only

If more than one item appears between the dashes above you have included more than one services tailoring option and need to DESELECT tailoring options.
****

****

NOTE: This Section MUST be used in conjunction with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC (as well as Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC and either Section 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS or Section 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS). Be sure to include the appropriate Sections and to select matching protocol tailoring options in each of them.

VRF systems may not be able to meet the open protocol requirements of Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, 23 09 23.01 LONWORKS DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS and 23 09 23.02 BACNET DIRECT DIGITAL CONTROL FOR HVAC AND OTHER BUILDING CONTROL SYSTEMS. UFC 3-410-02 includes a process by which specific systems can be excepted from some of the open protocol requirement and permitted to implement proprietary communication. Refer to UFC 3-410-02 for the requirements to permit these exceptions.

****

****

NOTE: You have currently SELECTED Energy Star in the tailoring options.

****

PART 1 GENERAL

1.1 SUMMARY

****

NOTE: VRF systems are manufactured with limited dehumidification and outside air ventilation capability. Selected systems must support an overall design that meets UFC 3-410-01 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS for dehumidification and ventilation requirements.

****

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

a. Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC applies to the VRF system, and all work under this Section must be in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC including but not limited to the open system, protocol, installation, submittal, testing and training requirements of that Section. Unless the specific VRF system being installed is specifically excepted from the open protocol requirements by Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC, the use of non-CEA-709.1-D Non-ASHRAE 135 networks are prohibited.

The VRF control system must be in accordance with Section 25 05 11 CYBERSECURITY FOR FACILITY-RELATED CONTROL SYSTEMS.

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

****
NOTE: When specifying a VRF system, coordinate cooling only or heating/cooling selection with VRF system selection.
****

c. Provide[cooling only][heating /cooling][two stage heating/cooling] control for each zone.[Second stage heating will activate supplemental heating.]

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

1.2 REFERENCES

****
NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
****

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

AIR-CONDITIONING, HEATING AND REFRIGERATION INSTITUTE (AHRI)

AHRI 1230	(2010; Addendum 1 2011; Addendum 2 2014) Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment
ANSI/AHRI 270	(2008) Sound Rating of Outdoor Unitary

	Equipment
ANSI/AHRI 495	(2005) Performance Rating of Refrigerant Liquid Receivers
ANSI/AHRI 760	(2007) Performance Rating of Solenoid Valves for Use With Volatile Refrigerants

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

ANSI/ASHRAE 15 & 34	(2013) ANSI/ASHRAE Standard 15-Safety Standard for Refrigeration Systems and ANSI/ASHRAE Standard 34-Designation and Safety Classification of Refrigerants
ASHRAE 90.1 - IP	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 90.1 - SI	(2013) Energy Standard for Buildings Except Low-Rise Residential Buildings
ASHRAE 135	(2016) BACnet—A Data Communication Protocol for Building Automation and Control Networks

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

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

AMERICAN WELDING SOCIETY (AWS)

AWS A5.8/A5.8M	(2019) Specification for Filler Metals for Brazing and Braze Welding
AWS Z49.1	(2012) Safety in Welding and Cutting and Allied Processes

ASTM INTERNATIONAL (ASTM)

ASTM A307	(2014; E 2017) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM B117	(2019) Standard Practice for Operating Salt Spray (Fog) Apparatus
ASTM D520	(2000; R 2011) Zinc Dust Pigment
ASTM E84	(2020) Standard Test Method for Surface Burning Characteristics of Building

Materials

ASTM F104 (2011; R 2020) Standard Classification System for Nonmetallic Gasket Materials

CONSUMER ELECTRONICS ASSOCIATION (CEA)

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

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

MSS SP-58 (2018) Pipe Hangers and Supports - Materials, Design and Manufacture, Selection, Application, and Installation

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250 (2018) Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA MG 1 (2018) Motors and Generators

NEMA MG 2 (2014) Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

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

U.S. DEPARTMENT OF DEFENSE (DOD)

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

U.S. DEPARTMENT OF ENERGY (DOE)

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

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

40 CFR 82 Protection of Stratospheric Ozone

UNDERWRITERS LABORATORIES (UL)

UL 207 (2009; Reprint Jan 2020) Refrigerant-Containing Components and Accessories, Nonelectrical

UL 429 (2013; Reprint Jan 2020) Electrically Operated Valves

UL 586 (2009; Reprint Dec 2017) UL Standard for Safety High-Efficiency Particulate, Air

	Filter Units
UL 900	(2015) Standard for Air Filter Units
UL 1995	(2015) UL Standard for Safety Heating and Cooling Equipment

1.3 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed item for Army projects.

