UNITARY SMALL AIR-CONDITIONERS AND AIR-SOURCE HEAT PUMPS (INCLUDES MIXED-MATCH COILS) (RATED BELOW 65,000 BTU/H) CERTIFICATION PROGRAM

AHRI OM 210/240 – MARCH 2015

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Sponsored and administered by:
PREFACE

The following manual outlines the procedures and policies of the Performance Certification Program for AHRI Unitary Small Air-Conditioners (including mixed-match coils) (USAC) and the AHRI Unitary Small Air-Source Heat Pumps (including mixed-match coils) (USHP) 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 USAC and USHP Certification Program by AHRI provides for independent verification of the USAC and USHP manufacturers’ stated equipment performance. 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 USAC and USHP Certification Marks hereinafter referred to as the “Marks”. The Marks are 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 Agreements.

Note:

This manual supersedes the AHRI Unitary Small Air-Conditioners (including mixed-match coils) and AHRI Unitary Small Air-Source Heat Pumps (including mixed-match coils) Certification Program Operations Manual, USE OM January 2014.
# USAC (INCLUDING MIX-MATCH COILS) AND USHP (INCLUDING MIX-MATCH COILS) CERTIFICATION PROGRAM OPERATIONS MANUAL

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1. Program Overview


1.2 Product Definitions.

1.2.1 Air-Source Unitary Heat Pump. One or more factory-made assemblies which normally include conditioning coil(s), compressor(s), and outdoor coil(s), including means to provide a heating function. 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.

1.2.2 Independent Coil Manufacturer (ICM). Any Participant in the program that manufactures only the Indoor Unit in an Air-Source Unitary Heat Pump and/or Unitary Air-Conditioner.

1.2.3 Indoor Unit. A component of a Split System central air-conditioner or heat pump that is designed to transfer heat between refrigerant and heat sink inside the conditioned space.

1.2.4 Outdoor Unit. A component of a Split System central air-conditioner or heat pump that is designed to transfer heat between refrigerant and heat sink outside the conditioned space.

1.2.5 Single Packaged System. Any Unitary Air-Conditioner or Air-Source Unitary Heat Pump that has the means for air circulation and heat removal, air cleaning, and the controls thereof, in the same cabinet.

1.2.6 Split System. Any Unitary Air-Conditioner or Air-Source Unitary Heat Pump that has one or more of the major assemblies separated from the others.

1.2.7 System Manufacturer. Any Participant in the program that manufactures all the major assemblies in an Air-Source Unitary Heat Pump and/or Unitary Air-Conditioner.

1.2.8 Unitary Air-Conditioner. One or more factory-made assemblies which normally include an evaporator or cooling coil(s), compressor(s), and condenser(s). Where such equipment is provided in more than one assembly, the separated assemblies are to be designed to be used together, and the requirements of rating outlined in the Standard are based upon the use of these assemblies in operation together.

1.3 Program Scopes.

1.3.1 Unitary Small Air-Conditioner (and Mix-Matched Coils) Certification Program (USAC). This program applies to Production Models of 50 and 60 Hz Unitary Air-Conditioners below 65,000 Btu/h cooling, as defined in Section 1.2 and as listed below:

- Unitary Air-Conditioners;
- Single Packaged System;
- Split Systems; and
- Air-conditioning coils (and air-handling products with air-conditioning coils) that an ICM rates as a system with other System Manufacturer’s Outdoor Units.
1.3.2 **Unitary Small Air-Source Heat Pump (and Mix-Matched Coils) Certification Program (USHP).** This program applies to the Production Models of 50 and 60 Hz Air-Source Unitary Heat Pumps below 65,000 Btu/h cooling, as defined in Section 1.2 and as listed below:

- Air-Source Unitary Heat Pumps;
- Single Packaged System;
- Split Systems; and
- Heat pump coils (and air-handling products with heat pump coils) that an ICM rates as a system with other System Manufacturer’s Outdoor Units.

1.3.3 **Program Distinction.** The Unitary Small Air-Conditioner (USAC) and the Unitary Small Air-Source Heat Pump (USHP) Certification Program are two separate programs. This also does not apply to products within the scope of AHRI Standard 390.

1.4 **Intended Market.** The Intended Market for both Certification Programs, where the Standard applies, includes all products defined in Section 1.3 that are sold for use in the U.S. (including U.S. Territories) and Canada.

1.5 **Basic Model Groups (BMGs).** A Participant’s listing shall be grouped by BMG.

1.5.1 **System Manufacturer BMG Criteria.** A Split System BMG consists of products with the same Outdoor Unit used with several Indoor Unit combinations (i.e. horizontal, vertical, A-coil, etc.). Same Outdoor Unit refers to models with the same or comparable compressor, used with the same outdoor coil surface area and the same outdoor air quantity.

1.5.1.1 **Determination of BMGs for Calculating the Number of Tests (System Manufacturer).** When calculating the number of tests for a Participant’s annual testing requirement, AHRI shall take the number of active BMGs at the time of selection. The number of tests shall be reviewed again at a later date to determine if additional tests are required. This number of active BMGs shall determine the thresholds for Probation and Penalty Modes.

1.5.2 **ICM BMG Criteria.** An ICM BMG consists of coils (Indoor Units) with matching capacity ranges of 6,000 Btu/h and the following identical geometry parameters: air-handler, evaporator fan type, evaporator number of rows, type of equipment (air-cooled, water-cooled or evaporatively-cooled), evaporator tube centers, evaporator fin types, evaporator fins/inch, evaporator tube OD, evaporator expansion device, fin length per slab, fin height per slab, number of slabs in the coil, fin material type, tube material type, and total number of active tubes (refer to Table E1).

1.5.2.1 **Determination of ICM BMG Coil Capacity Range for Calculating the Number of Tests.** Number of test selections shall be based on a Participant’s total number of 6,000 Btu/h capacity buckets (BMG Buckets) rated in the AHRI Directory of Certified Product Ratings (Directory) as shown on Table E2. For example, if a Participant builds Indoor Units in Btu/h increments from 6,000 to 65,000 Btu/h’s and offers all the variations of Coil Type and AHRI Type, the Participant would have 40 BMG Buckets. This number of BMG Buckets shall determine the thresholds for Probation and Penalty Modes.

1.6 **NAECA Compliance.** Only products meeting or exceeding ratings set by the Department of Energy (DOE) in the National Appliance Energy Conservation Act (NAECA) are eligible for certification through the AHRI certification program, where applicable.
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 4.1, Applicants shall submit the following documentation to AHRI:

- Form USAC_System_OEM-DS1;
- Form USAC_ICM_OEM-DS2;
- Form USHP_System_OEM-DS3;
- Form USHP_ICM_OEM-DS4;
- Form SinglePackageChars-DS5;
- Form Condenser-DS6;
- Form Evaporator-DS7;
- Form VSMSAC_OEM-DS8;
- Form VSMSHP_OEM-DS9;
- Form VSMS_Condenser-DS10;
- Form VSMS_Evaporator-DS11;
- One test report for each BMG (refer to Section 5.4.2) showing how each rating was developed;
- An Applicant requesting AHRI to submit data to CEC, DOE, FTC, and NRCan shall submit third-party authorization, compliance forms and other necessary information;
- Provide the DOE approval letter for their ARM (Alternate Rating Method), if applicable; and
- Additional information may be needed to meet EPA ENERGY STAR® program requirements.

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.

- System Manufacturers. 30% of an Applicant’s BMGs shall be tested, with a minimum of two (2) models for the USAC and/or the USHP Certification Programs, as applicable. Fractional numbers shall be rounded to the nearest whole number using traditional rounding methods.

- ICM. 30% of an Applicant’s BMG Buckets (refer to Section 1.5.2.1) shall be tested, with a minimum of two (2) models for the USAC and/or the USHP Certification Programs, as applicable. Fractional numbers shall be rounded up to the nearest whole number. If the Applicant has ratings that were
filtered via the Rating Screening for ICMs process (refer to Section 5.12) but still wish to certify them, then there shall be up to an additional three (3) models tested from those filtered models. If a Participant does not have ratings that were filtered out, they are not subject to this additional testing.

