

OPERATIONS MANUAL

VARIABLE REFRIGERANT FLOW MULTI-SPLIT AIR-CONDITIONERS AND HEAT PUMPS CERTIFICATION PROGRAM



VRF OM – MAY 2018

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PREFACE

The following manual outlines the procedures and policies of the Performance Certification Program for Variable Refrigerant Flow Multi-Split Air-Conditioners and Heat Pump (VRF) Certification Program operated by the Air-Conditioning, Heating, and Refrigeration Institute (AHRI). This manual is to be used in conjunction with the AHRI General Operations Manual for AHRI Certification Programs. Where the AHRI General Operations Manual and this product-specific manual differ, this product-specific operations manual shall prevail.

The revision of this manual supersedes all previous revisions. The current edition of this manual, as well as the AHRI General Operations Manual, can be accessed through the AHRI website, www.ahrinet.org.

The AHRI VRF Certification Program by AHRI provides for independent verification of the performance of the Participant's equipment. Safety criteria are not within the scope of this program.

Participation in the program is voluntary. Any manufacturer, regardless of AHRI membership, may obtain approval of Program Ratings and use of the AHRI VRF Certification Mark hereinafter referred to as the "Mark". The Mark is the Participant's public representation that the ratings of randomly selected units have been verified by an independent laboratory in accordance with test procedures prescribed by this operations manual. A Certification Agreement is executed between the manufacturer and AHRI specifying the conditions under which such Ratings and the Mark may be used. No manufacturer has the right to use Program Ratings or to state that their products have been tested in conformance with the procedures outlined in this Rating Procedure unless and until they have received written authority from AHRI to use the Marks as applied to the specific approved Program Ratings.

This Operations Manual has been prepared to assure that administration of the program is carried out in a uniform manner. It is an amplification of the license agreement signed by licensees and AHRI. General information, procedural details, and copies of forms are included in this Operations Manual. Provisions of the Operations Manual may be amended as provided in the Certification Agreement.

This certification program complies with requirements of the ISO/IEC Standard 17065:2012, *General Requirements for Bodies Operating Product Certification Systems*.

Notes:

1. This manual supersedes VRF Operations Manual, January 2018.
2. VRF Systems under 65,000 Btu/h will be tested per AHRI Standard 210/240 and corresponding OM until such time as these systems are transitioned into this program.

VRF CERTIFICATION PROGRAM OPERATIONS MANUAL

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1. Program Overview

1.1 Applicable Rating Standard. It is mandatory for program Participants to comply with the provisions of the latest edition of AHRI Standard 1230, *Performance Rating of Variable Refrigerant Flow (VRF) Multi-Split Air-Conditioning and Heat Pump Equipment* (Standard). A copy of the Standard is available for download from the AHRI website, www.ahrinet.org.

1.2 Product Definitions. All terms in this document shall follow the AHRI GOM and the Standard definitions unless otherwise defined in this section.

1.2.1 Indoor Unit. A separate assembly of a Split System (a service coil is not an Indoor Unit) that includes the features listed in Sections 1.2.1, 1.2.2, 1.2.3, and 1.2.4; and may or may not include the features listed in Sections 1.2.5, 1.2.6, and 1.2.7.

1.2.1.1 An arrangement of refrigerant-to-air heat transfer coil(s) for transfer of heat between the refrigerant and the indoor air

1.2.1.2 A condensate drain pan

1.2.1.3 An air temperature sensing device

1.2.1.4 An integrated indoor blower (i.e. a device to move air including its associated motor). A separate designated air mover that may be a furnace or a modular blower (as defined in appendix AA to the subpart) may be considered to be part of the Indoor Unit

1.2.1.5 Sheet metal or plastic parts not part of external cabinetry to direct/route airflow over the coil(s).

1.2.1.6 A cooling mode expansion device

1.2.1.7 External cabinetry

1.2.2 Variable Refrigerant Flow (VRF) System. An engineered direct expansion (DX) Multi-split System incorporating the following:

1.2.2.1 A Split System air-conditioner or Heat Pump incorporating a single refrigerant circuit that is a common piping network to multiple Indoor Units;

1.2.2.2 Air-conditioner, Heat Pump, or heat recovery type system;

1.2.2.3 One or multiple-manifolded Outdoor Units with a specific model number with at least one variable capacity compressor.

1.2.2.4 Indoor Units.

1.2.2.5 Three or more steps of control on common, inter-connecting piping.

1.2.2.6 VRF Multi-split Air-to-air System. A VRF system air-conditioner or VRF Heat Pump with one or more manifolded Outdoor Units that have air-to-air heat exchangers.

1.2.2.7 VRF Heat Recovery Multi-split System. A VRF air-to-air Heat Pump or VRF Water Source Heat Pump that is capable of providing simultaneous heating and cooling operation, 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.

Notes:

1. This may be achieved by a gas/liquid separator or a third line in the refrigeration circuit.

2. Single-phase VRF systems less than 65,000 Btu/h are considered as central air conditioners and central air conditioning Heat Pumps in 10 CFR 429 and 10 CFR 430 Appendix M.

1.2.3 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, may include a heating mode expansion device, reversing valve, and/or defrost controls; water-source Heat Pumps may not have an air movement device.