****

****

NOTE: The following submittals are required in addition to submittals specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Submittals specified in Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC are required for the VRF system.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in

accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Qualification Of Installer; G[, [_____]]

Verification Of Existing Conditions; G[, [_____]]

SD-02 Shop Drawings

VRF System Contractor Design Drawings; G[, [_____]]

SD-03 Product Data

Spare Parts Data; G[, [_____]]

Coil Corrosion Protection; G[, [_____]]

Manufacturer's Standard Catalog Data; G[, [_____]]

Sample Warranty; G[, [_____]]

Refrigerant SDS Sheets; G[, [_____]]

SD-05 Design Data

Manufacturer's Engineering Data; G[, [_____]]

SD-06 Test Reports

System Performance Tests; G[, [_____]]

SD-07 Certificates

Service Organizations; G[, [_____]]

Warranty; G[, [_____]]

Electronic Refrigerant Leak Detector Calibration; G[, [_____]]

Ozone Depleting Substances Technician Certification; G[, [_____]]

SD-08 Manufacturer's Instructions

Manufacturer's Instructions; G[, [_____]]

SD-09 Manufacturer's Field Reports

Refrigerant Charging; G[, [_____]]

SD-11 Closeout Submittals

Posted Instructions; G[, [_____]]

Inventory; G[, [_____]]

1.4 QUALITY ASSURANCE

Complete VRF systems must be purchased from a single supplier. The VRF

system supplier must be responsible for providing a fully functional VRF system.

1.4.1 VRF System Contractor Design Drawings

****
NOTE: The refrigerant piping system plans are required to be apart of the approval package by the manufacturer for complete system installations. Modify Section 23 23 00 REFRIGERANT PIPING to indicate that the piping systems plans for the VRF will be packaged with the VRF System Contractor Design Drawings in a single transmittal.
****

****
NOTE: Select a minimum of five weeks for the shop drawings submittal.
****

Submit VRF System Contractor Design Drawings drawings [5][_____] weeks prior to purchasing the VRF components in a single transmittal. Equipment layouts must be drawn to scale. Shop drawings must be approved by the VRF manufacturers representative. Include approval with name and contact information of VRF manufacturer's representative in the submittal. Place separation sheets before each of the following items covering each item with title and number.

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

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

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

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

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

f. Refrigerant piping system plans as required by Section 23 23 00 REFRIGERANT PIPING. Piping layouts must be to scale and piping must have radial and linear dimensions identifying pipe type. Identify each refrigerant circuit and indicate refrigerant type and mass. Indicate piping expansion components and directions of thermal expansion. Piping layouts must be in accordance with ANSI/ASHRAE 15 & 34.

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

h. Calculations for refrigerant mass and pipe expansion.

i. Sequence of Operations of system and components.

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

1.5 QUALITY CONTROL

1.5.1 Qualifications

1.5.1.1 Qualification Of Installer

****
NOTE: It is the responsibility of the Designer of Record to validate experience when reviewing Qualifications
****

****
NOTE: Select a minimum of three copies of qualifications for submittal.
****

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

1.5.1.2 Ozone Depleting Substances Technician Certification

All technicians working on equipment that contain ozone depleting refrigerants must be certified as a Section 608 Technician to meet requirements in 40 CFR 82, Subpart F. Provide copies of technician certifications to the Contracting Officer at least 14 calendar days prior to work on any equipment containing these refrigerants.

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

1.5.2 Standard Products

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

system components are environmentally suitable for the indicated geographic locations.

1.5.3 Manufacturer's Engineering Data

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

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

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

1.5.4 Manufacturer's Instructions

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

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

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

c. Maintenance: Include preventative.