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 equipment listed in Sections 3.6 and 3.7 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.

STEP 2.1.4.1 Operating Tests. In addition to the tests noted in Section 3.10 or 3.11, the following Operating Tests shall be conducted for all qualification tests:

- Maximum Operating Conditions (MOC);
- Voltage Tolerance (VT);
- Insulation Efficiency;
- Low Temperature Operation; and
- Condensate Disposal.

If any of these units fail any of the Operating Tests, the second sample selected shall pass in order to qualify into the program. If the second sample does not pass, then that model and BMG shall not be entered into the Directory and the Applicant shall cease production and sale of the failed model and BMG in order to qualify into the certification program. A new sample 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 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 Forms noted in the AHRI General Operations Manual, Section 5, STEP 5.1, Applicants shall submit the following documentation to AHRI:

- Certified product data sheets noting PBM/OEM equipment match-ups,
- An Applicant requesting AHRI to submit data to CEC, DOE, FTC, and NRCan shall submit third-party authorization, compliance forms and other necessary information,
- Additional information may be needed to meet EPA ENERGY STAR® program requirements.

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 System Manufacturers. 20% of a Participant’s BMGs shall be tested annually, with a minimum of two (2) models for the USAC and/or the USHP Certification Programs, as applicable. Fractional models shall be rounded up to the nearest whole number. The number of tests required of the Participant shall be reviewed by AHRI throughout the year.

3.1.1.1 Basis for System Manufacturer Test Selections. The selection of units for test are based on 1/3 at random, 1/3 for cause, and 1/3 Highest Sales Volume Tested Combination (HSVTC).

3.1.2 ICM. 20% of a Participant’s BMG Buckets in the Directory shall be tested annually, with a minimum of two (2) models for the USAC and/or the USHP Certification Programs, as applicable. Fractional numbers shall be rounded up to the nearest whole number.

3.1.2.1 Basis for ICM Test Selections. Each model(s) shall be selected from a different BMG Bucket.

3.1.2.2 Additional ICM Testing. If the Participant has ratings that were filtered via the Rating Screening (Section 5) for ICMs process, but was approved by AHRI to be listed in the Directory, then AHRI shall select up to three (3) additional models from those filtered models for test. If a Participant does not have ratings that were filtered out, they are not subject to this additional testing. The number of tests required of the Participant shall be reviewed by AHRI throughout the year.
3.2 **Location of Test.** Testing shall be performed at the Laboratory and samples shall be installed in the test facility in accordance with the Participant’s published installation instructions.

3.2.1 **Duties of Third-Party Laboratory Personnel.** The Laboratory is responsible for installing and starting the sample per the Participant's supplied instructions, and testing the sample in accordance with the Standard. The Laboratory shall also set up the sample according to the setup checklist in Appendix F. The Laboratory shall inform the Participant when it intends to test the sample at least two (2) weeks prior to the sample's installation. The Laboratory shall notify the Participant once the test is about to occur. In the event of a failure, the Laboratory shall notify both AHRI and the Participant immediately after the completion of the test. For items not deserving the manufacturer and/or AHRI’s immediate attention (i.e., not affecting the validity and/or the completion of the test) proper communication shall be made via email. For items deserving Participant and/or AHRI’s immediate attention (i.e., affecting the validity and/or the completion of the test) proper ways of communication shall be via phone with an email to follow-up.

3.2.2 **LEAP Requirement.** The Laboratory shall perform the Laboratory Evaluation and Adjustment Plan (LEAP) process for each facility that tests USE equipment once every 12 months on a continuous basis (refer to Appendix H).

3.3 **Selection of Test Samples.** Selections shall be made based on active and discontinued data contained in the Directory. AHRI shall inform the Participant, in writing, of the sample(s) selected for test.

3.3.1 **Selection Requirements for Annual Testing.** During the selection process, the Participant shall provide at least 50% of their selections within 45 calendar days of AHRI’s notification. Within 90 calendar days of AHRI’s notification, 100% of the selections shall be provided. Selections shall be complete systems; the Participant’s shall choose which systems are provided first. (The USAC and USHP certification programs are treated separately. For example, if a Participant receives notification of AHRI selections on January 1st for both USAC and USHP, within 45 calendar days the Participant must provide at least 50% of their selections for both programs. The Participant may not provide 100% of their USAC selections and 0% of their USHP selections.)

3.4 **Methods for Acquiring Test Samples.** AHRI or the Laboratory personnel shall make at least 50% of the Participant’s Random Sample Selections or Random Component Selections from the Participant’s stock inventory within 45 calendar days of a selection by AHRI. AHRI or the Laboratory personnel shall make 100% of the Participant’s Random Sample Selections or Random Component Selections from the Participant’s stock inventory within 90 calendar days of a selection by AHRI.

For Random Component Selection, the sample shall be comprised of a minimum set of three (3) of each major component, Indoor Unit coil, Outdoor Unit coil and compressor. Selected samples shall be shipped to the Laboratory accompanied by the Participant’s published installation instructions in printed or electronic format. The Two Sample Supply Option also applies. Refer to Section 9 of the AHRI General Operation Manual.

Discontinued and custom made models may be acquired from the distribution chain. Expenses for this option are borne by the Participant. If a discontinued model cannot be supplied for testing, then that model's listing shall be archived in the Directory.

3.4.1 **Selecting Three Additional Samples.** At the time of a sample selection, the Participant has the option to select three (3) additional samples of the same sample to be on hold at a Participant’s facility in case the first sample test fails. These samples would be submitted to the Laboratory if the Test Sampling Plan Option is chosen.

3.5 **Sample Acquisition Timeframe.** The Participant shall deliver the selected sample(s) to the Laboratory within 14 calendar days of Random Sample Selection or Random Component Selection by Laboratory personnel.
3.6 **System Manufacturer’s Required Equipment Provisions.** The System Manufacturer shall provide a complete system, consisting of the following:

- Outdoor Unit;
- Indoor coil;
- Expansion device;
- Air-moving equipment (if required);
- Other listed system enhancement devices; and
- Published installation instructions.

The Participant shall be 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.

3.7 **ICM’s Required Equipment Provisions.** The ICM manufacturer shall provide the following:

- Indoor coil;
- Expansion device;
- Air-moving equipment (if required);
- Other listed system enhancement devices;
- Published installation instructions.

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.

3.8 **Break-in Operation of Test Units.** A Participant, at its expense, shall have the Laboratory operate the equipment for a specified time prior to testing. The break-in request should be listed in the comments section of the Directory.

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

3.9.1 **Unitary Small Air-Conditioners (Systems and Mixed-Match Coils), Air-Cooled under 65,000 Btu/h [19,033 W].**

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

3.9.2 **Unitary Small Air-Conditioners (Systems and Mixed-Match Coils), Water-Cooled and Evaporatively Cooled under 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)

3.9.3 **Unitary Small Air-Source Heat Pumps (Systems and Mixed-Match Coils), Air-Cooled under 65,000 Btu/h [19,033 W].**

- Standard Rating Cooling Capacity, Btu/h [W]
- Energy Efficiency Ratio (EER), Btu/(W·h)
- Seasonal Energy Efficiency Ratio (SEER), Btu/(W·h)
- High Temperature Heating Standard Rating Capacity, Btu/h [W]
- Region IV Heating Seasonal Performance Factor (HSPF) Minimum Design Heating Requirement, Btu/(W·h)
3.10 **Tests, Air-Conditioning (Systems and Mix-Matched Coils).** All Unitary 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 **Tests, Heat Pumps (Systems and Mix-Matched Coils).** All Air Source Unitary 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.

3.12 **EER<sub>A</sub> Test.** EER<sub>A</sub> is calculated from the DOE “A” test conditions by dividing the capacity by the total system power. The calculated EER<sub>A</sub> shall be within 95% of the rated value. For multi-stage systems, the highest rated capacity is used to determine EER<sub>A</sub>. EER<sub>A</sub> ratings shall be given for all Single Packaged Systems and all combinations of Split Systems which the manufacturer intends to be used together.

