AHRI 1230-2023 (I-P)

2023 Standard for

Performance Rating of Variable Refrigerant Flow (VRF) Multi-split Air-conditioning and Heat Pump Equipment

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ICS No: 23.120

Note:

This standard supersedes AHRI Standard 1230-2021 (I-P).

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Foreword

Major changes made from the previous version, AHRI Standard 1230-2021 (I-P), are as follows

- Updates to definitions including the addition of Dessicant Dehumidification Components, Economizers, Fresh Air Dampers, Hail Guards, and Low Ambient Cooling Dampers.
- Expansion of Appendix C to add more information regarding CVP testing
- Updates to include Example piping size for Table D2
- Changes to Appendix E to clarify the changes needed for VRF testing
- Format changes to align with latest style guide.

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PERFORMANCE RATING OF VARIABLE REFRIGERANT FLOW (VRF) MULTI-SPLIT AIR-CONDITIONING AND HEAT PUMP EQUIPMENT

Section 1. Purpose

1.1 *Purpose.* This standard establishes definitions, classifications, test requirements, rating requirements, determination of Published Ratings, operating requirements, marking and nameplate data, conformance conditions, and minimum data requirements for Published Ratings and calculations for Variable Refrigerant Flow (VRF) Multi-split Air Conditioners and Heat Pumps.

1.1.1 *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors, and users.

Specific interests include, but are not limited to, federal/state/provincial regulations and efficiency standards developed by ASHRAE, the International Energy Conservation Code (IECC), the Canadian Standards Association (CSA), and the United States Department of Energy (DOE).

1.1.2 *Review and Amendment.* This standard is subject to review and amendment as technology advances.

Section 2. Scope

2.1 This standard applies to VRF Multi-split Air Conditioners and Multi-split Heat Pumps using distributed refrigerant technology, including VRF Water-source Heat Pump systems of any Cooling Capacity and VRF Air-source systems with Cooling Capacity ≥ 65,000 Btu/h, as defined in Section 3 and referenced as the Basic Model.

If this standard is used to demonstrate regulatory compliance, stakeholders shall abide by all published requirements applicable to the regulated product. For example, for products that contain one or more design characteristics that either prevent testing according to this standard or cause this standard to evaluate the equipment in a manner unrepresentative of the equipment's true energy consumption characteristics, DOE requires the manufacturer submit a petition for waiver that includes an alternative method of test.

2.2 This standard applies to VRF Systems defined in Section 3.2.47.

2.3 *Exclusions.* This standard does not apply to the rating and testing of:

- Individual assemblies, such as separate condensing units or indoor units;
- Air-conditioners and Heat Pumps, with capacities less than 65,000 Btu/h as defined in AHRI 210/240;
- Water-source Heat Pumps (other than Multi-split Systems) as defined in AHRI/ASHRAE/ISO 13256-1 (RA 2012);
- Unitary Air-conditioners and Unitary Heat Pumps as defined in AHRI 340/360, with capacities ≥65,000 Btu/h;
- Units equipped with desuperheater/water heating devices as defined in AHRI 470; and
- Commercial and Industrial Condensing units with a capacity greater than 135,000 Btu/h as defined in AHRI 365 (I-P).

2.4 *Energy Source.* This standard applies only to electrically operated, vapor compression refrigeration systems.

Section 3. Definitions

All terms in this document shall follow the standard industry definitions in the ASHRAE Terminology website unless otherwise defined in this section.

For this standard, the terms "equipment" and "systems" are used throughout to refer to Multi-split Air-conditioners or Multi-split Heat Pumps, or both unless otherwise specified.

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3.1 Expression of Provisions

Terms that provide clear distinctions between requirements, recommendations, permissions, options, and capabilities.

3.1.1 *"Can" or "Cannot"*. Express an option or capability.

3.1.2 *"May"*. Signifies a permission expressed by the document.

3.1.3 *"Must"*. Indication of unavoidable situations and does not mean that an external constraint referred to is a requirement of the document.

3.1.4 *"Shall" or "Shall not"*. Indication of mandatory requirements to strictly conform to the standard and where deviation is not permitted.

3.1.5 *"Should" or "Should not"*. Indication of recommendations rather than requirements. In the negative form, a recommendation is the expression of potential choices or courses of action that are not preferred but not prohibited.

3.2 Standard Specific Definitions

3.2.1 *Air Sampling Device(s)***.** A combination of Air Sampling Tree(s), conduit, fan and Aspirating Psychrometer or Dew point Hygrometer used to determine dry-bulb temperature and moisture content of an air sample from critical locations.

3.2.1.1 *Air Sampling Tree.* An assembly consisting of a manifold with two or more branch tubes with multiple sampling holes that draws an air sample from the unit under test from a critical location such as an indoor air inlet, indoor air outlet, or outdoor air inlet.

3.2.1.2 *Aspirating Psychrometer.* An instrument used to determine the humidity of air by simultaneously measuring both the wet-bulb and dry-bulb temperatures. The difference between these temperatures is referred to as the wet-bulb depression.

3.2.1.3 *Dew Point Hygrometer.* An instrument used to determine the humidity of air by detecting visible condensation of moisture on a cooled surface.

3.2.2 *Airflow-control Setting(s).* Programmed or wired control system configurations that control a fan to achieve discrete, differing ranges of airflow—often designated for performing a specific function such as cooling, heating, or constant circulation—without manual adjustment other than interaction with a user-operable control such as a thermostat as specified in the Manufacturer's Installation Instructions.

3.2.3 *Approach Temperature.* The refrigerant temperature at the outdoor liquid service port minus the outdoor ambient temperature.

3.2.4 *Basic Model.* All units manufactured by one manufacturer within a single equipment class, that have the same or comparably performing compressor(s), a common Nominal Cooling Capacity, and the same heat rejection medium such as air or water.

3.2.5 *Bubble Point*. Refrigerant liquid saturation temperature at a specified pressure.

3.2.6 *Capacity*

3.2.6.1 *Cooling Capacity*. The capacity associated with the change in air enthalpy that includes both the Latent Capacity and Sensible Capacity expressed in Btu/h.

3.2.6.2 *Heating Capacity*. The capacity associated with the change in dry-bulb temperatures expressed in Btu/h.

3.2.6.3 *Latent Cooling Capacity*. The rate that the equipment removes latent heat to reduce the moisture content of the air passing through the equipment under specified conditions of operation, Btu/h.

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3.2.6.4 *Nominal Cooling Capacity* (for Indoor Unit and Outdoor Unit). The approximated cooling capacity, when referenced, at Standard Rating Conditions, as published in product literature, Btu/h.

3.2.6.5 *Percent Load*. The ratio of the part-load Cooling Capacity over the measured full load Cooling Capacity at Standard Rating Conditions, expressed in units of percent, %.

3.2.6.6 *Rated Capacity*. The capacity achieved at the Standard Rating Conditions, Btu/h.

3.2.5.6.1 *Standard Rating Cooling Capacity.* The capacity of the system when all Indoor Units and Outdoor Units are all operated in cooling mode, in the Standard Rating Conditions Cooling, Btu/h.

3.2.5.6.2 *Standard Rating Heating Capacity.* The capacity of the system when all Indoor Units and Outdoor Units are operated in heating mode, in the Standard Rating Conditions (High Temperature Heating Steady-state Test and Low Temperature Heating Steady-state Test), Btu/h.