1.6 PROJECT SEQUENCING

****
NOTE: Include a project sequencing table here or include sequencing for this section in the table for Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.
****

[Project sequencing must be in accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC.

]

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 WARRANTY

****

NOTE: Manufacturer's provide up to a 10 year warranty for manufacturer components if the installation is in accordance with the manufacturer specific installation requirements. All installation requirements for each manufacturer are categorically similar but will require manufacturer specific methods in the selection, designing, installation and commissioning of the complete system. If installing a complete system, research the specific VRF type such as cooling only, heat pump or simultaneous heating/cooling and determine the maximum common warranty provided among at least three of the manufacturers for the specific system type. Select the maximum common warranty duration for the warranty duration.

****

Provide VRF manufactured equipment with the [Manufacturer's Standard Warranty.] [Manufacturer's Standard Warranty or [_____] year manufacturer's warranty, whichever is the longer duration] in addition to the Warranty of Construction. Submit Sample Warranty prior to construction. Compare warranty requirements with the requirements of this contract and identify discrepancies in the submittal that would prevent coverage of warranty by the manufacturer.

PART 2 PRODUCTS

****

NOTE: Inapplicable equipment and system requirements will be deleted or modified in all paragraphs to suit the system designed. Coordinate the standard and design option features typical for each VRF type air conditioning/Heat Pump unit and individual installation. Care must be taken to avoid specifying design options which are generally unavailable in certain combinations or are inappropriate for the application.

Projects must comply with the safety standards defined in ANSI/ASHRAE 15 & 34. Designers will be responsible for thoroughly researching and implementing the ANSI/ASHRAE 15 & 34 safety requirements.

****

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

2.1 MATERIALS

****

NOTE: Select a minimum of five weeks for the Manufacturer's standard catalog data

****

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

2.1.1 Performance Requirements

****
NOTE: Do not use the following Energy Efficiency paragraph and subparagraphs for Air Force Projects.
****

2.1.1.1 Energy Efficiency

Provide equipment meeting the efficiency requirements as stated within this section and provide documentation in conformance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING paragraph ENERGY EFFICIENT PRODUCTS.

****
NOTE: ENERGY STAR tailoring option is in this subpart. Research available ENERGY STAR products and if three or more different manufacturers of the same type VRF specified in this SECTION are listed then select ENERGY STAR.
****

****
NOTE: 10 CFR 436.42 specifies that ENERGY STAR qualified and FEMP designated products may be assumed to be life-cycle cost effective. Equipment having a lower efficiency may be specified if the designer determines the lower efficiency equipment to be more life-cycle cost effective. In making such a determination, the designer should rely on the life-cycle cost analysis method in 10 CFR 436, Subpart A.
****

Provide energy efficiency curve and data of EFFICIENCY vs. OAT. Provide at least five data points over the full range of operation capturing the minimums and maximums.

2.1.1.1.1 Variable Refrigerant Flow Multi-Split Air Conditioners

Information on Energy Star requirements can be found at https://www.energystar.gov/products/heating_cooling/light_commercial_heating_cooling/light_commercial_hvac_key_product_criteria

2.1.1.1.2 Variable Refrigerant Flow Multi-Split Heat Pumps

Information on Energy Star requirements can be found at https://www.energystar.gov/products/heating_cooling/light_commercial_

heating_cooling/light_commercial_hvac_key_product_criteria

2.1.1.2 Electrical Equipment / Motors

Provide electrical equipment, motors, motor efficiencies, and wiring which are in accordance with Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM. Electrical motor driven equipment specified must be provided complete with motors, motor starters, and controls. Electrical characteristics must be as shown, and unless otherwise indicated and field wiring must be in accordance with manufacturer's instructions. All motor(s):

a. 746 W 1 horsepower and above must be the premium efficiency type in accordance with NEMA MG 1.

b. Conform to NEMA MG 1 and NEMA MG 2 and be of sufficient size to drive the equipment at the specified capacity without exceeding the nameplate rating.

c. Continuous duty with the enclosure specified.

d. Starters must be provided complete with thermal overload protection and other appurtenances necessary for the motor control indicated.

e. Furnished with a magnetic across-the-line or reduced voltage type starter as required by the manufacturer.

f. Duty requirements must allow for maximum frequency start-stop operation and minimum encountered interval between start and stop.

g. Must be sized for all applicable loads.

h. Bearings with grease supply fittings must have grease relief to outside of enclosure.

i. [Manual][Automatic] control and protective or signal devices required for the operation specified and any control wiring required for controls and devices specified, but not shown, must be provided.