3.13 **IEER Test.** The calculated IEER shall be within 90% of the rated value. IEER ratings shall be given for all Water-Cooled and Evaporatively Cooled Unitary Small Air-Conditioners.

3.14 **Default Factors – Systems.** At the completion of DOE “A” and “B” tests, the Laboratory calculates the SEER using the Cyclic-Degradation Coefficient (C<sub>D</sub>) default factor 0.25 even if the sample is certified with a lower C<sub>D</sub>, not less than zero.

For heat pumps, at the completion of heating mode and frost accumulation tests, the Laboratory calculates the HSPF with C<sub>D</sub> default factor 0.25.

3.15 **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<sub>D</sub> value. The tested C<sub>D</sub> value shall be lower than the default C<sub>D</sub> for it to be used to calculate SEER.

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

AHRI may require, at the expense of the Program, “C” and “D” tests to be performed on systems to assure sufficient qualified condensing units for ICM tests.

3.16 **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<sub>D</sub> value. The tested C<sub>D</sub> value shall be lower than the default C<sub>D</sub> for it to be used to calculate HSPF.

Even if the requirements are met using a default C<sub>D</sub> value of 0.25, the Participant may, at his expense, opt to perform the High Temperature Heating Cyclic Test.

AHRI may require, at the expense of the Program, the High Temperature Heating Cyclic Test to be performed on systems to assure sufficient qualified condensing units for ICM tests.

3.17 **Outdoor Unit Qualification for ICM Testing:**

3.17.1 **Definitions:**

3.17.1.1 **Qualified Unit.** An Outdoor Unit that is provided from a certified HSVTC system that was tested at or above 97% of all certified values. (Note: As of the 2016 testing year, a Qualified Unit will be defined as an Outdoor Unit that is provided from a certified system that passes all certified values.)
3.17.1.2 **Provisionally Qualified Unit.** An Outdoor Unit that is provided from a certified HSVTC system whose SEER and HSPF was tested at or above 95% and is less than 97% with a default CD (CD has not been determined by test). (Note: As of the 2016 testing year, Provisionally Qualified Units will be removed.)

3.17.1.3 **Unqualified Unit.** An Outdoor Unit that has not been tested as an HSVTC. (Note: As of the 2016 testing year, an Unqualified Unit will be defined as an Outdoor Unit that is provided from a certified system that does not pass all certified values.)

3.17.1.4 **Disqualified Unit.** An Outdoor Unit that is provided from a certified HSVTC system that:

- was tested below 97% for any certified value with a tested CD;
- was tested below 95% or over 97% for SEER and HSPF with a default CD;
- was a previously Qualified or Provisionally Qualified Unit that has been used for testing for more than three (3) test years.

(Note: As of the 2016 testing year, a Disqualified Unit will be defined as an Outdoor Unit that is provided from a certified system that:

- did not pass all certified values;
- was a previously Qualified Unit that has been used for testing more than three (3) test years.)

3.17.2 **Qualified Units Testing.** ICM tests shall be performed with Qualified Units. If a Qualified Unit is not available, the ICM test may be performed using a Provisionally Qualified Unit following the procedure defined in Figure C1 of Appendix C. If neither a Qualified nor Provisionally Qualified Unit is available, the ICM test may be performed using an Unqualified Unit following the procedure defined in Figure C2 of Appendix C.

3.17.3 **Challenging a Qualified Condenser/Non-Qualified Condenser.** The performance of a condenser may be challenged by the ICM as a part of a defective claim per the applicable portion of the OM. Per the defective claim, the Participant shall provide a detailed defect report stating the reason the Participant believes the condenser is not performing correctly. If AHRI agrees with the report, a new Outdoor Unit with the same model number shall be obtained for the test.

3.17.4 **Fees.** Costs of tests to further Qualify Provisionally Qualified or Unqualified Outdoor Units as required by Appendix C shall be borne by the Program. Costs of ICM tests, where the condenser was determined to be the cause of the failure, shall be borne by the Program. Costs of valid ICM tests shall be borne by the Participant.

3.18 **Test Failures.**

3.18.1 **Certified Rating Test Failures – Systems.**

3.18.1.1 **First Sample Certified Rating Test Failure.** When the Participant is notified of a first sample certified rating failure, the Participant has seven (7) calendar days to select one (1) of the following options:

- Claim the sample Defective, as described in the AHRI General Operations Manual, Section 9.
- Re-rate all models within the failed sample’s BMG proportionate to the failed test’s results;
- Re-test the same sample if the sample has operated less than 16 hours including any break-in running time. After 16 hours of
operation, the Participant may request a second DOE “A” and “B” test, all at the Participant’s expense. This re-test shall establish whether the first test is a pass or fail.

- Test additional samples (up to 3) to determine if the test results meet the certified ratings. The Participant shall need to establish the number of additional samples that shall be tested at the time of choosing this option. All additional samples shall need to be provided at the same time within 30 days; otherwise the Participant forfeits this option.
- HSVTC Sample Option. Following failures from the additional sample option, the Participant can elect to save the HSVTC and the rest of the BMG from re-rate by testing the HSVTC sample and another sample from the same BMG (refer to Section 3.18.1.2).
- Obsolete the model, which also obsoletes all models within the corresponding BMG.

3.18.1.2 Option to Save HSVTC and Remaining BMG Ratings. If the failed system is not the HSVTC, the Participant may, at his expense and within seven (7) calendar days after notification of test results, request the HSVTC be tested. If the HSVTC passes the test, then the Participant has the option to have another sample selected for test by AHRI from the same BMG to save the rest of the BMG. If the other sample fails, the entire BMG other than the HSVTC is re-rated to the latest test results. For a BMG with multiple HSVTCs, the highest rated (SEER/HSPF or capacity) HSVTC shall be tested.

3.18.1.3 Test Sampling Plan Failure. When the Participant is notified of a Test Sampling Plan failure, the Participant has seven (7) calendar days to select one (1) of the following options for each sample that fails.

For ENERGY STAR® failures, refer to Section 16 of the AHRI General Operations Manual.

3.18.2 Certified Rating Test Failures – ICMs.

3.18.2.1 First Sample Certified Rating Test Failure. If an ICM Participant’s coil fails with a given System Manufacturer’s Outdoor Unit, then the ICM has seven (7) calendar days to decide to choose one of the following options:

- Claim the sample Defective, as described in the AHRI General Operations Manual, Section 9;
- Re-rate all models within the failed sample’s BMG proportionate to the failed test’s results;
- Test additional samples (up to 3) to determine if the test results meet the certified ratings. The Participant shall need to establish the number of additional samples that shall be tested at the time of choosing this option. All additional samples shall need to be provided at the same time within 30 days; otherwise the Participant forfeits this option. Additional tests shall not count toward the number of tests that a qualified condenser can be used. (refer to Section 3.18.1.3)
- Second Sample (utilizing same model coil and different System Manufacturer condenser). Direct AHRI to select and test a new sample coil with an Outdoor Unit from a different System Manufacturer. The coil shall be rated with the Outdoor Unit selected. Expenses for obtaining another Outdoor Unit and testing shall be paid for by the Participant.
If the combination passes, only the combination that failed shall be re-rated.
If the combination fails, then re-rate that combination and all the other combinations in that BMG.

- Obsolete the model, which also obsoletes all models within the corresponding BMG.

3.18.2.2 Test Sampling Plan Failure. When the Participant is notified of a Test Sampling Plan failure, the Participant has seven (7) calendar days to select one (1) of the following options.

3.18.2.3 Alternate Outdoor Unit Failures. Any ICM test selections made by AHRI using an HSVTC alternate Outdoor Unit that fails certified ratings per Figure C2 (Appendix C) shall be incremental to the OEM’s yearly selection. The test’s results shall be credited to the OEM’s following year’s selection and the test failure shall follow the current operations manual procedure. The re-rate shall apply immediately, but shall contribute to the following year’s consequence for improper ratings.