3.2.5.7 *Sensible Cooling Capacity*. The rate that the equipment lowers the dry-bulb temperature (removes sensible heat) of the air passing through the equipment under specified conditions of operation, Btu/h.

3.2.5.8 *Total Cooling Capacity*. The capacity associated with the change in air enthalpy that includes both the latent and sensible capacities expressed in Btu/h.

3.2.7 *Coefficient of Performance (COP).* A ratio of the Heating Capacity in Btu/h to the power input values in Btu/h at any given set of Rating Conditions expressed in Btu/h/Btu/h.

3.2.7.1 *Coefficient of Performance at High Temperature (COP_H).* The Coefficient of Performance, not including supplementary resistance heat, obtained at the 47°F temperature Rating Condition.

3.2.7.2 *Coefficient of Performance at Low Temperature (COP_L).* The Coefficient of Performance obtained at the 17°F temperature Rating Condition.

3.2.9 *Control Setting(s).* System configurations specified in the Manufacturer's Installation Instructions (MII) and Supplemental Testing Instructions (STI).

3.2.10 *Controls Verification Procedure (CVP).* The procedure to verify the Control Settings for the Critical Parameters used during the Steady-state Test. (See Appendix C.)

3.2.11 *Critical Parameter(s).* Key variables affecting the measured result. Any operating state or position for a component, either set manually or automatically by System Controls that can impact system performance. The settings of modulating components of a VRF System are: compressor speed(s), outdoor fan speed(s), and outdoor variable valve position(s).

3.2.12 *Degradation Coefficient (C_D).* A parameter used in calculating the part-load factor, a measure of the efficiency loss due to the cycling of the units.

3.2.13 *Desiccant Dehumidification Components*. An assembly that reduces the moisture content of the supply air through moisture transfer with solid or liquid desiccants.

3.2.14 *Dew Point*. Refrigerant vapor saturation temperature at a specified pressure.

3.2.15 *Economizers.*

3.2.15.1 *Air Economizer*. An optional feature that brings in additional outside cool air to cool the building when ambient temperature and or humidity levels are lower than the return air conditions.

3.2.15.2 *Integrating Economizing.* A control mode where both the economizer and mechanical cooling are operated to satisfy the building load. The economizer is operated at maximum capacity and the mechanical cooling is used to supplement the economizer cooling.

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3.2.16 *Energy Efficiency Ratio (EER).* A ratio of the Cooling Capacity in Btu/h to the power input value in watts at any given set of Rating Conditions expressed in Btu/(W·h).

3.2.16.1 *Integrated Energy Efficiency Ratio (IEER).* A weighted calculation of mechanical cooling efficiencies at full load and part load Standard Rating Conditions, as outlined in Section 11 expressed in Btu/h)/(W·h).

3.2.17 *Fresh Air Dampers.* An assembly with dampers and means to set the damper position in a closed and one open position so that the air is drawn into the equipment when the indoor fan is operating.

3.2.18 *Hail Guards*. A grille or similar structure mounted to the outside of the unit covering the outdoor coil to protect the coil from hail, flying debris and damage from large objects.

3.2.19 *Heat Pump(s).* A kind of central air conditioner(s) that utilizes an indoor conditioning coil, compressor, and refrigerant-to-outdoor air heat exchanger to provide air heating, and can provide air cooling, air dehumidifying, air humidifying, air circulating, and air cleaning.

3.2.20 *Heat Recovery Control Unit***.** A device that controls refrigerant flow between Indoor Units, so that there is simultaneous cooling and heating operation.

3.2.21 *Indoor Unit*. A separate assembly of a Split System, excluding a service coil, that includes all of the following features:

- An arrangement of refrigerant-to-air heat transfer coil(s) for transfer of heat between the refrigerant and the indoor air
- A condensate drain pan
- An air temperature sensing device
- An integrated indoor blower such as a device to move air including the device's associated motor

Units can include any or all of the following features:

- Sheet metal or plastic components not part of external cabinetry to direct/route airflow over the coil(s)
- Cooling mode expansion device
- External case

3.2.21.1 *Ducted Indoor Unit.* An Indoor Unit designed to be permanently installed and deliver all conditioned air through ductwork.

3.2.21.2 *Non-ducted Indoor Unit.* An Indoor Unit designed to be permanently installed, mounted on room walls, floors, or ceilings, or any combination thereof, that directly heats or cools air within the conditioned space and consists of the following types:

- Wall-mounted
- Floor-mounted
- Ceiling-suspended
- Standard Four-way Ceiling Cassette
- Compact Four-way Ceiling Cassette

3.2.22 *Individual Model*. An Individual Model means a model distributed in commerce with a unique model number.

3.2.23 *Indoor Unit Model Family.* A group of indoor unit models consisting exclusively of the same kind of indoor units, as specified in Section 3.2.23.1, Section 3.2.23.2 and Section 3.2.23.3.

3.2.23.1 *Non-ducted Indoor Unit Model Families*

3.2.23.1.1 *Ceiling-suspended*. A non-ducted Indoor Unit that is totally encased and is suspended below the ceiling.

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3.2.19.1.2 *Floor-mounted.* A non-ducted Indoor Unit intended for being installed at floor level either enclosed in the wall space in an uncased configuration or extended out from the wall in a cased configuration.

3.2.23.1.3 *Ceiling Cassette.* Non-ducted Indoor Units intended to be installed flush mounted with the ceiling. These Indoor Units can have configurations of indoor airflow coming from one, two, four, or circular direction(s). Each of the following represents a separate Indoor Unit Model Family:

3.2.23.1.3.1 *Compact. Four-way Ceiling Cassette.* A Ceiling Cassette with air discharge louvers on four or more sides (or circular), a central air return grill and main casing dimensions less than 32 in x 32 in (not including flanges).

3.2.23.1.3.2 *One-way Cassette*. A Ceiling Cassette with air discharge louvers on a single side.

3.2.23.1.3.3 *Standard Four-way Ceiling Cassette.* A Ceiling Cassette with air discharge louvers on four or more sides (or circular), a central air return grill and main casing dimensions greater than, or equal to, 32 in x 32 in (not including flanges).

3.2.23.1.3.4 *Three-way Cassette*. A Ceiling Cassette with air discharge louvers on three sides.

3.2.23.1.3.5 *Two-way Cassette*. A Ceiling Cassette with air discharge louvers on two sides.

3.2.23.1.4 *Wall-mounted.* A non-ducted Indoor Unit that is attached to the wall with a cased configuration.
Note: These units can be referred to as high-wall units.

3.2.23.2 *Ducted Indoor Unit Model Families.* Model families when operated at the full-load cooling airflow that produces the following ESP range:

3.2.23.2.1 *Low-static.* A ducted Indoor Unit that produces an external static pressure (ESP) between 0.01 in H_2O and 0.35 in H_2O.

3.2.23.2.2 *Mid-static*. A ducted Indoor Unit that produces an ESP between 0.20 in H_2O and 0.65 in H_2O.

If the Indoor Unit model grouping in a manufacturer's publicly accessible literature is not in accordance with Section 3.2.23.2, Section 3.2.23.2 takes precedence for the determination of Tested Combinations.

If the range of ESP as published in manufacturer's publicly accessible literature for an Indoor Unit falls within the ESP range for more than one type of Ducted System, then the Indoor Unit is classified based on where much of the ESP capability lies.