2.1.1.3 Refrigerant

****

NOTE: EPA, per the Significant New Alternative Policy rule, reviews refrigerant substitutes on the basis of ozone depletion potential, global warming potential, toxicity, flammability, and exposure potential. Lists of acceptable and unacceptable substitutes are updated several times each year. A chronological list of SNAP updates is available at http://www.epa.gov/ozone/snap/refrigerants/lists/index.html or from the stratospheric ozone information hotline at 1 (800) 296-1996. Reducing ozone depletion and global warming potential by reducing or eliminating CFC, and reducing or eliminating HCFC and Halon use in air conditioning equipment is required.

****

Refrigerants must have number designations and safety classifications in accordance with ANSI/ASHRAE 15 & 34. Refrigerants must have an Ozone Depletion Potential (ODP) no greater than 0.0, with the exception of

R-123. Provide Refrigerant SDS sheets for all refrigerants.

2.1.2 Safety Devices

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

2.2 CONTROLS

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

2.2.1 Zone Control

Provide a Space Sensor Module, in accordance with Section 23 09 13 INSTRUMENTATION AND CONTROL DEVICES FOR HVAC, for each fan coil unit unless otherwise indicated in contract drawings and with the following additional requirements:

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

b. Temperature setpoint adjustment in one degree increments.

****
NOTE: Keep bracketed text for override button if override is required. Specify the maximum amount of time for override accumulation.
****

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

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

]2.3 INDOOR FAN COIL UNITS

Provide with the following:

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

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

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

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

****
NOTE: If ECM are required, select ECM, otherwise select "or multi-speed."
****

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

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

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

h. Dedicated electronic modulating refrigerant expansion and flow control.

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

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

2.3.1 Concealed-In-Ceiling Units

Provide with the following:

a. Ducted horizontal discharge and return; galvanized steel cabinet in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

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

c. Switch box accessible from side or bottom.

2.3.2 Recessed Ceiling Units

Provide with the following:

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

****

NOTE: Coordinate with the end user for color selection.

****

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

c. Supply Airflow Adjustment:

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

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

2.3.3 Wall Surface-Mounted Units

Provide with the following:

****

NOTE: Coordinate with the end user for color selection.
****

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

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

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

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

2.4 OUTDOOR COMPRESSOR UNIT

Provide with the following:

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

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

****
NOTE: Select 58 dB(A) at 1 meter 3 feet unless otherwise approved by the Contracting Officer.
****

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

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

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

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

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

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

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

2.4.1 Air-Cooled

****

NOTE: Input final outside air temperatures used in approved final load calculations.
****

a. The unit must must have full design cooling capacity at [_____] degrees C [_____] degrees F dry bulb ambient.

b. For units other than cooling only, the unit must have full design heating capacity at [_____] degrees C [_____] degrees F dry bulb ambient.

2.4.2 Water-Cooled

a. Provide condenser water piping and accessories in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

b. Units must have full capacity at heating and cooling water temperature ranges as identified in the contract drawings.

2.4.3 Casing

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

2.4.4 Compressor

Each compressor system must have the following:

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

b. Factory installed vibration dampeners on all mounting points.

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

e. Oil separator with an oil balance circuit.