3.18.3 Test Additional Samples Option.

3.18.3.1 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 of the first additional test’s descriptors result in a rating greater or equal to 95% of the certified 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 certified rating, the first sample and the second sample shall be evaluated using the Statistical Analysis Procedure (refer to Section 3.18.3.1.1) with a T value of 3.078.
   c. Following the Statistical Analysis Procedure performed in 1.b., if all descriptors result in a rating greater or equal to 95% of the certified rating, testing shall halt and unused equipment shall be shipped back to the Participant, the original rating shall remain and no re-rates shall be needed.
   d. If any descriptor rating falls below 95% of the certified rating, the Participant may choose to continue testing in the plan or to concede to a re-rate to the second sample’s test results. In the later case the first additional 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 evaluated using the Statistical Analysis Procedure with a T value of 1.886.
   a. If all descriptors result in a rating greater or equal to 95% of the certified rating, testing shall halt and unused
equipment shall be shipped back to the Participant, the original rating shall remain and no re-rates shall be needed.

b. If any descriptor rating falls below 95% of the certified rating the Participant may choose to continue testing in the plan or to concede to a re-rate. In the latter case, the product shall be re-rated to the rating from the above procedure.

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 evaluated using the Statistical Analysis Procedure with a $T$ value of 1.638.

a. If all descriptors result in a rating greater or equal to 95% of the certified 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.

3.18.3.1.1 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 ($s_{\bar{x}}$)

$$s_{\bar{x}} = \frac{s}{\sqrt{n}}$$

Lower Confidence Limit (LCL)

$$LCL = \bar{x} - T \cdot s_{\bar{x}}$$

Statistical Rating

$$\frac{LCL}{0.95}$$

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.

3.18.4 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, 10 CFR Part 429, Subpart B, §429.16. Furthermore, all models within the failed sample’s BMG will be re-rated the same proportionately.

3.18.4.1 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.

3.19 NAECA and Energy Policy Act (EPACT) Re-rating Requirements. EPACT units are those that operate on three phase power.

- In all cases of tested combinations where the test results require re-rating at less than the applicable minimum efficiency, the model shall be made obsolete and listed with the appropriate “WAS” ratings. Failure option tests continue to apply.
- For Single Packaged Systems that do not meet the minimum efficiency requirement, all models in the BMG shall be re-rated in proportion to the test results and made obsolete.
- If a non-HSVTC model is tested, all combinations in the BMG shall be re-rated in proportion to the difference between the rated and test results.
  o The Participant may, at his expense and within seven (7) calendar days after notification of test results, request the HSVTC be tested. If the HSVTC passes the test, then the Participant has the option to have another non-HSVTC sample selected for test by AHRI from the same BMG to save the rest of the BMG. If the other sample fails, the entire BMG other than the HSVTC sample is re-rated to the latest test results.
- If any system in a BMG is re-rated below the applicable minimum efficiency, the Participant may elect to test any such combination to determine the pass/fail status of that combination only.

3.20 Test Sample Refrigerant Charge. The Laboratory shall charge the sample in accordance with the Participant’s installation instructions. If a range is provided, the mean of the range shall be used for the test. For ICMs, the Laboratory shall follow the ICM’s charging instructions. If no charging instructions are provided by the ICM, the Laboratory shall charge per the System Manufacturer’s installation instructions.

3.21 Consequences for Improper Ratings.


4. Challenge Tests

Except as noted below, the Challenge Test process shall proceed according to the AHRI General Operations Manual, Section 10.

4.1 System Manufacturer Challenges. The policies and procedures regarding the challenge of a System Manufacturer’s ratings are outlined in the AHRI General Operations Manual.
4.2 **ICM Challenges.** If an ICM’s rating is challenged, the following procedures shall be followed:

4.2.1 **Test the System HSVTC.** The Laboratory shall first test the Outdoor Unit as a system paired with the System Manufacturer’s HSVTC Indoor Unit. All performance ratings shall pass at or above 95%.

4.2.1.1 **Acquiring Challenge Units.** A new System Manufacturer Indoor Unit and Outdoor Unit shall be acquired in accordance with Section 10 of the General Operations Manual.

4.2.1.2 **System Challenge Test Pass.** If all system performance ratings pass at or above 95%, proceed to test the ICM match (Section 4.2.2).

4.2.1.3 **System Challenge Test Failure.** In the event the System Manufacturer’s system does not pass at or above 95%, the challenge test shall be redirected towards the System Manufacturer and treated as a System Manufacturer’s challenge. Failure options are the same as Participants with annual testing (Section 3.17.2). If the System Manufacturer ultimately re-rates the system, the ICM shall re-rate its affected models by the same percentage re-rate as the system’s ratings. Further testing of the ICM Indoor Unit shall not be required.

4.2.2 **Test the ICM Match.** The Laboratory shall test the ICM Indoor Unit with the System Manufacturer’s Outdoor Unit.

4.2.2.1 **ICM Challenge Test Pass.** If all ICM certified ratings pass, the Challenge test is over and the ICM Participant and challenger are notified of the outcome per Section 10 of the General Operations Manual.

4.2.2.2 **ICM Challenge Test Failure.** Following a first sample failure, the challenged party has all the same options as a Participant with annual testing (Section 3.18.2.1). If an option to test with a different Outdoor Unit is selected, expenses for obtaining another Outdoor Unit and testing shall be paid for by the challenged Participant. The coil shall be rated with the Outdoor Unit selected.

4.3 **Test Challenge Fees.** For challenge tests, the same fees apply as those for regularly scheduled testing.

The cost of all fees (e.g. selection, sample shipment and disposition, and testing) associated with the challenge test shall be borne by one of the three parties concerned (ICM Participant, System Manufacturer Participant, or challenger).

4.3.1 **Final Outcome System Challenge Test Failure.** If the final outcome of the system challenge test is a “fail,” the challenged System Manufacturer is responsible for all costs associated with the first sample test (Indoor Unit, Outdoor Unit and test fees).

4.3.2 **Final Outcome ICM Challenge Test Failure.** If the final outcome of the ICM challenge test is a “fail,” the challenged ICM is responsible for all costs associated with the first sample test (Indoor Unit, Outdoor Unit and test fees).

4.3.3 **Final Outcome ICM Challenge Test Pass.** If the final outcome of the challenge test is a “pass,” the challenging party is responsible for all costs associated with the first sample test (Indoor Unit, Outdoor Unit and test fees).

If the challenged party elects to test any additional samples, all associated costs for the additional testing shall be paid by the challenged party.
5. AHRI Directory of Certified Product Ratings Data Listings

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 in Certified Directory. The following information pertaining to each model certified shall be published in the Directory:

- AHRI Certified Reference Number
- Model Status
- Manufacturer Type
- Trade/Brand Name of Model
- Outdoor Unit
  - Name of Manufacturer
  - Model Number(s) or Designations
- Indoor Unit
  - Name of Manufacturer
  - Model Number(s) or Designations
- Furnace
- AHRI Standard Rating Cooling Capacity, Btu/h [W]
- Energy Efficiency Ratio, EER, Btu/(W·h)
- Seasonal Energy Efficiency Ratio, SEER, Btu/(W·h)
- Phase
- AHRI Type
- HSVTC
- Region Eligibility
- Exclusively for Canada or Export:
  - The following footnote may be added to AHRI Certificates: “The AHRI 210/240 certified EER ratings are calculated under the same methodology as the EER ratings at T1 conditions of ISO 5151:2010 and ISO 13253:2011.”
- High Temperature Heating Standard Rating Capacity, Btu/h [W], if applicable
- Low Temperature Heating Standard Rating Capacity, Btu/h [W], if applicable;
- Region IV Heating Seasonal Performance Factor, HSPF, if applicable
- Indoor Full-Load Air Volume Rate (A2 SCFM)
- Indoor Cooling Intermediate Air Volume Rate (Ev SCFM)
- Indoor Cooling Minimum Air Volume Rate (B1 SCFM)
- Eligibility for Tax Credit
- Energy Guide Label

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

5.2 Data Forms. Each Participant shall list its products by BMG. OEM and PBM Participants shall submit/edit product data via the Directory or data submittal sheets, as applicable.

5.2.1 Making Changes to Submissions. If a Participant submits new listings 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 EDT on the date of the submission. The data is published and sent to the DOE after midnight.