1.2.4 Water Source Unit. A water-source Heat Pump is typically one of multiple units using fluid circulated in a common piping loop as a heat source/heat sink. The temperature of the loop fluid is usually mechanically controlled within a moderate temperature range. The Heat Pump consists of one or more factory-made assemblies which normally include an indoor conditioning coil with air moving means, compressor(s) and refrigerant-to-water heat exchanger(s), including means to provide both cooling and heating or cooling only functions. When such equipment is provided in more than one assembly, the separated assemblies shall be designed to be used together, and the requirements of rating outlined in the standard are based upon the use of matched assemblies. Any references to Water Source Heat Pumps in this Standard includes all capacities \geq 17,000 Btu/h.

1.2.4.1 Water To Air Heat Pump and/or Brine to Air Heat Pump. A Heat Pump which consists of one or more heat source factory-made assemblies which normally include an indoor conditioning coil with air-moving means, at least one Variable Speed Compressor(s), and refrigerant-to- water or refrigerant-to-brine heat exchanger(s), including means to provide both cooling and heating, cooling-only, or heating-only functions. When such equipment is provided in more than one assembly, the separated assemblies should be designed to be used together. Such equipment may also provide functions of sanitary water heating, air cleaning, dehumidifying, and humidifying.

1.2.4.2 Water Loop Heat Pump. Water-to-air Heat Pump using liquid circulating in a common piping loop functioning as a heat source/heat sink. The temperature of the liquid loop is usually mechanically controlled within a temperature range of 59°F to 104°F.

1.2.4.3 Ground-Loop Heat Pump. Brine-to-air Heat Pump using a brine solution circulating through a subsurface piping loop functioning as a heat source/heat sink. The heat exchange loop may be placed in horizontal trenches, vertical bores, or be submerged in a body of surface water. (ANSI/ARI/ASHRAE ISO Standard 13256-1:1998) The temperature of the brine is related to the climatic conditions and may vary from 23°F to 104°F.

1.2.4.4 Ground-water Heat Pump. Water-to-air Heat Pump using water pumped from a well, lake, or stream functioning as a heat source/heat sink. The temperature of the water is related to the climatic conditions and may vary from 41°F to 77°F for deep wells.

1.2.5 Single Module. A single Outdoor Unit or Water Source Unit that is assembled with multiple indoor units and controls to form a system.

1.2.6 Combined Modules. Two (2) or more single modules that are mechanically and electronically joined together by a licensed contractor in the field or a technician in a test lab to operate as a single outdoor unit that is assembled with multiple indoor units and controls to form a system.

1.3 Program Scope. This Certification Program applies to Production Models of 50 and 60 Hz VRF Systems, as defined in Section 1.2, that meet the following criteria:

- Include multi-split, system air-conditioners and heat pumps irrespective of their type of electric power source, or secondary fluid (e.g. air-to-air or water-to-air);
- Use distributed refrigerant technology with cooling and heating capacities for Outdoor Units and Water Source Units from 12,000 Btu/h [3508 W] to 760,000 Btu/h [222,734 W] and indoor units from 5,000 Btu/h [1,462 W] to 144,000 Btu/h [42,202 W]. Each indoor unit is designed to condition a single zone;

- Consisting of the following matched components: a) an Outdoor Unit with single or multiple compressors or variable capacity compressor; b) multiple Indoor Units; and c) a zone temperature control device; and
- 1.4 Intended Market. The Intended Market for this Certification Program includes all products defined in Section 1.3 that are sold for use in the U.S. (including U.S. Territories) and Canada. The Participant may choose to certify products outside of the intended market by Basic Model Group (BMG).

1.5 Basic Model Group (BMG). A Participant's listings shall be grouped by BMG. Each BMG shall have the following characteristics:

- Air-source and water source are in separate BMGs
- Heat pump and heat recovery may be in the same BMG
- Systems with different voltages may be in the same BMG
- All systems within a BMG must have the same nominal cooling capacity

2. Qualification Process

2.1 Original Equipment Manufacturer (OEM) Applicants. With the additions noted below, the OEM qualification process shall proceed according to the AHRI General Operations Manual, Section 4.

STEP 2.1.1 Certification Application Package. In addition to the Application for AHRI Certification and Annual Sales Volume Form noted in the AHRI General Operations Manual, Section 4, Step 1, Applicants shall submit the following documentation to AHRI. System data submitted must be consistent with the Tested Combination definition contained in the latest edition of AHRI 1230.

- VRF DS4 data submittal forms (for systems $\geq 65,000$ Btu/h [19,033 W]);
- One test report for each BMG;
- Supplemental testing instructions PDF for each system (Appendix J of AHRI Standard 1230-2014 with Addendum 1 provides guidance on how to develop such instructions);
- An Applicant requesting AHRI to submit data to CEC, DOE, and FTC shall submit third-party authorization, compliance forms and other necessary information.

Electronic forms shall be obtained from AHRI (available on www.ahrinet.org under the Product-Specific Certification Program).

STEP 2.1.2 Processing Application Package.

STEP 2.1.2.1 Performance Certification Agreement for Original Equipment Manufacturer (OEM Agreement). No further action required beyond that listed in Section 4, STEP 4.2 of the AHRI General Operations Manual.