2.5 COMPONENTS

2.5.1 Fans

****
NOTE: AIR FORCE tailoring option is in this subpart. Select AIR FORCE tailoring option for Air Force projects.
****

Fan wheel shafts must be supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Unit fans must be selected to produce the flow rate required at the fan total pressure. Motor starters, if applicable, must be magnetic across-the-line type with a[n][open][dripproof][totally enclosed][explosion proof] enclosure. Thermal overload protection must be of the manual or automatic-reset type. Fan wheels or propellers must be constructed of aluminum or galvanized steel. Centrifugal fan wheel housings must be of galvanized steel, and both centrifugal and propeller

fan casings must be constructed of aluminum or galvanized steel. Steel elements of fans, except fan shafts, must be hot-dipped galvanized after fabrication or fabricated of mill galvanized steel. Mill-galvanized steel surfaces and edges damaged or cut during fabrication by forming, punching, drilling, welding, or cutting must be recoated with an approved zinc-rich compound. Fan wheels or propellers must be statically and dynamically balanced. Forward curved fan wheels must be limited to [_____] mm inches. Direct-drive fan motors must be of the multiple-speed variety. Belt-driven fans must have adjustable sheaves to provide not less than [_____] percent fan-speed adjustment. The sheave size must be selected so that the fan speed at the approximate midpoint of the sheave adjustment will produce the specified air quantity. Centrifugal scroll-type fans must be provided with streamlined orifice inlet and V-belt drive. Each drive will be independent of any other drive. Propeller fans must be[direct-drive][V-belt] drive type with[adjustable][fixed] pitch blades. V-belt driven fans must be mounted on a corrosion protected drive shaft supported by either maintenance-accessible lubricated antifriction block-type bearings, or permanently lubricated ball bearings. Each drive will be independent of any other drive. Drive bearings must be protected with water slingers or shields. V-belt drives must be fitted with guards where exposed to contact by personnel and[fixed pitch][adjustable pitch] sheaves. Axial fans may not be used to distribute air through duct systems.

2.5.2 Supplemental Electric Heating Coil

Coil must be an electric duct heater in accordance with UL 1995 and NFPA 70. Coil must be duct- or unit-mounted. Coil must be of the[nickel chromium resistor, single stage, strip][nickel chromium resistor, single stage, strip or stainless steel, fin tubular] type. Coil must be provided with a built-in or surface-mounted high-limit thermostat interlocked electrically so that the coil cannot be energized unless the fan is energized. Coil casing and support brackets must be of galvanized steel or aluminum. Coil must be mounted to eliminate noise from expansion and contraction and be completely accessible for service. Supplemental Electric Resistance Heating controls must be provided to prevent operation when the heating load can be met by the primary source alone during both steady-state operation and setback recovery. Supplemental heater operation is permitted during outdoor coil defrost cycles.

2.5.3 Air Filters

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

2.5.4 Coil Frost Protection (Defrost Mode)

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

2.5.5 Pressure Vessels

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

2.5.5.1 Liquid Receiver

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

2.5.5.2 Suction Accumulator

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

2.5.5.2.1 Vertical Type

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

2.5.5.2.2 Horizontal Type

Provide only in non-freezing environments.

2.5.5.3 Oil Separator

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

2.5.5.4 Oil Reservoir

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

2.5.6 Internal Dampers

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

2.5.7 Mixing Boxes

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

2.5.8 Refrigerant Piping

Provide refrigerant piping external to equipment in accordance with Section 23 23 00 REFRIGERANT PIPING.

2.5.9 Condensate Drain Piping

Provide condensate drain piping in accordance with Section 23 05 15 COMMON PIPING FOR HVAC.

2.5.10 Ductwork

Provide interface to ductwork in accordance with Section 23 30 00 HVAC AIR DISTRIBUTION.

2.5.11 Refrigerant Solenoid Valves

Solenoid valves must comply with ANSI/AHRI 760 and UL 429, be suitable for continuous duty rated voltage at maximum and minimum encountered pressure and temperature service conditions. Solenoid valves must be direct-acting or pilot-operating type, packless, seal capped. Manual lifting provisions must be furnished. Solenoid coils must comply with NEMA 250 type 4. Valves must have safe working pressure of 125 percent of maximum working pressure and a maximum operating pressure differential of at least half of the valve maximum working pressure at 85 percent rated voltage. Valves must have an operating pressure differential suitable for the fluid phase and refrigerant used.