5.3 NAECA Requirements. The Directory only lists equipment meeting NAECA minimum. If a product, or group of products, shall be removed from the Directory for failure to meet NAECA minimum, AHRI shall notify DOE of the delisting. It is solely the Participant’s responsibility to address all DOE requests and obligations. This requirement exists only for where NAECA minimums are applicable.
5.4 **DOE Approved Alternate Rating Method.** By means of input interface on the Directory or through data submittal spreadsheets, all Participants shall indicate whether product ratings were established through testing or with an ARM. All Participants are required to submit to AHRI the DOE approval letter for their ARM, if an ARM was used to develop the sample’s ratings. Failure to submit the DOE approved letter of their ARM to AHRI shall result in the removal of the products in the Directory until AHRI has received and reviewed the ARM.

5.4.1 **ARM Ratings and Test Report Submission.** Participants in Penalty Mode shall be required to provide test reports and/or ARM ratings. Failure to submit a test report and/or ARM rating to AHRI to support the claimed rating shall render the Participant ineligible to list products in the Directory.

5.4.2 **Minimum Requirements of Test Reports Submitted to AHRI by Participants.** The following are minimum requirements that should be included in test reports, as applicable:

- AHRI Reference Number;
- Model Number;
- Test Procedure Name;
- Test Date;
- Sample Number and/or Serial Number;
- Sample description (e.g: number of products listed);
- Test engineer and witness names and signatures;
- Test results organized by applicable test procedure section; and
- Marked to indicate test results are relevant to EPA ENERGY STAR (if applicable)
  - Equipment calibration dates and next due dates and within range/Environmental conditions (e.g: temperature, humidity).

5.5 **Designation of Highest Sales Volume Tested Combination (HSVTC).** A HSVTC is the system combination designated by a Participant as being the most likely to be sold. For multi-split units, the HSVTC represents highest sales model family. A System Manufacturer Participant shall designate a HSVTC within each BMG. Two (2) or more HSVTCs are permitted within the same BMG. The HSVTC within each BMG shall be indicated and affirmed by the Participant’s senior engineering executive and senior marketing executive.

5.5.1 **Single-Speed, Split System Air-Conditioner Requirements.** The HSVTC for a single-stage, Split System air-conditioner shall be an Indoor Unit likely to have the largest volume of retail sales with the particular model of Outdoor Unit. In other words, the HSVTC for such a product shall be an RCU-A-C (air-cooled condensing unit, coil alone) combination. This rule excludes mini-splits and multi-splits.

5.5.2 **Split System Heat Pumps.** The above ICM HSVTC requirement does not apply to any Split System heat pumps.

5.5.3 **Challenge of HSVTC Designation.** A System Manufacturer participating in the certification program may challenge the HSVTC designation of another participating System Manufacturer. The challenger shall submit, in writing, the basis for such a challenge to AHRI. Within 30 calendar days of being notified of the challenge, the challenged party shall justify to AHRI, in writing, its determination of the HSVTC to AHRI. Resolution of the challenge, and any appeal, shall be conducted in accordance with the procedure and policies noted in the AHRI General Operations Manual.

5.6 **ICM Listing Requirements.** ICMs shall list certified ratings for all coils together with each Outdoor Unit intended to be used in a system. Published installation instructions shall be available with the coil. Optional and standard devices, not a part of the coil assembly, which affect ratings, shall be indicated in the Participant's installation instructions.
5.6.1 **Heat Pump Listing Requirements.** ICMs shall comply with Requirements for Certification of ICM Heat Pump Ratings (refer to Appendix A).

5.7 **Identical Coil Ratings.** Should the performance of two (2) coils be identical and the only physical difference is that one is encased or in a sleeve, both can be listed on the same line and both be designated with the condensing unit as the HSVTC.

5.8 **Listing Equipment with Enhancement Components.** The air moving device and enhancements (e.g. thermal expansion valve (TXV), time delay relay (TDR), etc.) shall be indicated by model number and when assembled, shall result in a complete Indoor Unit with sufficient information contained in the installation instructions to describe the assembly.

Enhancements, available via distribution by the ICM, are to be indicated in Directory listings by the plus (+) sign, following the Indoor Unit designation. All combinations of these enhancements shall be listed, with respective certified system performance data.

5.9 **ICM Notice of Revised System HSVTC and/or Baseline Rating.** ICM Participants using an ARM shall be notified by AHRI if a change is made to a system HSVTC and/or baseline rating. The baseline rating is derived from an existing AHRI certified system combination provided by the ICM. The ICM Participant shall have 30 calendar days to review the notice and choose to a) re-rate its affected units or b) decide no rating change is required. If the ICM Participant does not make a choice within 30 calendar days and the system was de-rated, AHRI shall automatically de-rate the ICM’s ratings by the same percentage of de-rate in the system’s rating.

5.9.1 **Test Locked Ratings.** Section 5.9 also applies to ratings that are locked for testing. For ratings that are locked, the ICM can only adjust the ratings no more than the same percentage of de-rate in the system manufacturer’s rating.

5.10 **Specific Indoor Coil Data.** Participants can download additional specific indoor coil data and condenser curve coefficients from the Directory.

5.11 **Condenser Curve Coefficients.** Refer to Appendix B for definitions of the condenser curve coefficients to be supplied by System Manufacturers.

5.12 **Rating Screening for ICMs.** AHRI shall not list any new ratings that exceed the following thresholds. All ratings that fall within the thresholds shall appear in the Directory within three (3) calendar days of submission.

5.12.1 **6% Screen.** AHRI shall screen all USAC and USHP ratings that are in excess of the System Manufacturer’s SEER, EER and HSPF ratings in accordance with the criteria described below. Ratings exceeding the thresholds indicated below shall be published only after AHRI has reviewed and approved the data. The screening criteria are as follows:

- All ICM USAC ratings that are in excess of the ICM System Manufacturer’s rating by more than 6% SEER and/or EER;
- All variable speed furnace USAC ratings that are in excess of the System Manufacturer’s HSVTC coil ratings with the same furnace and condensing unit by more than 6% SEER and/or EER;
- For variable speed furnace USAC ratings, in the event of absence of HSVTC coil rating with the furnace, all ratings that are more than 6% SEER and/or EER in excess of the highest rating of a System Manufacturer’s coil rated with that furnace and Outdoor Unit;
- All coil-blower USHP ratings that are in excess of the HSVTC coil-blower System Manufacturer’s rating by more than 6% SEER and/or EER and/or HSPF ratings;
• For variable speed air-handler USAC and USHP ratings, in the event of absence of variable speed HSVTC air-handler rating, all ratings that are more than 6% SEER and/or EER and/or HSPF in excess of the highest rating of a System Manufacturer’s coil rated with that variable speed air-handler and Outdoor Unit;

• For variable speed furnace USHP ratings, in the event of absence of HSVTC coil rating with the furnace, all ratings that are more than 6% SEER and/or EER and/or HSPF ratings in excess of the highest rated System Manufacturer’s coil matched with that furnace and Outdoor Unit;

• All ICM USHP ratings that are in excess of the coil-only System Manufacturer’s highest rating by more than 6% SEER and/or EER and/or HSPF ratings; and/or

• For ratings of ICM combinations (-C ratings) that are based on System Manufacturer HSVTC coil blower (-CB) BMG and without coil-only (-C) ratings, if the System Manufacturer HSVTC coil blower (-CB) system combination is with either a furnace or air-handler with a brushless DC motor (Ex: Multiple Speed – Constant Torque, Variable Speed), then the ICM cannot list a coil-only (-C) rating with it. If the HSVTC coil blower type is a PSC motor (Ex: Single Speed, Dual Speed, Multiple Speed – PSC), then the ICM coil-only (-C) rating cannot be in excess of the System Manufacturer’s HSVTC by more than 6% SEER and/or EER and/or HSPF ratings.

5.12.1.1 **Entering Data Above 6% Screen.** If a Participant provides ratings to AHRI that exceed the 6% threshold, Participants shall be required to provide test reports and/or ARM simulation input/output justifying the rating. Based on AHRI’s approval, the listings shall be published in the Directory.