STEP 2.1.2.2 Participation and Licensing Fee Invoice. Payment of the Participation and Licensing Fee is due within 30 calendar days of the invoice issue date. Testing shall not be conducted until the invoice is paid in full. No further action required beyond that listed in Section 4, STEP 4.2 of the AHRI General Operations Manual.

STEP 2.1.3 Selection and Acquisition of Test Samples.

STEP 2.1.3.1 Number of Qualification Tests.

- For less than 65,000 Btu/h [19,033 W]. For less than 65,000 Btu/h [19,050 W], 30% of Applicant's BMG's are rounded to the nearest integer number of system models using traditional rounding methods (i.e. calculated 2.49 tests results in the selection of two (2) systems and calculated 2.50 test results in the selection of three (3) systems). No less than two (2) systems shall be tested.

- For Single Module Systems $\geq 65,000$ Btu/h [19,033 W]. For single module system $\geq 65,000$ Btu/h [19,050 W], 30% of Applicant's BMGs are rounded to the nearest integer number of system models using traditional rounding methods (i.e., calculated 2.49 tests results in the selection of two (2) systems and calculated 2.50 tests results in the selection of three (3) systems). No less than two (2) systems shall be tested.
- For Combined Module Systems $\geq 65,000$ Btu/h (19,033 W). 20% of Applicant's BMGs are rounded to the nearest integer number of system models using traditional rounding methods (i.e., calculated 2.49 tests results in the selection of two (2) systems and calculated 2.50 tests results in the selection of 3 units). No less than two (2) systems shall be tested. If a BMG contains both Single Module systems and Combined Module systems, the BMG will be counted as a BMG with Combined Module systems.

STEP 2.1.3.2 Acquisition of Qualification Test Samples/Selection Criteria. Within 30 calendar days of a request from AHRI, the Applicant shall have samples available for selection. Samples shall be acquired in accordance with Section 3.4 of this manual. All samples shall be provided with the requirements listed in Section 3.5 of this manual.

STEP 2.1.4 Qualification Testing. AHRI shall supply the Independent Third-Party Laboratory Contracted by AHRI (Laboratory) with the Published Ratings. The Laboratory shall conduct the testing of the samples in accordance with the Standard, against the Published Ratings.

In addition to the tests required to determine the energy efficiencies and capacities noted in 3.11, the following additional tests shall be conducted for qualification purposes at the expense of the Participant.

STEP 2.1.4.1 Operating Tests. In addition to the Performance Rating tests, all qualification tests shall include all of the following Operating Tests to be conducted:

- Maximum Operating Conditions (MOC);
- Voltage Tolerance for systems $< 65,000$ Btu/h [19,033 W] only;
- Insulation Efficiency;
- Low Temperature Operation; and
- Condensate Disposal.

STEP 2.1.4.1.1 Operating Test Failures. If the sample fails the Operating Test, a second sample, to be selected by AHRI, shall pass in order to qualify into the program. If the second sample does not pass, then that system model and its BMG shall not be entered into the AHRI Directory of Certified Product Performance (Directory) and the Applicant shall cease production and sale of the failed system model in order to qualify into the certification program. A new system shall be selected and tested to continue the qualification process.

STEP 2.1.4.2 Successful Completion of All Qualification Tests. If all qualification tests pass proceed to STEP 2.1.5.

STEP 2.1.4.3 First Sample Qualification Test Failure. Refer to Section 4, STEP 4.4.2 of the AHRI General Operations Manual for details regarding the first sample qualification failure options:

STEP 2.1.4.4 Second Sample Qualification Test Failure. Refer to Section 4, STEP 4.4.3 of the AHRI General Operations Manual for details regarding the second sample qualification failure options.

STEP 2.1.5 *Welcome to the Program*. No further action required beyond that listed in Section 4, STEP 4.5 of the AHRI General Operations Manual.

2.2 *Private Brand Marketer (PBM) Applicants*. With the additions noted below, the PBM qualification process shall proceed according to the AHRI General Operations Manual, Section 5. PBM Applicants are not required to undergo initial qualification testing. PBM product certification is contingent upon the certification of the associated OEM product.

STEP 2.2.1 *Certification Application Package*. In addition to the Application for AHRI Certification Form noted in the AHRI General Operations Manual, Section 5, STEP 5.1, Applicants shall submit the following documentation to AHRI:

- An Applicant requesting AHRI to submit data to CEC, DOE, and FTC shall submit third-party authorization, compliance forms and other necessary information; and

STEP 2.2.2 *Processing Application Package*.

STEP 2.2.2.1 *Performance Certification Agreement for Private Brand Marketer (PBM Agreement)*. No further action required beyond that listed in Section 5, STEP 5.2.1 of the AHRI General Operations Manual.

STEP 2.2.2.2 *OEM Agreement on Behalf of the PBM Applicant*. No further action required beyond that listed in Section 5, STEP 5.2.2 of the AHRI General Operations Manual.

STEP 2.2.2.3 *Licensing Fee Invoice*. Payment of the Licensing Fee is due within 30 calendar days of the invoice issue date.

STEP 2.2.3 *Welcome to the Program*. No further action required beyond that listed in Section 5, STEP 5.3 of the AHRI General Operations Manual.

3. Equipment Selection and Testing

3.1 *Annual Testing Requirement*.