If an Indoor Unit can operate between 0.15 in H_2O and 0.65 in H_2O, then this Indoor Unit is designated as a Mid-static Indoor Unit. If an Indoor Unit can operate between 0.35 in H_2O and 0.75 in H_2O, then this Indoor Unit is designated as a Mid-static Indoor Unit.

3.2.23.3 *Small-duct, High-velocity (SDHV) Indoor Unit Model Family*. An Indoor Unit designed to be permanently installed and deliver all conditioned air through ductwork and that produces at least 1.2 in H_2O of ESP when operated at the full-load cooling airflow of at least 220 scfm per ton of Nominal Cooling Capacity. This Indoor Unit Model Family is a unique type that is not one of the Ducted Indoor Unit Model Families.

3.2.24 *Low Ambient Cooling Dampers*. An assembly with dampers and means to set the dampers in a position to recirculate the warmer condenser discharge air so that there is reliable operation at low outdoor ambient conditions.

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3.2.25 *Manufacturer's Installation Instructions (MII)*. Manufacturer documents that come packaged with or appear in the labels applied to the unit(s). Online manuals can be used if referenced on the unit label or in the documents that come packaged with the unit.

3.2.25.1 *Manufacturer-Specified*. Required information provided by the manufacturer through either the STI or MII.

3.2.25.2 *Supplemental Testing Instructions (STI)*. Additional instructions developed by the manufacturer for the purpose of being able to test a VRF System to this test standard. Refer to Section 5.4 for STI requirements.

3.2.26 *Nominal Point Value*. The value that corresponds to a 1% variation in the given critical parameter. Refer to Table C3 for individual parameter values.

3.2.27 *Oil Recovery Mode*. An automatic system operation that returns oil to the compressor crankcase when the control system determines that the oil level in the Outdoor Unit is low.

3.2.28 *Outdoor Two-position Valves.* Two-position refrigerant valves in the Outdoor Unit.

3.2.29 *Outdoor Unit*. A separate assembly of a Split System that transfers heat between the refrigerant and the outdoor air or refrigerant and water, and consists of an outdoor heat exchanger, compressor(s), an air moving device, and in addition for Heat Pumps, can include a heating mode expansion device, reversing valve, or defrost controls, or any combination thereof. VRF Water-source Heat Pumps do not have an air movement device.

3.2.29.1 *Combined Module.* Two or more Single Modules that are mechanically and electronically joined together to operate as a single Outdoor Unit, and that is assembled with multiple Indoor Units to form a system. When such equipment is provided in more than one assembly, the separated assemblies are designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies.

3.2.29.2 *Single Module.* A single Outdoor Unit that is assembled with multiple Indoor Units and controls to form a system.

3.2.30 *Outdoor Variable Valves.* Variable position refrigerant valves in the Outdoor Unit.

3.2.31 *Power Correction Capacitors*. A capacitor that increases the power factor measured at the line connection to the equipment.

3.2.32 *Published Rating.* A statement of the assigned values of those performance characteristics, under stated Rating Conditions, where a unit can be chosen to fit the application. These values apply to all units of the same nominal size and type (identification) produced by the same manufacturer. This includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

3.2.32.1 *Application Rating.* A rating based on tests performed at Rating Conditions other than Standard Rating Conditions.

3.2.32.2 *Standard Rating.* A rating based on tests performed at Standard Rating Conditions.

3.2.33 *Rating Conditions.* Any set of operating conditions where a single level of performance results and causes only that level of performance to occur.

3.2.33.1 *Standard Rating Condition*. Rating Conditions used as the basis of comparison for performance characteristics.

3.2.34 *Return Air Temperature Unit Sensor(s).* A factory installed component that measures the temperature of the return air or indoor room air entering the unit under test.

3.2.35 *Root Sum of Square Point Total (RSS Point Total)*. An instantaneous measure of Critical Parameter variation, the root-sum-square of the points accrued by all overridden critical parameters, as defined by Equation C5.

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3.2.36 *Sensible Heat Ratio (SHR).* A ratio of the Sensible Cooling Capacity to the Total Cooling Capacity at a given condition.

3.2.37 *Set Point Bias.* The difference between 80ºF and the nominal thermostat set point required for the thermostat to control for 80ºF-sensed temperature at the sensed location.

3.2.38 *Set Point Offset.* The difference between the temperature indicated by a thermostat's temperature sensor and the actual temperature at the sensor's location.

3.2.39 *Service Tool.* A manufacturer's tool for checking system hardware/software, often provided as a download from either the manufacturer's certified installer website or from an authorized representative.

3.2.40 *Simultaneous Cooling and Heating Efficiency (SCHE).* The ratio of the total capacity of the system (heating and cooling capacity) to the Total Power when operating in the heat recovery mode, (Btu/h)/W.

3.2.41 *Small-duct, High-velocity System (SDHV).* Split System where all Indoor Units are SDHV Indoor Units.

3.2.42 *Stable Conditions*. Balanced operating conditions in the indoor and outdoor section of the test chamber where the test unit is maintaining Steady-state Test conditions and the test chamber is maintaining test room conditions within prescribed tolerances.

3.2.43 *Standard Air*. Air weighing 0.075 lb/ft^3 that approximates dry air at 70°F and 29.92 in Hg.

3.2.44 *Standard Airflow.* The volumetric flowrate of air corrected to standard air conditions, in scfm.

3.2.45 *Standard Rating Test.* Tests performed at Standard Rating Conditions.

3.2.46 *Steady-state Test*. A test where the controlled test parameters are regulated to remain within the specified tolerances while the unit operates continuously in the same mode.

3.2.47 *Steam or Hydronic Coils*. An assembly that conditions air through coils containing steam or water.

3.2.48 *System Controls.* A set of mechanical and electrical devices that manages, commands, directs or regulates the behavior of the unit(s) under test. The system can include:

- An integral network operations and communications system with sensors to monitor the status of items such as temperature, pressure, oil, refrigerant levels, and fan speed.
- A microprocessor, algorithm-based control scheme to:
  - communicate with a managed compressor(s), fan speed of Indoor Units, fan speed of the Outdoor Unit(s), solenoids, other accessories
  - manage metering devices
  - concurrently operate multiple parts of the system.
- Regulate system efficiency and refrigerant flow through an engineered distributed refrigerant system to conduct zoning operations, matching capacity to the load in each of the zones.

3.2.49 *Test Condition Tolerance.* The maximum permissible difference between the average value of the measured test parameter and the specified test condition.

3.2.50 *Test Operating Tolerance.* The maximum permissible range a measurement can vary over the specified test interval. When expressed as a percentage, the maximum allowable variation that can be used is the specified percentage of the average value.

3.2.51 *Tested Combination.* An arrangement of Indoor Units and Outdoor Units that are production units (or for product development purposes are representative of production units) and provides representative performance values. Refer to Section 6.2 for the requirements for these arrangements.

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3.2.52 *Thermally Active.* The state of an Indoor Unit when the unit is cooling, as indicated by the digital on/off signal from the Service Tool or by a liquid expansion valve (LEV) position indicated by the Service Tool greater than the minimum LEV position for that valve.

3.2.53 *Thermally Inactive.* The state of an Indoor Unit when the unit is not Thermally Active.