5.12.1.2 **Entering Air-Handler Ratings.** If a Participant adds ICM combination air-handler (i.e. – a blower unit and evaporator coil combined) ratings when the System Manufacturer HSVTC combination is coil-only, Participants shall be required to provide test reports and/or ARM simulation input/output justifying the rating. Based on AHRI’s approval, the listings shall be published in the Directory.

5.12.2 **Coil Geometry Screening.** AHRI shall screen all single-speed and single-stage units as per Appendix G.

5.12.3 **Internal Refrigerant Volume (IRV) Screening.** AHRI shall screen all Heat Pump ratings for ICMs where the IRV is above or below the System Manufacturer’s IRV, in accordance with the criteria described in Appendix A.

5.13 **DOE Regional Standard Requirements.**

5.13.1 **Air-Conditioner Regional Label Requirement.** If a Participant is manufacturing a model that can be installed in the Southwest region (as defined in 10 CFR Part 430.32), no label is required.

If a Participant is manufacturing a model that can only be installed in the North region (as defined in 10 CFR Part 430.32), the Participant shall have the statement, “Install Prohibited in Southeast and Southwest.” on or near the nameplate of the condensing unit.

If a Participant is manufacturing a model that can only be installed in the North and Southeast regions (as defined in 10 CFR Part 430.32), the Participant shall have the statement, “Install Prohibited in Southwest.” on or near the nameplate of the condensing unit.

The Laboratory shall verify there is a statement present, where applicable. If the required statement is not present, the Laboratory shall notify AHRI immediately. This requirement is for products
manufactured after the effective date of March 1, 2015. The Participant shall provide a method of determining the date of manufacture upon request.

5.13.2 **Condenser Characteristics.** Participants shall identify the regions that the condenser is eligible for installation in the “Regions” field of the Condenser Characteristics.

5.13.2.1 **Regional Standards for Single Line Add/Edits.** If a Participant submits a single line new/edit to the Directory via the input interface that would alter the region where the model can be installed, the Directory shall prevent the ratings from being added. Participants shall edit the region field in the condenser characteristics table, and resubmit the listings. The data shall be published and sent to DOE after the Directory overnight process, on the date of the submission.

5.13.2.2 **Regional Standards for Mass Upload Add/Edits.** If a Participant submits a mass upload of new/edit listings to the Directory via the input interface that would alter the region where the model can be installed, the Directory shall prevent the ratings from being added. An email shall be sent listing the invalid submissions. Participants shall edit the region field in the condenser characteristics table, and then resubmit the listings. The data shall be published and sent to DOE after the Directory overnight process, on the date of the submission.

5.13.2.3 **Regional Efficiency Range.** When a Participant is adding or editing model listings, the Directory shall validate whether the new rating exceeds the range specified on the condenser characteristics table. For ratings submitted that exceed the regional efficiency range, the Directory shall prevent the ratings from being added. Participants shall edit the range for SEER and/or HSPF in the condenser characteristics table, and then resubmit the listings to enter the listings in.

Note: The ranges provided in the condenser characteristics table shall only be used for validation purposes, the FTC EnergyGuide label generated from the Directory shall determine the range automatically from the data in the Directory and place it on the label.

6. **Assessment and Payment of Certification Fees**

Except as noted below, the assessment and payment of certification fees shall proceed according to the AHRI General Operations Manual, Section 12.

6.1 **Equipment Delivery/Disposal Fees.** The Participant is responsible for the delivery and expenses associated with shipping test samples to the Laboratory. However, following the completion of the test, the sample shall be shipped prepaid by AHRI to the destination specified by the Participant. The Participant shall provide instruction to the Laboratory regarding the disposal/shipment of the sample(s).

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 the AHRI Brand Usage Manual.
APPENDIX A: REQUIREMENTS FOR CERTIFICATION OF ICM HEAT PUMP RATINGS

1. Information regarding the mixed Indoor Unit may be verified by the matched System Manufacturer.

2. Mixed Coil Requirements

   A. Should the matched System Manufacturer elect to list more than one (1) Internal Refrigerant Volume (IRV) coil for a system:
      - The IRV of the mixed Indoor Unit assembly shall not be less than 97% of the volume of the smallest matched certified Indoor Unit assembly of the System Manufacturer; and
      - The IRV shall not exceed the larger of either:
         o 103% of the IRV of the largest matched certified Indoor Unit assembly of the System Manufacturer; or
         o 120% of the IRV of the smallest matched certified Indoor Unit assembly of the System Manufacturer.

      IRV shall be rounded to the nearest 1%.

   B. Should the matched System Manufacturer elect to list only one (1) IRV coil for a system:
      - The mixed Indoor Unit assembly shall not be less than 97% of the matched certified Indoor Unit assembly of the System Manufacturer, and
      - The mixed Indoor Unit assembly shall not be greater than 120% of the IRV of the matched certified Indoor Unit assembly of the System Manufacturer.

      IRV shall be rounded to the nearest 1%.

   C. Calculation of IRV

      \[
      \text{Number of Tubes in a Row} = \frac{\text{Slab Finned Height}}{\text{Value of First Dimension Identified in Evaporator Tube Centers}}
      \]

      \[\text{(Ex: If Evaporator Tube Centers} = 1.00 \times 0.625, \text{the value of the first dimension identified in the Evaporator Tube Center field would be 1.00)}\]

      \[
      \text{Total Number of Tubes} = \text{Number of Tubes in a Row} \times \text{Evaporator Number of Rows} \times \text{Number of Slabs}
      \]

      Note: Number of Tubes in a Row is rounded to the nearest whole number.

      \[
      \text{IRV} = (\text{Slab Finned Length} \times \text{Number of Tubes} \times \left(\left(\frac{\text{Evap OD} - (2.00 \times \text{Wall Thickness})}{2}\right)^2\right)\pi)
      \]

      \[
      + \text{ Charge Compensator}
      \]

      Note: Wall thickness is 0.012 for Copper and 0.029 for Aluminum.

      Manufacturers have the option to perform an AHRI test at the Laboratory over and above what their yearly testing requirements are to add in a rating that does not meet this criteria.

   D. The Heating Capacity (Btu/h) of the mixed coil shall not be less than 100% of the smallest certified matched indoor capacity when rated with a given Outdoor Unit, nor shall it exceed the largest certified matched Indoor Unit capacity when rated with a given Outdoor Unit.
3. **Mixed Expansion Device Requirements**

   A. Mixed systems may use an appropriately sized thermostatic expansion valve (TXV) except for series restrictor systems described below.

   B. Flow Factor requirements on mixed coils with fixed restrictions:

   - If the Highest Sales Volume Tested Combination (HSVTC) matched system has a fixed restrictor, then the mixed system flow factor shall be within the range of 100-125%; unless the HSVTC matched system uses a series capillary tube restriction arrangement (i.e. no check valves), then the flow factor for the mixed system shall be within the range of 100-115%.

   - If the HSVTC system is a TXV system, but there are other matched systems which use a fixed indoor restrictor, then the flow factor for the mixed system is based on the fixed indoor restrictor with cooling capacity closest to the tested system. The mixed flow factor shall be within the range of 100-125%.

   C. If the certified matched system combinations have only TXV indoor, then the mixed system shall be TXV.

4. The mixed Indoor Unit assembly shall meet the same burst strength requirements as the matched Indoor Unit assembly.

5. If a supplemental heater is operated simultaneously with the heat pump, the heater shall be located in the indoor air circuit downstream from the indoor coil. The heater shall be capable of operating reliably at elevated ambient conditions (30-40°F above return air temperatures).

6. If the return air passes over the indoor coil before passing over the blower motor, the motor shall be capable of operating reliably at elevated ambient conditions (30-40°F above return air temperatures).
APPENDIX B: CONDENSER CURVE INFORMATION

Purpose

This appendix shall:

- Characterize the refrigeration effect (capacity) and power of the Highest Sales Volume Tested Combination (HSVTC) Outdoor Unit independent of the Indoor Unit and its associated power;
- Provide a standardized, general equation form to characterize Outdoor Unit performance and power; and
- Provide a method of identifying the equation coefficients required for the capacity and power equations.