2.5.12 Branch Selector Unit

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

2.6 EQUIPMENT ACCESSORIES AND MISCELLANEOUS EQUIPMENT

2.6.1 Refrigerant Leak Detector

****

NOTE: Refrigerant leak detectors will be provided as required by the "System Application Requirements" in ANSI/ASHRAE 15 & 34.

When a detector is required, the location will be indicated on the drawings. Detectors are best located between the refrigeration system and the room exhaust. Sampling points from a detector will be located a maximum of 458 mm 18 inches above the finished floor since all commonly-used refrigerants are heavier than air.

As a rule of thumb, the distance between any refrigeration system and a refrigerant sampling point shouldn't exceed 15 m 50 feet. In order to meet the recommended 15 m 50 feet distance, a mechanical room can be provided with either multiple detectors each with single sampling points or with one detector that has the capability of monitoring at multiple sampling points. If multiple sampling points are required, enter the number in the appropriate blank below.

As required by ANSI/ASHRAE 15 & 34, when a detector senses refrigerant it must activate an alarm and initiate the room ventilation system. In regards to alarms, as a minimum indicate that the detector will energize a light on or near the detector as well as a second light installed on the outside wall next to the mechanical room entrance. The exterior light will be provided with a sign that warns personnel entering the mechanical room of a refrigerant release and that a SCBA is required to enter. If applicable to the installation, include an audible alarm on the exterior of the mechanical room.

Include the electrical design for the alarm system on the drawings.

As an additional item, ANSI/ASHRAE 15 & 34 states that open-flame devices (i.e., boilers, etc.) cannot be installed in the same area as a refrigeration system, unless either combustion air for the open-flame device is ducted straight from outside to the device; or the alarm relay from the detector is used to automatically shutdown the combustion process in the event of refrigerant leakage. Indicate all applicable alarm controls on the drawings.

Delete the information in the last bracketed sentences if an EMCS is not applicable to the design.
****

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

2.6.2 Refrigerant Relief Valve/Rupture Disc Assembly

****

NOTE: ANSI/ASHRAE 15 & 34 requires refrigeration systems to be protected with a pressure-relief device that will safely relieve pressure due to fire

or other abnormal conditions. A relief valve/rupture disc assembly is the optimum solution. The rupture disc will provide visual indication of a release while also providing immediate shutoff once a safe pressure is achieved.

Designer will indicate on the drawings the location of each new relief valve/rupture disc assembly as well as the routing and size of corresponding pressure-relief piping. The routing and size of new pressure-relief piping will be in accordance with ANSI/ASHRAE 15 & 34.

****

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

2.6.3 Refrigerant Signs

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

2.6.3.1 Installation Identification

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

a. Contractor's name.

b. Refrigerant number and amount of refrigerant.

c. The lubricant identity and amount.

d. Field test pressure applied.

2.6.3.2 Controls and Piping Identification

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

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

b. Pressure limiting device(s).

2.6.4 Gaskets

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

2.6.5 Bolts and Nuts

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

2.7 FINISHES

2.7.1 Coil Corrosion Protection

****

NOTE: Research local conditions to determine the corrosiveness of the environment. Where condenser or evaporator coils are to be installed in highly corrosive atmospheres, carefully consider the coil and fin combinations specified. Standard coil construction is typically copper tubes with aluminum fins. For excessively corrosive atmospheres, either copper tubes with copper fins or aluminum tubes with aluminum fins should be considered.

For maximum coil protection, include the requirements of this paragraph. This paragraph addresses phenolic, vinyl, and epoxy type coatings. For coils with relatively close fin spacing the phenolic or epoxy coating are the preferred types as these have less tendency to bridge across the fins than vinyl. In addition, the phenolic and epoxy type coatings can typically provide better thermal conductivity than vinyl.

If coatings are specified, note that a coil's heat transfer capacity can be reduced anywhere between 1 to 5 percent; total unit capacity may have to be increased as a result, see manufacturer's guidance.

****

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

2.7.2 Equipment and Components Factory Coating

****

NOTE: For equipment to be installed outdoors, adequate protection will be specified. Manufacturers must submit evidence that unit specimen have passed the specified salt spray fog test. A 100 hour test will be specified in a noncorrosive environment and a 500 hour test will be specified in a corrosive environment.