3.2.54 *Total Power*. The sum of the average electrical power input consumed by all components of a system, expressed as W, including all of the following:

- Power input for operation of the compressor(s)
- Power input to electric heating devices used only for defrosting
- Power input to all control and safety devices of the equipment
- Power input to factory installed condensate pumps
- Power input for operation of all fans and, if applicable, any Water-source condenser pump(s) (including pump power adjustments)

3.2.55 *Variable Refrigerant Flow (VRF) System.* An engineered direct expansion (DX) air-conditioning or Heat Pump multi-split system that incorporates the characteristics and components:

- A single refrigerant circuit that has a common piping network to multiple Indoor Units;
- Single Module or Combined Module Outdoor Units;
- Two or more Indoor Units;
- Three or more steps of capacity; and
- A zone temperature control device such as a thermostat.

Note: VRF Systems less than 65,000 Btu/h Cooling Capacity are designated as central air conditioners and central air conditioning Heat Pumps in 10 CFR §429, 10 CFR §430, and 10 CFR §431.

3.2.55.1 *VRF Air-source System*. A VRF Heat Pump with Single Module or Combined Module Outdoor Units that have air-to-refrigerant heat exchangers.

3.2.55.2 *VRF Heat Recovery System*. A VRF Air-source System or VRF Water-source Heat Pump capable of providing simultaneous heating and cooling operation through a Heat Recovery Control Unit, where recovered energy from the Indoor Units operating in one mode can be transferred to one or more other Indoor Units operating in the other mode.

Note: This can be achieved by a gas/liquid separator or a third line in the refrigeration circuit.

3.2.55.3 *VRF Water-source Heat Pump*. The Heat Pump consists of one or more factory-made assemblies that can include an indoor conditioning coil with air moving means, compressor(s), and refrigerant-to-fluid heat exchanger(s), including a means to provide both cooling and heating functions. The three main types of VRF Water-source Heat Pumps are;

3.2.55.3.1 *Ground-loop Heat Pump.* A Brine-to-air Heat Pump that uses a brine solution circulating through a subsurface piping loop as a heat source/heat sink.

Note: The heat exchange loop can be placed in horizontal trenches, vertical bores, or be submerged in a body of surface water. The temperature of the brine is related to the climatic conditions and can vary from 23°F to 104°F.

3.2.55.3.2 *Ground-water Heat Pump.* A Water-source Heat Pump that uses water pumped from a well, lake, or stream as a heat source/heat sink.

Note: The temperature of the water is related to the climatic conditions and can vary from 41°F to 77°F for deep wells.

3.2.55.3.3 *Water Loop Heat Pump*. A Water-source Heat Pump using liquid circulating in a common piping loop as a heat source/heat sink.

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Note: The temperature of the liquid loop can be controlled to be within a temperature range of 59°F to 104°F.

3.2.56 *Variable Speed Compressor.* A compressor that has capability of varying the rotational speed in non-discrete stages or steps from low to intermediate to full using an inverter or variable frequency drive.

3.2.57 *Ventilation Energy Recovery System (VERS)*. An assembly that preconditions outdoor air entering the equipment through direct or indirect thermal or moisture exchange with the exhaust air, or both, defined as the building air being exhausted to the outside from the equipment. Also known as exhaust air energy recovery.

Section 4. Classifications

4.1 Equipment covered within the scope of this standard shall be classified as shown in Table 1.

Table 1. Classification of VRF Systems

System Identification	VRF Air-conditioner or Heat Pump System	VRF Heat Recovery System
Air-conditioner (Air-source)	MSV-A-CB[1]	Not Applicable
Air-conditioner (Water-source)	Not Applicable	Not Applicable
Heat Pump (Air-source)	HMSV-A-CB[1]	HMSR-A-CB[1]
Heat Pump (Water-source)	HMSV-W-CB[1]	HMSR-W-CB[1]

Note:
- "-A" indicates Air-source condenser and "-W" indicates Water-source condenser.

Section 5. Test Requirements

5.1 *Test Requirements.* All testing for Standard Ratings shall be conducted in accordance with the test methods and procedures described in this standard.

5.1.1 *Standards*. VRF Systems shall be tested in accordance with Section 6, Appendix C, and Appendix E. Additionally, VRF Water-source Heat Pump systems shall be tested in accordance with Section 6.3.1.6 of ASHRAE 30.

5.1.2 *Equipment setup.* To set up equipment for test, manufacturer authorized personnel with knowledge of the control software can support commissioning of the system being tested.

5.1.2.1 *Critical Parameters.* At each load point, Critical Parameters shall be set to the values in the STI. In cases where a Critical Parameter value is not in the STI, the system shall operate by commands from the System Controls for that parameter. Once set, Control Settings shall remain unchanged for the remainder of the test (except for allowable adjustment of Critical Parameters as described in Section 6.3.3 for IEER tests). The initial setting and any allowable adjustment of Critical Parameters shall be performed by manufacturer authorized personnel and monitored by a member of the laboratory.

5.1.2.2 *Control Settings*. Control Settings other than Critical Parameters shall be set by a member of the laboratory. All Control Settings are to remain unchanged for all load points once system setup has been completed.

Airflow-control Settings shall be in accordance with Section 6.3.1.

5.1.2.3 *Thermally Active State.* If the Thermally Active state of an indoor unit cannot be determined from the digital on/off signal from the Service Tool, active status is indicated by an LEV position indicated by the Service Tool greater than the minimum LEV position for that valve. The time history of the temperature difference between the inlet and outlet thermocouple grids of an indoor unit can be examined to verify either of these indication methods.

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5.1.3 *Oil Recovery Mode.* The Oil Recovery Mode shall be enabled during testing. If the Oil Recovery Mode prevents a Steady-state Test, use the transient test procedure as described in Section 8.8.3, except Section 8.8.3.3, of ASHRAE 37, with the following modifications:

For tests of VRF Systems that cannot reach steady state because of Oil Recovery Mode, Section 8.8.3 (except Section 8.8.3.3) of ASHRAE 37 shall be modified by replacing all mentions of "defrost" with "Oil Recovery Mode", replacing all mentions of "Heat Pump" with "system" and replacing all mentions of "heating" with "conditioning". The test tolerances specified in Table 2 of ASHRAE 37 for "heat portion" under "heat with frost" shall be satisfied when conducting the tests. The test tolerance parameters included in Table 2 of ASHRAE 37 shall be sampled throughout the preconditioning and data collection period. To evaluate compliance with the specified test tolerances, the dry-bulb temperature of the air entering the indoor-side and the outdoor-side and the water vapor content of the air entering the indoor or outdoor-side shall be sampled at least every minute. All other parameters shall be sampled at equal intervals that span five minutes or less.

5.1.4 *Defrost Controls*. Defrost controls shall be left at manufacturer's factory settings if the MII provided with the equipment do not specify otherwise. Any Control Settings for defrost specified by the MII that can be achieved through methods outlined in the MII can be used to achieve Steady-state Test operation. If unable to run a Steady-state Test procedure due to Control Settings for defrost, the transient test procedure as defined in ASHRAE 37 shall be used with the following exclusions:

- The Test Operating Tolerance for the outdoor entering conditions is omitted during the defrost portion.
- The Test Operating Tolerances and Test Condition Tolerances for the heat portion shall apply when the unit is in heating mode except for the first thirty minutes after terminating a defrost cycle.

To facilitate testing of any unit, the manufacturer shall provide information and any necessary hardware to manually initiate a defrost cycle.

5.1.5 *Indoor Unit Temperature Control Set Point.* The temperature set point for each Indoor Unit that is Thermally Active shall be set to 80°F.