Scope

The methods outlined herein are applicable to:

- HSVTC Outdoor Units that are used for cooling only applications;
- HSVTC heat pump Outdoor Units, cooling only performance and power; and
- AHRI/DOE A, B, C, D, F, and H test conditions as defined in AHRI Standard 210/240.

Definitions

- Condensing Unit – Consists of the Outdoor Unit and all interconnecting lines, liquid and suction, used to connect the outdoor refrigeration system to the Indoor Unit.
- Condenser performance is characterized by the general linear equation:
  \[ \text{Gross Capacity or Power} = m \cdot (\text{Evaporator Saturation Temperature}) + b \]
  Where;
  \[ m = \text{slope} \]
  \[ b = \text{intercept} \]
- Condenser power – power, watts, associated with the Outdoor Unit only; no indoor power is to be included.
- Condenser capacity – total capacity, Btu/h, with no indoor power.
- Evaporator Saturation Temperature – the refrigerant saturation temperature based on the outlet refrigerant pressure of the evaporator.
- HSVTC – Highest sales volume tested combination.
- Liquid temperature – the mean of the actual liquid temperature, °F, measured at the inlet to the evaporator flow control during HSVTC tests.

Requirements

The following information is required for AHRI submittal of each HSVTC Outdoor Unit and heat pump:

<table>
<thead>
<tr>
<th>Item</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>m1</td>
<td>Slope of capacity equation, A-test</td>
</tr>
<tr>
<td>m2</td>
<td>Slope of power equation, A-test</td>
</tr>
<tr>
<td>m3</td>
<td>Slope of capacity equation, B-test</td>
</tr>
<tr>
<td>m4</td>
<td>Slope of power equation, B-test</td>
</tr>
<tr>
<td>b1</td>
<td>Intercept of capacity equation, A-test</td>
</tr>
<tr>
<td>b2</td>
<td>Intercept of power equation, A-test</td>
</tr>
<tr>
<td>b3</td>
<td>Intercept of capacity equation, B-test</td>
</tr>
<tr>
<td>b4</td>
<td>Intercept of power equation, B-test</td>
</tr>
<tr>
<td>TL A</td>
<td>Liquid temperature entering flow control, A-test</td>
</tr>
</tbody>
</table>
For two-stage systems, a set of capacity and power coefficients as well as liquid temperature are required at each operational stage. One (1) set of coefficients, shown above, is required at each capacity level at the A and B test conditions. Low stage requires reporting at B and F conditions. Older systems may be grandfathered using A and B similar to High Stage.

| Table B2: AHRI Submittal Requirements for Low Stage |
|----------|-----------------|
| Item     | Definition                                |
| m1       | Slope of capacity equation, B-test        |
| m2       | Slope of power equation, B-test           |
| m3       | Slope of capacity equation, F-test        |
| m4       | Slope of power equation, F-test           |
| b1       | Intercept of capacity equation, B-test    |
| b2       | Intercept of power equation, B-test       |
| b3       | Intercept of capacity equation, F-test    |
| b4       | Intercept of power equation, F-test       |
| TL B     | Liquid temperature entering flow control, B-test |

**Guidelines to Determine Coefficients**

Figure B1 provides an overview of the process to determine the equation coefficients. Tables B1, B2, B3, B4 and B5 provide a tabular form of the information required to determine the coefficients. As noted on these Tables, information is required from the HSVTC tests and simulation of the HSVTC system at different evaporating temperatures.

Rules governing coefficient determination:

1. Simulations are run in the range of 40-52°F evaporator temperatures.
2. Simulations shall take into account the pressure drops associated with the liquid and suction interconnecting lines.
3. Simulated evaporator superheat is to remain a constant value in the case of HSVTC systems utilizing an expansion valve. For fixed orifice, capillary tubes, or other fixed flow control devices, the superheat shall remain at a constant value for all A-test simulations and remain constant for all B-test simulations. The A-test and B-test superheat are not required to be the same superheat value.
4. Indoor airflow changes, suggested range of ±20-25%, can be used to simulate different evaporator temperatures.
5. Corrections to the simulated values are required so that the performance and power curves pass through the actual mean HSVTC test points. This is accomplished through changes in the intercept values (b1...b4). Reference Figures B2 and B3.

**Condenser Curve Check**

If condenser curves are found on a quarterly audit to be outside of a ±10% tolerance with tested data, then AHRI shall notify the Participant of those coefficients out of tolerance. AHRI shall send Participants’ data at least seven (7) days before meeting to review condenser curve results. Participants shall investigate those coefficients out of tolerance, and have 30 days to make the appropriate corrections or provide evidence to validate their curve. If Participants do not make the corrections and respond to AHRI within 30 days, AHRI shall hide the invalid BMGs in the Directory until corrected.
Determine required HSVTC Data
See Table 1

Simulate Use different evaporating temperatures

Determine the values required in Table 2

Only 2 evaporator temperatures simulated?

No

Perform least squares linear regression using simulations (Ref Table 2)

Yes

Calculate slopes; m1, m2, m3, & m4 from simulations, Table 2

Calculate intercepts; b1, b2, b3, & b4 based on HSVTC data in Table 1

Correct intercepts based on HSVTC data in Table 1

Determination of Coefficients Complete

Figure B1: Equation Coefficients
### Table B3: DOE HSVTC Test Data

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor Power, watts</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Mean System Net Capacity, A-test, Btu/h</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Outdoor Unit Gross Capacity, A-test, Btu/h</td>
<td></td>
<td>Calculated value; Mean system net + indoor power converted to Btu/h</td>
</tr>
<tr>
<td>Mean System Net Capacity B-test, Btu/h</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Outdoor Unit Gross Capacity, B-test, Btu/h</td>
<td></td>
<td>Calculated value; Mean system net + indoor power converted to Btu/h</td>
</tr>
<tr>
<td>Mean System Power A-test, watts</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Outdoor Unit System Power, A-test, watts</td>
<td></td>
<td>Calculated value; Mean system net – indoor power</td>
</tr>
<tr>
<td>Mean System Power B-test, watts</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Outdoor Unit System Power, B-test, watts</td>
<td></td>
<td>Calculated value; Mean system net – indoor power</td>
</tr>
<tr>
<td>Mean Indoor Liquid Temperature, A-test, F</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Mean Indoor Suction Pressure, A-test, psig</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Mean Evaporator Temperature, A-test F</td>
<td></td>
<td>Input or Calculated value; Calculation based on saturation temperature for pressure above</td>
</tr>
<tr>
<td>Mean Indoor Suction Pressure B-test, psig</td>
<td></td>
<td>Mean of the values measured during HSVTC testing</td>
</tr>
<tr>
<td>Mean Evaporator Temperature, B-test F</td>
<td></td>
<td>Input or Calculated value; Calculation based on saturation temperature for pressure above</td>
</tr>
</tbody>
</table>