3.1.1 *For Systems Less than 65,000 Btu/h [19,033 W]*. For less than 65,000 Btu/h [19,033 W], 20% of Participants BMGs shall be tested annually, with a minimum of two (2) systems. Fractional numbers shall be rounded up to the nearest whole number.

3.1.2 *For Single Module Systems \geq 65,000 Btu/h [19,033 W]*. For single module systems \geq 65,000 Btu/h [19,033 W], 20% of Participant's BMGs shall be tested annually, with a minimum of two (2) systems. Fractional numbers shall be rounded to the nearest whole number using traditional rounding methods.

3.1.3 *For Combined Module Systems \geq 65,000 Btu/h [19,033 W]*. For Combined Module Systems \geq 65,000 Btu/h [19,033 W], 20% of Participant's BMGs shall be tested annually, with a minimum of two (2) systems. The selected systems shall contain 10% of BMGs with combined module systems consisting of three (3) or more modules, with a minimum of one (1) system model and a maximum of two (2) systems to be tested. Fractional numbers shall be rounded to the nearest whole number using traditional rounding methods. If a BMG contains both Single Module systems and Combined Module systems, the BMG will be counted as a BMG with Combined Module systems.

3.2 *Location of Test*. Testing shall be performed at an AHRI recognized Laboratory of the Participant's choosing.

3.3 *Selection of Test Samples*. Selections shall be made by AHRI based on Active and Production Stopped data contained in the Directory. AHRI shall inform the Participant, in writing, of the systems selected for test.

3.4 Methods for Acquiring Test Samples. AHRI or the Laboratory personnel shall make a Random Sample Selection from the Participant's stock inventory within 60 calendar days of a selection by AHRI. Selected samples shall be shipped to the Laboratory accompanied by the Participant's published installation instructions in printed or electronic format. Refer to Section 9 of the AHRI General Operation Manual. Production Stopped models may be acquired from the distribution chain. Expenses for this option are borne by the Participant. If a system model with a status of Production Stopped cannot be supplied for testing, then that system model's listing shall be Discontinued from the Directory.

3.4.1 System Selection. Laboratory personnel shall randomly select Outdoor Units and indoor units from a minimum of three (3) samples of each. However, for all selections that include multiples of identical Outdoor Units or indoor units, the number of samples available for selection shall be based on the formula below:

$$\begin{aligned} \text{Number of samples available for selection} &= id + 3 \text{ or} \\ \text{Number of samples available for selection} &= od + 3 \end{aligned}$$

when $id > 1$ or
when $od > 1$

Where

id = Number of identical indoor units required
 od = Number of identical Outdoor Units required

Examples:

- If two (2) 10-ton identical Outdoor Units are selected by AHRI, the Participant shall make five (5) 10-ton identical Outdoor Units available for selection. [if $od = 2$, then number of outdoor units provided for selection = $od + 3 = 5$]
- If five (5) 2-ton identical indoor units are required for testing, the manufacturer shall make eight (8) 2-ton identical indoor units available for selection. [if $id = 5$, then number of indoor units provided for selection = $id + 3 = 8$]

Tested Outdoor Units and indoor units and interconnecting components can be re-used for testing in the same year. Doing so may result in additional charges billed by the Laboratory. Outdoor Units that are tested in a Combined Module system test may also be used for Single Module system testing.

3.5 Sample Acquisition Timeframe. Participants shall make all systems available for selection within sixty (60) calendar days after notification of selected systems by AHRI. Laboratory personnel shall make a selection from the Participant's stock inventory within the timeframe agreed upon by the Laboratory, Participant, and AHRI. Unless otherwise authorized by AHRI, the Participant shall deliver all selected sample(s) to the Laboratory within 60 calendar days of selection by Laboratory personnel.

3.6 Required Equipment and Personnel Provisions. The Participant shall provide the Outdoor Unit (Single Module or Combined Modules), indoor units and controls. Participants shall also provide information on connecting systems components electronically and mechanically, including piping layout and diameters and other listed system enhancement devices as a complete system for test. The Participant is responsible for shipping all necessary equipment and parts to the Laboratory in order to ensure that the sample functions properly and test(s) can be performed in accordance with the Standard. All refrigerant and refrigerant piping fees shall be borne by the Participant. Participants shall provide AHRI with a list of contacts available in case the Laboratory has an issue with testing and needs direction.

A Participant may assist in the setup of the test system as outlined in Appendix B.

The Participant shall be allowed in the Laboratory during setup and start-up of testing to verify the Participants' installation requirements and adjust compressor and/or blower speed control in accordance with Appendix B.

3.7 Sample Installation. The sample shall be installed in the Laboratory in accordance with Appendix B, the Participant's published installation instructions in printed or electronic format, and the Participant's supplemental testing instructions PDF.

3.8 Break-in Operation and Start-Up of Test System. At the Participant's expense, it may have the Laboratory operate the equipment for a Participant-specified number of hours, not to exceed 20 hours. The break-in requests shall be listed in the comments section of the Directory.

3.9 Refrigerant Line Length Considerations. The correction factors listed in the latest edition of the Standard shall be applied for test setups where the actual refrigerant line length used by the Laboratory exceeds the minimum line length listed in the Standard.