5.1.5.1 *Set Point Offsets.* Identify and correct for Set Point Offset(s) that can be present in indoor unit thermostats by using the following procedures. Round set point adjustments to the nearest set point increment.

5.1.5.1.1 *Independent Return/Indoor Ambient Air Temperature Unit Sensor.* If the control for the Indoor Unit utilizes an independent return/indoor ambient air temperature unit sensor for each Indoor Unit, adjust the set point for each Indoor Unit by the difference between the measurements of the return air thermocouple grid and the Return Air Temperature Unit Sensor. The latter can be determined using either the on-board thermostat reading or the Service Tool.

5.1.5.1.2 *Common Return Air Temperature Unit Sensor.* If the control for the Indoor Unit utilizes a common Return Air Temperature Unit Sensor for multiple Indoor Units in operation, make a single adjustment by the difference between the average of the thermocouple grid measurements and the Indoor Units group's return/ambient air temperature sensor that is determined using either the on-board thermostat reading or from the Service Tool.

5.1.5.2 *Set Point Bias.* If the controls of the unit under test include a Set Point Bias, the manufacturer can include the Set Point Bias in the STI. If a Set Point Bias is included in the STI, the temperature set point for each Indoor Unit that is Thermally Active shall be set to 80°F, less the STI-reported Set Point Bias up to 2°F. If the controls have a Set Point Bias and there is also Set Point Offset, the temperature set point for each Indoor Unit that is Thermally Active shall be set to 80°F, less the STI-reported Set Point Bias up to 2°F, plus the difference between the thermocouple grid measurement or average and the Return Air Temperature Unit Sensor.

5.2 *Head Pressure Control for VRF Air-source Systems and VRF Water-source Heat Pump Systems*. For units that have condenser head pressure control to verify proper flow of refrigerant through the expansion valve during low condenser air or water inlet temperature conditions, the head pressure controls shall be enabled and operate in automatic control mode. The setting shall be set at the factory settings or as defined in the MII.

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If the head pressure control is engaged by the control logic during part-load cooling tests, then use the following steps. For all part-load cooling tests for VRF Water-source Heat Pump systems, the water flow rate shall not exceed the value for the full-load cooling test.

5.2.1 *Control Logic.* The System Controls shall control the operation of the unit. If the unit can be run and Stable Conditions are obtained and the test tolerances in Table 15 are met, then a standard part-load cooling test shall be run.

5.2.2 *Head Pressure Control Time Average Test.* If the head pressure control results in unstable conditions and the test tolerances in Table 15 cannot be met, then a series of two one-hour Steady-state Tests shall be run. Prior to the first one-hour test the condenser entering temperature, meaning the outdoor air dry-bulb temperature or condenser water temperature, defined by Table 8 or Table 9 as applicable shall be approached from at least a 10ºF greater than temperature until the tolerances specified in Table 2 are met. Prior to the second one-hour test, the condenser entering temperature defined by Table 8 or Table 9 as applicable shall be approached from at least a 5ºF less than temperature until the tolerances specified in Table 2 are met. For each test, once all tolerances in Table 2 are met, the one-hour test shall be started and test data shall be recorded every five minutes for one hour, resulting in twelve test measurements for each test parameter. During each one-hour test, the tolerances specified in Table 2 shall be met.

If the tolerances in Table 2 are met, the test results for both one-hour Steady-state Tests shall then be averaged to determine the capacity and efficiency that is to be used for the IEER calculation.

5.2.3 *Tolerances Not Met.* If the tolerances in Table 2 cannot be met for the head pressure control time average test, MII shall be used to determine the settings required to stabilize operation. However, if the MII does not provide guidance for stable operation or results in a condensing (liquid outlet) pressure corresponding to a Bubble Point temperature less than 75°F, proceed to Section 5.2.4.

5.2.4 *Manufacturer's Installation Instructions Cannot be Used.* If the MII cannot be used to achieve stable operation, the fan(s) for Air-Source units or valve(s) for VRF Water-source Heat Pump systems causing the instability shall be set manually at a speed, operating state (on/off), or positioned to achieve a condensing liquid outlet pressure corresponding to a Bubble Point temperature as close to 85°F as can be achieved while not dropping less than 85°F.

5.3 *Instruments*. Use instruments that meet the applicable requirements specifications in Section 5 of ASHRAE 37 with the amendments in Section 5.3.1 and Section 5.3.2.

5.3.1 For measurement of indoor and outdoor air temperatures, the provisions of Appendix E4 of this standard applicable to instruments take precedence over Section 5 of ASHRAE 37.

5.3.2 The atmospheric pressure measuring instruments shall be accurate to within ±0.5% of the reading.

5.4 *Literature Hierarchy*. For system set-up and Control Settings, use specifications from the STI. For instructions not specified in the STI, the hierarchy shall be Outdoor Unit MII, followed by the Outdoor Unit labels, followed by the Indoor Unit MII. For settings not specified in any of the preceding sources, the as-shipped setting shall be used.

STI shall include all instructions that do not deviate from the MII but provide additional specifications for test standard requirements where there is more than one option in the MII. In addition, documentation of settings and software required to obtain all deviations from the MII necessary to comply with Steady-state Test requirements shall be included.

STI shall provide steady operation that matches to the extent possible the average performance that can be obtained without deviating from the MII. STI shall not include instructions that deviate from the MII other than those described in this section.

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Table 2. Tolerances for Head Pressure Control Time Average Test			
		Operating Tolerance	Condition Tolerance
Indoor air dry-bulb temperature (°F)	Entering	3.0	1.0
	Leaving	3.0	-
Indoor air wet-bulb temperature (°F)	Entering	1.5	0.5
	Leaving	1.5	—
Outdoor air dry-bulb temperature (°F)	Entering	3.0	1.0
	Leaving	—	
Outdoor air wet-bulb temperature (°F)	Entering	1.5	—
	Leaving	—	—
Water serving outdoor coil temperature (°F)	Entering	0.75	0.3
	Leaving	0.75	
Voltage		2%	1%

5.5 *Test Unit Location.* All Indoor Unit(s) and VRF Water-source Heat Pump Outdoor Unit(s) shall be in an indoor test room(s) such as a test chamber(s) maintained at the air conditions specified for return indoor air during all tests. VRF Air-source System Outdoor Unit(s) shall be in an outdoor test room(s) such as a test chamber(s) maintained at the air conditions specified for outdoor ambient air during all tests.

5.6 *Heat Recovery Control Units*. For VRF Heat Recovery Systems, the Heat Recovery Control Unit shall be attached during all tests.

5.7 *Atmospheric Pressure*. Tests shall be conducted at an atmospheric pressure of at least 13.7 psia.

5.8 *Refrigerant Charging.* All test samples shall be charged at Standard Rating Conditions in accordance with the MII or labels applied to the unit. If the MII gives a specified range for superheat, sub-cooling, or refrigerant pressure, the average of the range shall be used to determine the refrigerant charge.

In the event of conflicting information between charging instructions, use the hierarchy of Section 5.4. Conflicting information is defined as multiple conditions given for charge adjustment where all conditions specified cannot be met.

In such instances, follow the hierarchy in Table 3 for priority unless the manufacturer specifies a different priority. Unless the manufacturer specifies a tighter charging tolerance, the tolerances specified in Table 3 shall be used.