****

Unless otherwise specified, equipment and component items, when fabricated from ferrous metal, must be factory finished with the manufacturer's standard finish, except that items located outside of buildings must have weather resistant finishes that will withstand [100] [500] hours exposure to the salt spray test specified in ASTM B117. Immediately after completion of the test, the specimen must show no signs of blistering, wrinkling, cracking, or loss of adhesion and no sign of rust creepage beyond 3 mm 1/8 inch on either side of the scratch mark. Cut edges of galvanized surfaces where hot-dip galvanized sheet steel is used must be coated with a zinc-rich coating conforming to ASTM D520, Type I.

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

2.7.2.1 Phenolic Coating

Provide a resin base thermosetting phenolic coating. Apply coating by immersion dipping of the entire coil. Provide a minimum of two coats. Bake or heat dry coils following immersions. After final immersion and prior to final baking, spray entire coil with particular emphasis given to building up coating on sheared edges. Total dry film thickness must be 0.064 to 0.076 mm 2.5 to 3.0 mils.

2.7.2.2 Chemical Conversion Coating with Polyelastomer Finish Coat

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

2.7.2.3 Vinyl Coating

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

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

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

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

2.7.3 Factory Applied Insulation

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

2.8 TESTS, INSPECTIONS, AND VERIFICATIONS

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

PART 3 EXECUTION

3.1 EXAMINATION

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

3.2 INSTALLATION

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

3.2.1 Equipment General

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

in the direction of other outdoor unit intakes.

3.2.2 Safety Devices

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

3.2.3 Controls

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

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

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

c. Fan speed adjustment for each fan coil.

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

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

f. Temperature limitation in both heating and cooling mode.

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

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

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

3.2.4 Isolation Valves

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NOTE: Isolation valve seals can be a possible source of leakage over time. Provide isolation valves only if required by the end user.

****

Provide Isolation Valves in accordance with Section 23 23 00 REFRIGERANT PIPING. Provide with service ports on downstream side.

3.2.5 Electrical Equipment / Motors

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

3.2.6 Branch Selector Unit

Locate Branch Selector Units inside of the facility with full access for inspection, maintenance and removal. Locate no more then 2 meters 6 feet above finished floor. The unit must have a minimum clearance of 30

centimeters 12 inches from all serviceable sides and be removable without modification to the surroundings.

3.2.7 Condensate Removal

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

3.2.8 Access Panels

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

3.2.9 Air Filters

Allow access space for servicing filters. Install filters with suitable sealing to prevent bypassing of air. Perform and document that proper indoor air quality during construction procedures have been followed in accordance with Section 01 33 29 SUSTAINABILITY REQUIREMENTS AND REPORTING, paragraph Indoor Air Quality During Construction; this includes providing documentation showing that after construction ends, and prior to occupancy, new filters were provided and installed.

3.2.10 Flashing and Pitch Pockets

Provide flashing and pitch pockets for equipment supports and roof penetrations and flashing where piping or ductwork passes through exterior walls in accordance with Section 07 60 00 FLASHING AND SHEET METAL.

3.2.11 Identification Tags and Plates

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

3.2.12 Refrigerant Signs

Locate refrigerant signs with in reading distance of outdoor unit.

3.2.13 Field Applied Insulation

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

3.2.14 Piping

3.2.14.1 Pipe Hangers and Supports

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

3.2.14.2 Refrigerant Piping

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

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

3.2.14.3 Condenser Water Piping

Install condenser water piping and accessories in accordance with Section 23 64 26 CHILLED, CHILLED-HOT, AND CONDENSER WATER PIPING SYSTEMS.

3.2.14.4 Solenoid Valve Installation

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

3.2.15 Auxiliary Drain Pans, Drain Connections, And Drain Lines

Provide auxiliary drain pans under units located above finished ceilings or over mechanical or electrical equipment. Pan must extend beyond the limits of the units. Provide separate drain lines for the unit drain and auxiliary drain pans. Trap drain pans from the bottom to ensure complete pan drainage. Provide drain lines full size of drain opening. Traps and piping to drainage disposal points must conform to Section 22 00 00 PLUMBING, GENERAL PURPOSE.