3.10 Certified Data. In accordance with the Standard, the following certified ratings are verified by test:

3.10.1 For VRF Multi-Split Air-Conditioners < 65,000 Btu/h [19,033 W]

- Standard Rating Cooling Capacity, Btu/h [W];
- Seasonal Energy Efficiency Ratio (SEER), Btu/(W·h); and
- Energy Efficiency Ratio (EER), Btu/(W·h).

3.10.2 For VRF Multi-Split Air-Conditioners ≥ 65,000 Btu/h [19,033 W]

- Standard Rating Cooling Capacity, Btu/h [W];
- Energy Efficiency Ratio (EER), Btu/(W·h); and
- Integrated Energy Efficiency Ratio (IEER), Btu/(W·h).

3.10.3 For VRF Multi-Split Heat Pumps < 65,000 Btu/h [19,033 W]

- Standard Rating Cooling Capacity, Btu/h [W];
- Seasonal Energy Efficiency Ratio (SEER), Btu/(W·h);
- Energy Efficiency Ratio (EER), Btu/(W·h);
- High Temperature Heating Standard Rating Capacity, Btu/h [W]; and
- Region IV Heating Seasonal Performance Factor Minimum Design Heating Requirement (HSPF), Btu/(W·h).

3.10.4 For VRF Multi-Split Heat Pumps ≥ 65,000 Btu/h [19,033 W]

- Standard Rating Cooling Capacity, Btu/h [W];
- Energy Efficiency Ratio (EER), Btu/(W·h);
- Integrated Energy Efficiency Ratio (IEER), Btu/(W·h);
- High Temperature Heating Standard Rating Capacity, Btu/h [W];
- High Temperature Coefficient of Performance (COP);
- Low Temperature Heating Standard Rating Capacity, Btu/h [W]; and
- Low Temperature Coefficient of Performance (COP).

3.10.5 For VRF Multi-Split Heat Recovery Systems (air source and water source)

- Ratings listed in 3.10.3 and 3.10.4 above
- Simultaneous Cooling and Heating Efficiency (SCHE) (50% heating/50% cooling).

3.11 Tests for Air-source Systems < 65,000 Btu/h.

3.11.1 Tests, Air-Conditioning. All Air-Conditioning equipment shall be tested with the DOE "A" and "B" cooling tests as described in the Standard. Standard Rating tests shall be conducted using the nameplate rated voltage and frequency specified in the Standard. For dual nameplate voltage ratings (other than NAECA equipment), tests shall be conducted at 230V.

3.11.2 Tests, Heat Pumps. All Heat Pump equipment shall be tested with the DOE "A" and "B" cooling tests, High and Low Temperature Heating, and Frost Accumulation tests as described in the Standard. Standard

Rating tests shall be conducted using the nameplate rated voltage and frequency specified in the Standard. For dual nameplate voltage ratings (other than NAECA equipment), tests shall be conducted at 230V.

3.11.3 EER_A Test. EER_A is calculated from the DOE “A” test conditions by dividing the capacity by the total system power. The calculated EER_A shall be within 95% of the rated value. For multi-stage systems, the highest rated capacity is used to determine EER_A.

3.11.4 Default Factors. At the completion of DOE “A” and “B” tests, the Laboratory calculates the SEER using the Cyclic-Degradation Coefficient (C_D) default factor 0.25 even if the sample is certified with a lower C_D, not less than zero.

For heat pumps, at the completion of heating mode and frost accumulation tests, the Laboratory calculates the HSPF with C_D default factor 0.25.

3.11.5 DOE “C” and “D” Tests. If the calculated SEER is less than 95% of the certified SEER, the sample may proceed through the DOE “C” and “D” tests at the Participant’s option and expense to obtain a tested C_D value. The tested C_D value shall be lower than the default C_D for it to be used to calculate SEER.

Even if the requirements are met using a default C_D value of 0.25, the Participant may opt for “C” and “D” tests to be performed at his expense. If the tested C_D is higher than the default value, the default value is to be used to calculate SEER and HSPF.

3.11.6 High Temperature Heating Cyclic Test. For heat pumps whose calculated HSPF is less than 95% of the certified HSPF, the model may, at the Participant’s option and expense, undergo High Temperature Heating Cyclic Test to obtain a tested C_D value. The tested C_D value shall be lower than the default C_D for it to be used to calculate HSPF.

Even if the requirements are met using a default C_D value of 0.25, the Participant may, at his expense, opt to perform the High Temperature Heating Cyclic Test.

3.12 Test Failures. A failure is a test result less than 95% of Published Ratings for capacities, SEER, HSPF, EER, and COP and less than 90% of Published Ratings for IEER and SCHE.

3.12.1 Certified Rating Test Failures.

3.12.1.1 Options Following 1st Sample Failure. When the Participant is notified of a first sample certified rating failure, the Participant has seven (7) calendar days to select one of the following options:

- Re-rate all system models within the failed sample’s BMG proportionate to the failed test’s results;
- Re-test the same unit if the unit has operated less than 16 hours, including any break-in running time.
- Test second sample or additional samples (up to 3 for systems < 65,000 Btu/h) of the same system model (sample shall be available within the timeframe and procedure allotted in Section 3.4 following notification of decision to AHRI via Manufacturer’s Decision Form [MDF]); or
- Obsolete the system model, which also obsoletes all system models within the corresponding BMG.