Table 3. Test Condition Tolerance for Charging Hierarchy		
Charging Method		Test Condition Tolerance of the Target Value in the MII, ±
1	Charge Weight	1.0 oz
2	Sub-cooling	10%; Not less than 0.5°F, not more than 2.0°F
3	High Side Pressure or Saturation Temperature	4.0 psi or 1.0°F
4	Low Side Pressure or Saturation Temperature	2.0 psi or 0.8°F
5	Approach Temperature	1.0°F

The resulting refrigerant charge obtained shall then be used to conduct all cooling cycle and heating cycle tests unless an adjustment is required based on the sections below. Once the correct refrigerant charge is determined, all tests shall run until completion without further modification.

Note: After completion of all required tests, laboratories should achieve full-load cooling test conditions for thirty continuous minutes and compare the results to the previous set of full-load cooling tests. Measured charge parameters outside of those listed in Table 3 are an indication the refrigerant charge or other parameters have changed, and an analysis should be performed, and corrective actions made.

5.8.1 *Heat Pumps.* The refrigerant charge shall be set at the full-load cooling conditions or as specified by the manufacturer. The initial heating test shall be the high-temperature heating test. Charge parameters shall be checked in accordance with the MII (if provided). If conditions are within the range specified by MII continue with the remainder of the tests.

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5.8.1.1 If heating refrigerant charge parameters are not within the range specified by the MII then the smallest adjustment to refrigerant charge to get within the heating refrigerant charge and cooling refrigerant charge parameters shall be made. If the heating and cooling refrigerant charge requirements cannot be met simultaneously, maintain the charge within the tolerance for the cooling test while keeping the charge as close as possible to the requirement for the heating test. Re-run the cooling tests after any adjustment of system charge.

5.9 *Requirements for Separated Assemblies (Applies to all Systems)*. The Indoor Units and Outdoor Unit are in two separate assemblies.

5.9.1 The Indoor Units and Outdoor Unit shall be installed with a minimum of 25 ft of actual interconnecting refrigerant piping length, running from the Outdoor Unit to each of the Indoor Units. The distance is measured from the nearest Outdoor Unit to each of the Indoor Units. There is a common length of piping from the Outdoor Unit to the first branching device. Refer to Table 4 for minimum total refrigerant piping lengths for each capacity range of Outdoor Unit and configuration of either ducted or non-ducted Indoor Units. In certain testing situations, test room capacity or arrangement can cause the user to run refrigerant piping that is longer than the minimum. To validate fairness of testing, Table 5 accounts for system capacity that is lost due to the additional refrigerant piping length above the minimum. If the minimum refrigerant piping lengths provided in Table 4 need to be exceeded for at least 33%, a minimum of two lengths, of the Indoor Units, then a Cooling Capacity correction factor from Table 5 shall be applied.

5.9.2 In all cases, the absolute minimum length necessary to physically connect the system shall be used. If the minimum refrigerant piping lengths provided in Table 4 are exceeded for at least 33% (minimum of two) of the Indoor Units, then a Cooling Capacity correction factor shall be applied.

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Table 4. Piping Requirements from Outdoor Unit to Each Indoor Unit		
System Standard Rated Cooling Capacity, Btu/h	Systems with Non-ducted Indoor Units, ft	Systems with Ducted Indoor Units, ft
0 to <65,000[1]	25	25
≥65,000 to <105,000	50	25
≥105,000 to <135,000	75	25
≥135,000 to <350,000	100	50
≥350,000	150	75
Note: 1. For VRF Water-source Heat Pumps		

Table 5. Refrigerant Piping Length Correction Factors in Cooling	
Additional Piping Length, ft	Cooling Capacity Correction Factor
3.3 < X ≤ 20	1.01
20 < X ≤ 40	1.02
40 < X ≤ 60	1.03
60 < X ≤ 80	1.04
80 < X ≤ 100	1.05
100 < X ≤ 120	1.06
Notes: • The Cooling Capacity correction factor is determined by the average refrigerant piping length in addition to the minimum defined in Table 4. • This table applies to Standard Rating Cooling Capacity only.	

5.9.3 For VRF Air-source Systems, at least 10 ft of the system interconnection tubing shall be exposed to the outdoor room conditions. The line diameters, insulation, installation details, evacuation and charging shall follow the MII. The manufacturer shall provide a schematic of the Tested Combination installation (see Figure 1). Refer to Appendix E for additional set-up information. For regulatory compliance, refer to Appendix D. To minimize performance degradation, surplus copper tubing shall be coiled in a space where the coils cannot be disturbed. The coils shall be horizontal with a minimum diameter of 2 ft. The coils shall be in a place where the manufacturer can check the copper tubing for any potential issues. The minimum length of the refrigerant path shall be not less than the minimum length as designated in Table 4. If the manufacturer supplies piping and does not recommend cutting to length, all the piping shall be used so long as the refrigerant path is not less than the minimum length as designated in Table 4.

5.9.4 For systems with Combined Modules, the modules shall be arranged in a straight line where able and placed with a spacing of 2 ft ± 3 in between the modules, unless the MII specifies a greater minimum spacing. If a single outdoor laboratory section cannot accommodate the straight alignment of the Combined Modules, then an L-shaped configuration shall be attempted. If an L-shaped configuration cannot be achieved, then a second outdoor laboratory section shall be used.

5.10 *Indoor Unit Operation for Load Point Tests*. For full-load and part-load point tests the Indoor Units that are Thermally Active shall be in accordance with the STI. For the 25% load point test, at least half of the total Indoor Units, as calculated per the total capacity of the connected Indoor Units, shall remain Thermally Inactive. Forced air circulation through any Indoor Unit that is Thermally Inactive shall be prevented. This can be achieved by blocking the inlet and outlet. For the Indoor Unit(s) that are Thermally Inactive, the indoor unit control settings shall be set to “OFF” by using the remote or wireless thermostat.

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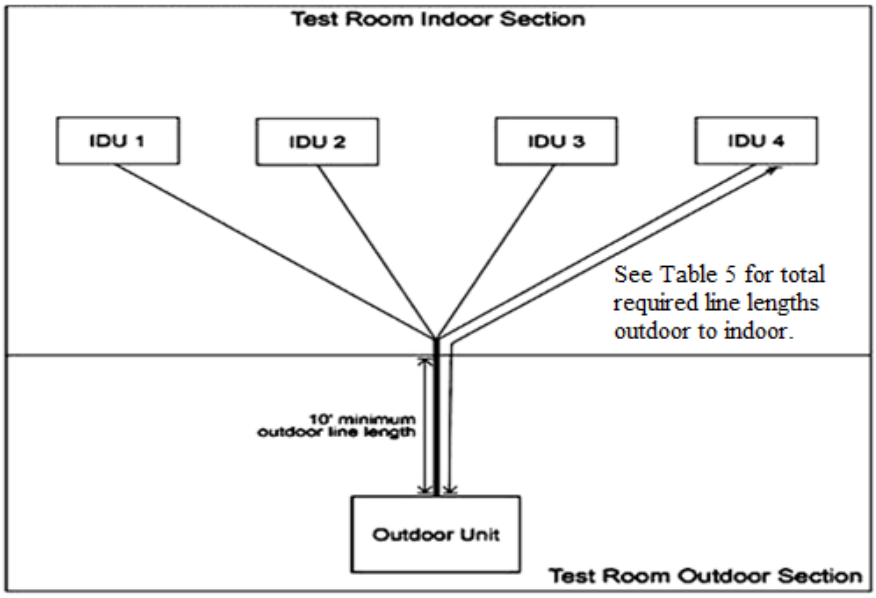


Figure 1. Test Room Layout

Section 6. Rating Requirements

6.1 *Standard Ratings*

6.1.1 *Nominal Cooling Capacity Requirements.* The Nominal Cooling Capacity of the Basic Model shall not be more than 105% of the Standard Rated Cooling Capacity.