3.3 REFRIGERANT PIPING TESTS

Perform refrigerant piping tests as specified in Section 23 23 00 REFRIGERANT PIPING and per manufacturer's recommendations in the presence of the contracting officer. Use electronic type leak detector with a sensitivity of 3 grams/year 0.1 ounces/year and a calibrated reference

leak rated at 5 grams/year 0.17 ounces/year. Submit current electronic refrigerant leak detector calibration certificate prior to testing. Before testing the refrigerant piping system, perform a test of the leak detector with the reference leak fitting in the presence of the Contracting Officer.

3.4 REFRIGERANT CHARGING

After refrigerant piping test and before system performance test, perform evacuation and dehydration procedures in accordance with manufacturers recommendations and requirements and Section 23 23 00 REFRIGERANT PIPING. Evacuate system to a minimum of 100 microns 0.004 inches Hg for one hour or per manufacturers requirements. Use fresh oil in the vacuum pump. Connect electronic vacuum gauge to system piping for measurement. The refrigerant must be to the weight specified in the shop drawing calculations. The supplemental refrigerant must be weighed in with an electronic scale. Supplemental refrigerant must be introduced to the system in a liquid state for refrigerant blends. Conduct refrigerant charging in the presence of the Contracting Officer. Submit refrigerant charging report before system performance test. Outline refrigerant charging procedures in the report. Report must indicated who performed and witnessed the task. Provide signatures from all parties.

3.5 SYSTEM PERFORMANCE TESTS

****
NOTE: Select at minimum the default value for the following bracketed items
****

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

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

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

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

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

instruments, and personnel required for the test.

****

NOTE: For the next item, choose either Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS or Section [01 91 00.15 10] [01 91 00.15 20] TOTAL BUILDING COMMISSIONING.

****

d. Coordinate field tests with [Section [01 91 00.15 10] [01 91 00.15 20] TOTAL BUILDING COMMISSIONING] [Section 23 05 93 TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS]. Submit [3] [_____] copies of the report provided in bound 216 by 279 mm 8-1/2 by 11 inch booklets. The report must document compliance with the specified performance criteria upon completion and testing of the system. The report must indicate the number of days covered by the tests and any conclusions as to the adequacy of the system. Submit the report including the following information (where values are taken at least three different times at outside dry-bulb temperatures that are at least 3 degrees C 5 degrees F apart):

(1) Date and outside weather conditions.

(2) The load on the system based on the following:

(a) The refrigerant used in the system.
(b) Condensing temperature and pressure.
(c) Suction temperature and pressure.
(d) Ambient, condensing and coolant temperatures.
(e) Running current, voltage and proper phase sequence for each phase of all motors.

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

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

(5) Subcooling.

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

(7) Low oil pressure switch set-point.

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

(9) Moisture content.

(10) Capacity control set-points.

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

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

3.6 CLEANING

Equipment must be wiped clean, with all traces of oil, dust, dirt, or paint spots removed. Temporary filters must be provided for all fans that

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

3.7 CLOSEOUT ACTIVITIES

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

3.7.1 Extra Materials

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

3.7.2 Maintenance Service Providers

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

3.7.3 Warranty

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NOTE: Navy tailoring option is in this subpart. Select Navy tailoring option for Navy and Marine Corps projects.
****

Submit warranty certificate to the Contracting Officer. Provide warranty management plan in accordance with 01 78 00 CLOSEOUT SUBMITTALS.

3.7.4 VRF Operation And Maintenance Manual

****
NOTE: Modify Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC to include items from this Section by reference.
****

Provide the following in addition to and accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC:

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

b. Manufacturer's Engineering Data.

c. Manufacturer's Instructions.

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

3.7.5 Posted Instructions

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

3.7.6 Training

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NOTE: Modify Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC to include items from this section by reference.
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Provide training, for all items provided under this section, in addition to and accordance with Section 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC. Also include refrigeration leak detection and leak detection response training. The training period must consist of a total [8] [_____] hours of normal working time for items covered in this section.

-- End of Section --