3.12.1.2 Options Following 2nd Sample Failure. When the Participant is notified of a second sample certified failure, the Participant has seven (7) calendar days to select one of the following options:

- Re-rate all system models within the failed sample's BMG proportionate to the failed test's results; or
- Obsolete the system model, which also obsoletes all system models within the corresponding BMG.

3.12.2 Test Additional Samples Option for Systems < 65,000 Btu/h [19,033 W].

3.12.2.1 Following a First Sample Failure. The Participant shall identify the maximum number of additional tests requested up to a maximum of three (3).

1. The first additional test shall be performed; this sample is considered the "second sample" test.
 - a. If all descriptors result in a rating greater or equal to 95% of the Directory rating testing shall halt and unused equipment shall be shipped back to the manufacturer, the original rating shall remain and no re-rates shall be needed.
 - b. If any descriptor rating falls below 95% of the Directory rating, the first sample and the second sample test shall be rated using the DOE rating procedure with a T value of 3.078.
 - c. If all descriptors result in a rating greater or equal to 95% of the Directory rating, testing shall halt and unused equipment shall be shipped back to the manufacturer, the original rating shall remain and no re-rates shall be needed.
 - d. If any descriptor rating falls below 95% of the Directory rating, the Participant may choose to continue testing in the plan or to concede to a re-rate. In the latter case the first test statistic shall stand.
2. If any descriptor still falls below the 95% threshold a second additional test shall be performed, the first, second and third samples shall be rated using the DOE rating procedure with a T value of 1.886.
 - a. If all descriptors result in a rating greater or equal to 95% of the Directory rating, testing shall halt and unused equipment shall be shipped back to the manufacturer, the original rating shall remain and no re-rates shall be needed.
 - b. If any descriptor rating falls below 95% of the Directory rating the Participant may choose to continue testing in the plan or to concede to a re-rate. In the latter case the first test statistic shall stand.
3. If any descriptor still falls below the 95% threshold a third and final additional test shall be performed, the first, second, third and fourth sample shall be rated using the DOE rating procedure with a t value of 1.638.
 - a. If all descriptors result in a rating greater or equal to 95% of the Directory rating, the original rating shall remain and no first test failure statistic shall be considered.

- b. If a descriptor falls below 95% then the product shall be considered non-compliant and the product shall be re-rated to the rating from the above procedure.
- 4. At any time in the above procedure the Participant may concede to a re-rate and testing shall cease and the rating shall be revised to the most recent multi sample rating determined above.

3.12.2.1.1 Statistical Analysis Procedure. AHRI shall perform a statistical analysis based on the number of samples tested.

Mean (\bar{x})	$\bar{x} = \frac{\sum_{i=1}^n x_i}{n}$
Standard Deviation (s)	$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$
Standard Error (s_x)	$s_x = \frac{s}{\sqrt{n}}$
Lower Confidence Limit (LCL)	$LCL = \bar{x} - T * s_x$

For 2 Test Samples, $T = 3.078$
 For 3 Test Samples, $T = 1.886$
 For 4 Test Samples, $T = 1.638$

The T value used shall be based on the number of samples tested with a 90% confidence limit. To derive at the statistical rating, LCL is divided by 0.95. The lower of either the mean or statistical rating is used to compare against the certified rating. If the analysis shows that the product rates above 95% of the Participant's rating, the rating shall pass, if it does not, then the rating fails. The statistical analysis calculations are taken from the Code of Federal Regulations (CFR) Title 10, Part 429, Subpart B, §429.16 Central air conditioners and heat pumps.

3.12.2.2 Re-Rate Following Test Additional Sample. Following the decision to Test Additional Samples, if the Participant concedes to re-rate their rating or it has been determined that the rating is non-compliant through the statistical analysis, the model combination will be re-rated based on the DOE Rating Procedures, CFR Title 10, Part 429, Subpart B, §429.16. Furthermore, all models within the failed sample's BMG will be re-rated the same proportionately.

3.12.2.2.1 Re-Rate Following First Additional Test "Second Sample". If the Participant concedes to re-rate their rating after the first additional test or "second sample", the model combination will be re-rated to the second sample test results.

4. Challenge Tests

Refer to Section 10 of the AHRI General Operations Manual.

5. AHRI Directory of Certified Product Performance

All certified products shall be listed in the Directory, www.ahridirectory.org. Certification shall not be implied nor claimed for any product not listed in the Directory. Except as noted below, the Participant shall follow the steps outlined in Section 11 of the AHRI General Operations Manual.

5.1 Publication of Ratings for Air-cooled VRF Systems $\geq 65,000$ Btu/h [19,033 W] and all Water-source VRF Systems in Certified Directory. The following information pertaining to each certified system model shall be published in the Directory:

- AHRI Certified Reference Number;
- Name of Manufacturer;
- System Model Status;
- Brand Name of System Model;
- Series Name
- System Model Number;
- Module Model Number(s);
- Indoor Unit Type;
- Classification;
- Cooling Capacity, EER, and IEER;
- SCHE, if applicable;
- High Heating Capacity and COP, if applicable; and
- Low Heating Capacity and COP, if applicable.

5.2 Publication of Ratings $\leq 65,000$ Btu/h [19,033 W] in Certified Directory. The following information pertaining to each certified system model shall be published in the Directory:

- AHRI Certified Reference Number;
- Name of Manufacturer;
- System Model Status;
- Brand Name of System Model;
- Series Name;
- Module Model Number(s);
- Indoor Unit Type;
- Classification;
- Cooling Capacity;
- SEER;
- EER;
- Low Heating Capacity, if applicable;
- High Heating Capacity, if applicable;
- HSPF, if applicable; and
- Indoor Coil Air Quantity.