6.1.2 *Minimum External Static Pressure Requirements for Ducted Indoor Units.* The minimum ESP for individual ducted Indoor Units are shown in Table 6. Small-duct, High-velocity Systems (SDHV) shall be tested at 1.15 in H_2O. If the manufacturer only has Low-static ducted models and if the manufacturer's specified maximum external static pressure is less than 0.10 in H_2O, then the Indoor Unit shall be tested at 0.02 below the maximum external static pressure.

Table 6. Minimum External Static Pressure (ESP) for Individual Ducted Indoor Units

Capacity, Btu/h [1,2]	ESP [3], in H_2O
Up through 28,800	0.10
29,000 to 42,500	0.15
43,000 to 70,000	0.20
71,000 to 105,000	0.25
106,000 to 134,000	0.30
135,000 to 210,000	0.35
211,000 to 280,000	0.40
281,000 to 350,000	0.45
351,000 and above	0.55

Notes:
1. The Indoor Unit capacity as specified in the MII, when operated at the Standard Rating Cooling Conditions.
2. For heating-only Heat Pumps, the value the manufacturer cites in MII for the capacity of the Indoor Unit when operated at the Standard Rating Conditions (High Temperature Steady-state Test) conditions.
3. For ducted units tested without an air filter installed, increase the applicable tabular value by 0.08 in H_2O.

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6.1.3 *Electrical Conditions.* Tests shall be performed at the nameplate rated frequency. For equipment that is rated with 208/230 V dual nameplate voltages, tests conducted at Standard Rating Conditions shall be performed at 230 V. For all other dual nameplate voltage equipment covered by this standard, the tests shall be performed either at both voltages or at the lower of the two voltages if only a single Standard Rating is to be published.

6.1.4 *Integral Condensate Pump*. If a Non-ducted Indoor Unit or a Ducted Indoor Unit contains an integral condensate pump, the power to operate the pump shall be included in the system Total Power calculation.

6.2 *Tested Combinations.* A Tested Combination for all VRF Air-source Systems and VRF Water-source Heat Pump systems greater than or equal to 65,000 Btu/h consists of an Outdoor Unit and a minimum of two and a maximum of twelve Indoor Units. Only Ducted Indoor Units are used to determine the ratings for ducted VRF systems. Only Non-ducted Indoor Units are used to determine the ratings for non-ducted VRF systems.

6.2.1 The requirements for model families of Indoor Units shall be as follows:

6.2.1.1 All non-ducted Tested Combinations shall use Standard Four-way Ceiling Cassettes with the lowest normalized coil volume, as defined in Section 6.2.4. If a manufacturer does not have Four-way Ceiling Cassettes, the Tested Combination shall include Indoor Units with the lowest normalized coil volume, as defined in Section 6.2.4, only from the first Non-ducted Indoor Unit Model Family of the following when a valid Tested Combination can be assembled:

- Compact Four-way Ceiling Cassette;
- Three-way Cassette;
- Two-way Cassette;
- Wall-mounted;
- One-way Cassette; or
- Floor-mounted and Ceiling-suspended.

6.2.1.2 All ducted Tested Combinations shall use Mid-static Indoor Units with the lowest normalized coil volume, as defined in Section 6.2.4. If a manufacturer does not have Mid-static ducted units, the Tested Combination shall include indoor units with the lowest normalized coil volume, as defined in Section 6.2.4, only from the Indoor Unit Model Family with highest static capabilities. See minimum ESP requirements in Table 6.

6.2.1.3 Small-duct, High-velocity Tested Combinations shall use Small-duct High-velocity Indoor Units with the lowest normalized coil volume/motor efficiency, as defined in Section 6.2.4.

6.2.2 Indoor Units shall together have a Nominal Cooling Capacity of 100% ± 5.0% of the system Standard Rated Cooling Capacity. The Nominal Cooling Capacity of each Indoor Unit shall be the published capacity when the ratings are first established and shall not be changed upon subsequent publications.

6.2.3 Indoor Units shall not, individually, have a Nominal Cooling Capacity greater than 50% of the System Standard Rated Cooling Capacity, unless the System Standard Rated Cooling Capacity of the VRF Water-source Heat Pump is 24,000 Btu/h or less.

6.2.4 All Indoor Units shall either be production units or units representative of production units. If a manufacturer has multiple Indoor Unit models within the Capacity ranges as defined in Table 7 that meet the Tested Combination requirements, the manufacturer shall use the following criteria to select the Indoor Unit model for testing from these models. The first criterion shall be the coil size described in Section 6.2.4.1, and the second shall be the indoor fan motor efficiency described in Section 6.2.4.2.

6.2.4.1 The model with the lowest normalized coil volume, calculated using Equation 1, shall be used.

$$NCV = \frac{L_c \times W_c \times D_c}{q_{nom}} \quad \textbf{1}$$

6.2.4.2 If more than one of the models has the same lowest normalized coil volume, the one with the lowest efficiency indoor fan motor (highest fan motor input power at rated indoor airflow) shall be used for Standard Ratings.

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Table 7. Nominal Indoor Unit Cooling Capacity Buckets	
Allowable Capacity Range	
Btu/h (minimum)	**Btu/h (maximum)**
2500	4499
4500	6499
6500	8499
8500	10,499
10,500	13,999
14,000	16,999
17,000	19,999
20,000	26,999
27,000	32,999
33,000	38,999
39,000	44,999
45,000	50,999
51,000	56,999
57,000	62,999
63,000	77,999
78,000	89,999
90,000	102,999

6.3 *Conditions for test for VRF Air-source and VRF Water-source Heat Pump Systems.* Table 8 and Table 9 indicate the test and test conditions that shall be used to measure capacity and energy efficiency. All tests listed in Table 8 and Table 9 shall be conducted at Stable Conditions. VRF Air-source Systems and VRF Water-source Heat Pump Systems with dual-rated frequencies shall be tested at each frequency.

6.3.1 *Indoor Unit Airflow and External Static Pressure.* Airflow-control Setting(s) shall be determined before testing begins. Unless otherwise identified in Section 6.3.1, changes shall not be made to the Airflow-control Setting(s) after initiation of testing. The fan operational speeds can be different for each part-load test provided that the Airflow-control setting(s) remain unchanged. The Airflow-control Setting for heating tests can be different than the Airflow-control Setting for cooling tests; however, the same Airflow-control Setting shall be used for all heating tests. For the Indoor Unit(s) that are specified Thermally Inactive, the Airflow-control Setting(s) shall be set to "OFF" in accordance with Section 5.10.

6.3.1.1 *Minimum External Static Pressure for Testing.*

6.3.1.1.1 *Non-ducted Indoor Units.* All tests shall be performed at zero ESP, with a tolerance of –0.00 to +0.02 in H_2O for all test conditions.

6.3.1.1.2 *Ducted Indoor Units.* For the full-load cooling test, test each Indoor Unit using the minimum ESP specified in Table 6. When conducting heating or part-load cooling tests when the indoor airflow rates are different than the airflow rates used for the full-load cooling test, calculate adjusted minimum ESP requirements using Equation 2. The minimum ESP requirement shall be applied to each individual Indoor Unit. For example, if half of Indoor Units are Thermally Inactive, the full-load ESP requirement is maintained for each Indoor Unit that is Thermally Active if the airflow rate through the Thermally Active Indoor Unit has not changed. If the airflow rate through a Thermally Active Indoor Unit has automatically changed through the Airflow-control Setting for a part-load test, then the ESP for that Indoor Unit shall be modified using Equation 2.

$$ESP_{adj} = ESP_{CFL} \cdot \left(\frac{Q_{dif}}{Q_{CFL}}\right)^2 \quad \textbf{2}$$

6.3.1.2 *Airflow Target Values.*

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6.3.1.2.1 For the full-load cooling test, use the manufacturer-specified Airflow-control Setting for each Indoor Unit. If the cooling Airflow-control Setting is not specified by the manufacturer, use an Airflow-control Setting resulting in an airflow greater or equal to the manufacturer-specified airflow. If the cooling Airflow-control Setting or airflow are not specified by the manufacturer, use an Airflow-Control Setting that results in an airflow not greater than 400 scfm per ton, for example per 12,000 Btu/h, of Indoor Unit Nominal Cooling Capacity.

6.3.1.2.2 For the heating tests, use the manufacturer-specified Airflow-control Setting for each Indoor Unit. If the delivered airflow differs from the part-load test at the same Airflow-control setting, then adjust the minimum ESP using the value obtained in Equation 2. If the heating Airflow-control Setting is not specified by the manufacturer, use the full-load cooling Airflow-control Setting for the heating tests.

6.3.1.2.3 For the part-load cooling tests, use the full-load Airflow-control Setting as defined in Section 6.3.1.2.1. If the delivered airflow differs from the part-load test at the same Airflow-control setting, then adjust the minimum ESP in accordance with the calculation obtained in Equation 2.

6.3.1.3 *Maximum Airflow for Non-ducted Indoor Units.* For cooling tests, maximum airflow for any indoor unit shall not exceed the lower of the following limits:

- 105% of the nominal airflow as published in product literature for that unit; or
- 55 scfm per 1000 Btu/h of nominal Indoor Unit cooling capacity.

If the airflow rate exceeds either or both limits, then use an Airflow-control Setting that results in an airflow not greater than the lower of the two limits mentioned in this section.

For heating tests, there is not a maximum airflow if the Airflow-control Setting used in the heating test is the same as the Airflow-control Setting used in the full-load cooling test. If the Airflow-control Setting used is different, the heating airflow shall not exceed 55 scfm per 1000 Btu/h of nominal Indoor Unit cooling capacity. If 55 scfm per 1000 Btu/h is exceeded, use an Airflow-control Setting that results in an airflow not greater than 55 scfm per 1000 Btu/h.

If the Nominal Capacity of each Indoor Unit is not accessible, then use total airflow and system Rated Capacity to determine the maximum allowable airflow rate.

If multiple Indoor Units discharge to a common duct, the cooling airflow limit is the lower of either the sum of nominal cooling capacities at 55 scfm per 1000 Btu/h or 105% of the sum of nominal airflows as published in product literature. When using the same Airflow-control Setting as cooling, the heating airflow does not have a maximum limit. If the Airflow-control Settings are different from cooling, the maximum limit is the sum of nominal cooling capacities at 55 scfm per 1000 Btu/h. These limits include all Indoor Units connected to the common duct and apply to the total airflow measured for all Indoor Units connected to the common duct.

The grouping of indoor units shall be manufacturer specified. However, if the manufacturer specifications do not consist of this grouping, any grouping of the specified indoor unit models connected to common ducts can be used, provided all test standard provisions are met.

6.3.1.4 *Maximum Airflow for Ducted Indoor Units.* The same restrictions in Section 6.3.1.3 for Non-ducted Indoor Units apply to Ducted Indoor Units, except 42 scfm per 1000 Btu/h shall be used instead of 55 scfm per 1000 Btu/h.

6.3.1.5 *Tolerances.* If a common duct is used for the combined discharge airflow of multiple Indoor Units, the measured combined airflow shall be compared to the sum of the airflow target value as defined in Section 6.3.1.2. In such a case, the following airflow tolerances apply to the measured combined discharge airflow.

6.3.1.5.1 *Condition Tolerances.* All tolerances for airflow and ESP specified in this section for setting airflow and ESP apply throughout each test. The average value of a parameter measured over

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the course of the test shall not vary from the target value by more than the condition tolerance specified in Table 12.

6.3.1.5.2 *Non-Ducted Indoor Units*.

6.3.1.5.2.1 Use the airflow target values defined in Section 6.3.1.2 for each respective test.

6.3.1.5.2.2 For all tests, conduct the test at zero ESP with a tolerance of –0.00 to +0.02 in H_2O.

6.3.1.5.2.3 For the full-load cooling test, the airflow tolerance is ±5% of target full-load cooling airflow. For the heating test, if the full-load cooling airflow is used or the target heating airflow is provided, the airflow tolerance is ±5% of the target airflow. If the manufacturer provides instructions to obtain steady-state heating operation in accordance with Section 6.3.1.2.2, an airflow tolerance is not required for the heating test. For part-load cooling tests, if the full-load cooling airflow is used or the target part-load cooling airflow is provided, the airflow tolerance is ±5% of the target airflow. If the manufacturer provides instructions to obtain steady-state part-load cooling operation in accordance with Section 6.3.1.2.3, an airflow tolerance is not required for part-load cooling tests.

6.3.1.5.2.4 If both the ESP and airflow cannot be maintained within tolerance for the full-load cooling and heating tests, maintain the ESP within the required tolerance and use an airflow as close to the target value as can be achieved**.**

6.3.1.5.3 *Ducted Indoor Units.*

6.3.1.5.3.1 *Full-Load Cooling Test.*

6.3.1.5.3.1.1 Operate the unit under conditions specified for the full-load cooling test using the airflow target value specified in Section 6.3.1.2. Adjust the airflow-measuring apparatus to maintain ESP within -0.00 to +0.05 in H_2O of the requirement specified in Table 6 or to maintain the airflow within ±5% of the full-load cooling airflow target value.

If both the ESP and airflow cannot be maintained within tolerance for the full-load cooling test, maintain the ESP within the required tolerance and use an airflow as close to the manufacturer-specified value as can be achieved.

6.3.1.5.3.2 *Heating Test.*

6.3.1.5.3.2.1 If the manufacturer-specified heating Airflow-control Setting is the same as the manufacturer-specified full-load cooling Airflow-control Setting, or if a heating Airflow-control Setting is not specified and the specified full-load cooling airflow target value is used as the airflow for the test in accordance with the provisions of Section 6.3.1.2.2, use the Airflow-control Settings used for the full-load cooling test. Adjust the airflow-measuring apparatus to maintain the airflow within ±5% of the measured full-load cooling airflow without regard to the resulting ESP.

6.3.1.5.3.2.2 If the manufacturer-specified heating Airflow-control Setting differs from the manufacturer-specified full-load cooling Airflow-control Setting (or if a heating Airflow-control Setting is not specified and the full-load cooling delivered airflow differs from the part-load test at the same Airflow-control Setting, in accordance with the provisions of Section 6.3.1.2.2), use the following provisions.

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