Additional data may be shown for products sold in areas requiring further product information/ratings or EPA ENERGY STAR® listings.

5.3 Data Forms. Each OEM Participant shall list its products by BMG. OEM and PBM Participants shall submit/edit product data via the Directory.

5.3.1 Making Changes to Submissions. If a Participant submits new listings for products less than 65,000 Btu/h [19,033 W] to the Directory via the input interface on the Directory, the Participant shall be able to make corrections to the listings until 11:59 pm ET on the date of the submission. The data is published and sent to the DOE after midnight.

6. Assessment and Payment of Certification Fees

Refer to Section 12 of the AHRI General Operations Manual.

7. Issuance of Violations and/or Termination

Refer to Section 14 of the AHRI General Operations Manual.

8. Program Hierarchy, Complaints, and the Appeals Process

Refer to Section 15 of the AHRI General Operations Manual.

9. Proper Use of the AHRI Certification Mark and Claims to Certification

Refer to Section 8.1 of the General OM and the AHRI Brand Usage Guide.

APPENDIX A. SETUP, COMMISSIONING AND OPERATING PROCEDURES FOR LABORATORY PERSONNEL**Setup checklist and operating procedures for the Laboratory personnel:**

1. Check the nameplate model is the same as the AHRI requested model.
 - a. Check if there are additional comments in the data.
2. Follow the manufacturer's installation instructions and related drawings (manufacturer representative may be present):
 - a. Charging instructions;
 - b. Tubing sizing;
 - c. Airflow settings;
 - d. Expansion device. If there is a use of a TXV, ensure there is insulation on the bulb. Check that the bulb is attached and positioned correctly;
 - e. Verify all enhancements per the rating are installed properly (e.g. demand defrost board, liquid line solenoid, TXV, time delay relay);
 - f. Note any deviations from the manufacturer's installation instructions; and
 - g. Verify that the unit is physically installed per the installation instructions.
3. Verify that the coil dimensions match the values in the AHRI Directory.
4. Verify that the ductwork meets ASHRAE Standard 37 requirements.
5. Verify that there is a minimum of 3' clearance for the intakes of ducted indoor unit. Make sure that data reflects that intakes are not obstructed or restricted.
6. Inspect the indoor ductwork for leaks.
7. Inspect to ensure that the indoor coil is sitting in the housing and is positioned correctly.
8. Inspect to ensure the trap for condensate is clear of obstructions and check if the condensate is leaving.
9. Verify that the correct nozzles are selected for the given airflow range.
10. Verify that the voltage to be applied matches voltage listed on nameplate.
11. Verify that the major components are of compatible voltage.
12. Verify installation to the manufacturer's supplemental testing instructions PDF (if available).
13. Verify refrigerant line length between outdoor and indoor units.
14. Verify airflow rates of indoor units.

Additional checks following a failure:

1. For high and low speed:
 - a. ID airflow;
 - b. ID watts;
 - c. ID static;
 - d. OD airflow if OD air is the secondary check or refrigerant mass flow;
 - e. OD watts on fan motor;
 - f. Compressor watts;
 - g. Sub-cooling and superheat; and
 - h. Liquid temperature.
2. Photos of test setup.
3. Time between defrost
4. Report any error messages or abnormally flashing lights.
5. Last date that the LEAP was conducted.

APPENDIX B. START-UP PROCEDURE FOR VRF PERFORMANCE VERIFICATION TESTING

B1. Start-up Procedure. Manufacturers shall provide supplemental testing instructions PDF that describe and layout of system set-up in the testing laboratory. In the event of conflicting Instructions regarding the set-up of the system, outdoor unit installation instructions prevail, followed by the outdoor unit label, followed by the indoor unit installation instructions, followed by the supplemental testing instructions PDF.

Table B1. VRF Start-up Procedural Steps	
Procedural Step	Responsible Entity
1. Assemble system components (all components must be production models) a. Outdoor Unit(s) b. Indoor Unit(s) c. Heat recovery devices d. VRF system control devices e. Connecting devices; headers, branch connector, twinning kit, etc.	Laboratory
2. Assemble supplies a. Insulated copper tubing for supply and return lines between components – length based on ODU Type and capacity and IDU type b. Power wiring c. Control wiring d. Drain piping	Laboratory
3. Assemble test apparatus: a. Indoor Units test stand b. Air sampling trees c. Static ports	Laboratory
4. Position the system components and connect with insulated refrigerant piping a. IDUs for heat recovery systems must be appropriately split for SCHE test per the Supplemental Testing Instructions PDF	Laboratory Per Manufacturer’s Piping Diagram and Supplemental Testing Instructions PDF
5. Evaluate the system for potential refrigerant leaks and repair as necessary	Laboratory
6. Pull a vacuum on the system to remove moisture and verify leak integrity	Laboratory (Default: initial vacuum of 500 microns).
7. Address Indoor Units / Port number setting for heat recovery devices (if necessary)	Manufacturer
8. Run power wire to each of the system components	Laboratory
9. Run control wiring to each of the system components	Laboratory
10. Check power to the system	Laboratory
11. Check communication wiring with the VRF system control device	Manufacturer
12. Check airflow of the IDU’s with the refrigerant-side off	Laboratory
13. Check duct box to ensure complete insulation and no air leakage	Laboratory
14. Charge system with refrigerant per AHRI Standard 1230.	Laboratory Per Manufacturer’s Instruction Manual
15. Laboratory to stabilize test room conditions with input from the manufacturer	Laboratory
16. Perform system start-up procedures (system initialization) at a non-standard rating, uncontrolled condition for up to 3 hours, per supplemental testing instructions PDF. If start-up procedures	Manufacturer

are not included in the supplemental testing instructions PDF, then skip step # 16.	
17. Allow the system to run for up to 20 hours to break-in the compressor as prescribed by the Manufacturer prior to testing. (optional). This time period includes the 3-hour period used in Step 16.	Laboratory Per Supplemental Testing Instructions PDF

B2. Testing Operation Procedure for Standard Rating Tests

B2.1 Standard Rated Cooling Capacity and EER (100% Cooling Test, SRT)

The variable operation components shall only be adjusted to conditions that are intended to operate in the field.

B2.1.1 Manufacturer's representative adjusts each module's compressor speed to achieve the Rated Capacity. All compressors shall initially operate at the setting provided to AHRI and/or the DOE supplemental testing instructions PDF.

B2.1.2 Manufacturer's representative shall adjust the compressor speed to achieve 95% or greater of the Rated Capacity. This tested capacity becomes the capacity used for IEER and SCHE testing.

B2.1.3 Once the manufacturer's representative is satisfied that the system has achieved the Rated Capacity and is operating under Stable Conditions for the full-load cooling capacity test, all variable components will be fixed, all compressor speeds are recorded by the laboratory, and the manufacturer's representative must leave the area. If the system is unable to achieve the Rated Capacity, the test will continue to run to completion.

B2.2 Integrated Energy Efficiency Rating IEER (Part Load Tests)

During the part load tests, the compressors can only be stopped if the manufacturer's operating system control would cause that mode of operation in the field. The variable operation components shall only be adjusted to conditions that are intended to operate in the field.

B2.2.1 The following rules of testing apply for each of the remaining IEER tests (75% capacity, 50% capacity, and 25% capacity).

B2.2.2 The number of compressors can be stopped according to the manufacturer's supplemental test instructions in PDF format. All IDUs are required to remain in operation during the test.

B2.2.3 Manufacturer's representative adjusts each module's compressor speed to achieve a Total Cooling Capacity value corresponding to 75%, 50%, or 25% (matching each particular part load test) of the tested full load cooling capacity.

B2.2.4 While adjusting the compressor speed(s), the manufacturer's rep may also adjust any other variable operation components (such as expansion valves) within the system components (ODU's, IDU's, heat recovery devices) per Section C2.4 to achieve stable operation.

B2.2.5 Within 2.5 hours, the system shall achieve the capacity referenced in B2.2.3 and shall operate under Stable Conditions for the particular part load test, all variable components will be fixed, all compressor speeds are recorded by the testing agency - and the manufacturer's representative, only for the 100% test, may adjust the set-up to achieve an appropriate balance between capacity and power. After making these setting the manufacturer's representative must leave the area.

B2.3 High Temperature and Low Temperature Heating Standard Rating Capacity and COP

B2.3.1 Manufacturer's representative adjusts each module's compressor speed to achieve the Rated Capacity. All compressors should operate within the operating range provided to AHRI and/or the DOE supplemental testing instructions PDF.

B2.3.2 Manufacturer's representative shall adjust the compressor speed to achieve 95% or greater of the Rated Capacity.

B2.3.3 For the high temperature heating capacity test, the manufacturer representative shall have 2.5 hours to fix the compressor speed and all variable components. The manufacturer's representative may adjust the set-up to achieve an appropriate balance between capacity and power. With the system operating under Stable Conditions, all variable components will be fixed and all compressor speeds are recorded by the laboratory. After making these setting the manufacturer's representative must leave the area.

B2.3.4 For the low temperature heating capacity test, the manufacturer representative shall fix the compressor speed and all variable components. The manufacturer's representative may adjust the set-up to achieve an appropriate balance between capacity and power. With the system operating under Stable Conditions, all variable components will be fixed and all

compressor speeds are recorded by the laboratory. After making these setting the manufacturer’s representative must leave the area.

B2.4 *Performance Testing Adjustments.* The system shall operate per commands from the system control except where the control attempts to take action when the system is forced to operate at constant compressor speed. In the cases where forcing constant compressor speed causes 'abnormal' system operation, the manufacturer shall provide Instructions regarding what additional settings need to be made (specific Instructions on which components and what the required settings are) prior to test. This shall be included at the time the basic model is submitted to AHRI. The variable operation components below shall only be adjusted to conditions that are intended to operate in the field.

- B2.4.1** Compressor Speed Input
- B2.4.2** Outdoor Unit Expansion Valve
- B2.4.3** Indoor Unit Expansion Valve
- B2.4.4** Heat Recovery Device EXV
- B2.4.5** Indoor Unit Fan Speed
- B2.4.6** Outdoor Unit Fan Speed
- B2.4.7** Defrost Timing