### Table B4: Simulation Inputs for High or Single Stage

<table>
<thead>
<tr>
<th>Item</th>
<th>Value</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-Test Evaporator Temperature, T1, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td>Saturated suction temperature, evaporator leaving</td>
</tr>
<tr>
<td>Condenser Capacity, A-test, @ T1, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
</tr>
<tr>
<td>Condenser Power, A-test, @ T1, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td>Compressor &amp; OD air mover power only</td>
</tr>
<tr>
<td>Evaporator Temperature, T2, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td>Saturated suction temperature, evaporator leaving</td>
</tr>
<tr>
<td>Condenser Capacity, A-test, @ T2, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
</tr>
<tr>
<td>Condenser Power, A-test, @ T2, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td>Compressor &amp; OD air mover power only</td>
</tr>
<tr>
<td>B-Test Evaporator Temperature, T1, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td>Saturated suction temperature, evaporator leaving</td>
</tr>
<tr>
<td>Condenser Capacity, B-test, @ T1, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
</tr>
<tr>
<td>Condenser Power, B-test, @ T1, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td>Compressor &amp; OD air mover power only</td>
</tr>
<tr>
<td>Evaporator Temperature, T2, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td>Saturated suction temperature, evaporator leaving</td>
</tr>
<tr>
<td>Condenser Capacity, B-test, @ T2, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
</tr>
<tr>
<td>Condenser Power, B-test, @ T2, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td>Compressor &amp; OD air mover power only</td>
</tr>
<tr>
<td>Simulation Inputs</td>
<td>Comments</td>
<td></td>
</tr>
<tr>
<td>------------------------</td>
<td>---------------------------------------------------------------------------</td>
<td></td>
</tr>
<tr>
<td><strong>B-Test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporator Temperature, T1, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td></td>
</tr>
<tr>
<td>Condenser Capacity, B-test, @ T1, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td></td>
</tr>
<tr>
<td>Condenser Power, B-test, @ T1, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td></td>
</tr>
<tr>
<td>Evaporator Temperature, T2, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td></td>
</tr>
<tr>
<td>Condenser Capacity, B-test, @ T2, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td></td>
</tr>
<tr>
<td>Condenser Power, B-test, @ T2, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td></td>
</tr>
<tr>
<td><strong>F-Test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaporator Temperature, T1, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td></td>
</tr>
<tr>
<td>Condenser Capacity, F-test, @ T1, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td></td>
</tr>
<tr>
<td>Condenser Power, F-test, @ T1, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td></td>
</tr>
<tr>
<td>Evaporator Temperature, T2, F</td>
<td>Saturated suction temperature, evaporator leaving</td>
<td></td>
</tr>
<tr>
<td>Condenser Capacity, F-test, @ T2, btuh</td>
<td>Includes pressure loss of interconnecting lines with addition of indoor power converted to btuh</td>
<td></td>
</tr>
<tr>
<td>Condenser Power, F-test, @ T2, watts</td>
<td>Compressor &amp; OD air mover power only</td>
<td></td>
</tr>
</tbody>
</table>
Figure B2: Typical Condenser Capacity Curve

Figure B3: Typical Condenser Power Curves
Figure C1: Use of Provisionally Qualified Outdoor Units for ICM Testing
Figure C2: Use of Unqualified Outdoor Units for ICM Testing
APPENDIX D: COMPLIANCE PROGRAM FLOW CHARTS

Figure D1: Selection and Testing Process
System Manufacturer First Test Failure Options (Efficiency Above NAECOA Minimum)

- Rerate – Rerate all Combinations in the BMG using the First Sample Test Results
  - Complete

- Total runtime < 16 hours?
  - Yes
    - Retest the same unit as first sample test
      - Retest determines the first test pass or fail.
  - No
    - Obsolete – Entire BMG is derated and obsolete
      - Complete

- Defective unit?
  - Yes
    - Refer to general OM for the defective claim requirements
      - Replace the defective component and retest the unit
  - No
    - Test Additional Samples
      - Manufacturers must supply additional samples within 30 days
      - Conduct Additional Testing

Figure D2: System Manufacturer First Test Failure Options
Coil-Only Manufacturer
First Test Failure Options
(Efficiency at or above NAECA minimum)

Rerate all combinations in that BMG. Rerate will be the same % by which the tested unit failed.

Defective coil?

Refer to the general OM for the defective claim requirements

Replace the defective component and retest the unit

Obsolete – All combinations in that BMG will be derated and obsolete.

Test Second Sample with a Different Outdoor Unit

Same coil & AHRI selects outdoor unit from another manufacturer

Second Sample Test

Test Additional Samples

Manufacturers must supply additional samples within 30 days

Conduct Additional Testing

Figure D3: ICM First Test Failure Options
ICM Second Sample Test with Different Outdoor

Figure D4: ICM Second Sample Test
Test Additional Samples Process

Receive Additional Sample Tests

Break-in Requested?

Yes → Break-in per Participant’s Instructions (Participant’s Expense)

No → Additional Test Sample Certification Testing

Is this First Additional Sample Test?

Yes → Did First Additional Sample Pass?

Yes → Testing is Complete

No → Perform Statistical Analysis with Samples

Did First Additional Pass?

Yes → Testing is Complete

No → Do the Results Meet the Testing Requirement?

Yes → Testing is Complete

No → Does Participant Continue Testing?

Yes → Test a New Additional Sample

No → Rerate all combinations in that BMG. Rerate will be the same % as the failure.

Testing is Complete

Figure D5: Test Additional Samples Process
Figure D6: System Manufacturer Test Additional Samples Failure Options
ICM or Systems Manufacturer Test Failure Options
Test Efficiency < NAECA or EPACT Minimum

Test Efficiency < NAECA or EPACT Minimum

Is this First Sample Test? Yes → Participant Elects to Test Additional Samples? Yes → See Test Additional Samples Process

No → Tested Combination is Obsoleted and Tested Ratings are Shown

Is Tested Combination HSVTC? Yes → All Combinations within the BMG are Rerated by the % by which the Tested System Failed

No → Is HSVTC Test Requested? Yes → See Test Additional Samples Process

No → HSVTC is Tested for BMG

HSVTC Test Pass? Yes → All Combinations within the BMG are Rerated by the % by which the HSVTC Combination Failed, Except the HSVTC Combination

No → Test Failure of HSVTC Follow OM Procedures

See First Test Failure Options

Rerated Combination > Applicable Minimum? Yes → Complete

No → Rerated Combination is Obsoleted and Rerated Values are Shown

Single Combination can be Tested to Restore Ratings for that Combination

Figure D7: ICM or System Manufacturer First or Additional Sample Failure Options
# APPENDIX E – INDEPENDENT COIL MANUFACTURER BMG DEFINITION

## Table E1: ICM BMG Definition

**Evaporator Parameters that Define a ICM Basic Model Group**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Characteristics</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>6,000 Btu/h increments</td>
<td>One Per 6,000 Btu/h capacity. (For example, see Table F2)</td>
</tr>
<tr>
<td>Air-Handler</td>
<td>Yes or No (mixed case)</td>
<td></td>
</tr>
<tr>
<td>Evaporator Fan Type</td>
<td>Single Speed; Dual Speed; Multiple Speed; Variable Speed (mixed case)</td>
<td></td>
</tr>
<tr>
<td>Evaporator Number of Rows</td>
<td>Whole number</td>
<td></td>
</tr>
<tr>
<td>Air-Cooled, Water-Cooled or Evaporatively-Cooled</td>
<td>Air-Cooled, Water-Cooled or Evaporatively-Cooled</td>
<td></td>
</tr>
<tr>
<td>Evaporator Tube Centers</td>
<td>0.800 x 0.693; 0.85 x 0.736; 1.00 x 0.625; 1.00 x 0.750; 1.00 x 0.866; 1.25 x 1.08; Other; N/A (this option only applicable to Non-Air-Cooled Product)</td>
<td></td>
</tr>
<tr>
<td>Evaporator Fin Type</td>
<td>Flat; Corrugated; Hi Performance; Lanced; Louvered; N/A (This option only applicable to Non-Air-Cooled product) (mixed case)</td>
<td></td>
</tr>
<tr>
<td>Evaporator Fins/Inch</td>
<td>Whole Number</td>
<td>Two (2) fins/inch per BMG (example: 8-9,10-11, 12-13,14-15..etc)</td>
</tr>
<tr>
<td>Evaporator Tube OD</td>
<td>1/4 in; 5/16 in; 3/8 in; 7/8 in; 1/2 in; 1 x 0.072 in; rifled 1/4 in; rifled 5/16 in; rifled 3/8 in; rifled 1/2 in; rifled 7mm; N/A (This option only applicable to Non-Air-Cooled product)</td>
<td></td>
</tr>
<tr>
<td>Evaporator Expansion Device</td>
<td>Orifice, Capillary Tube, Expansion Valve (mixed case)</td>
<td></td>
</tr>
<tr>
<td>Finned Length per Slab (in)</td>
<td>One decimal. Minimum 0, maximum 60 in</td>
<td></td>
</tr>
<tr>
<td>Finned Height per Slab (in)</td>
<td>One decimal. Minimum 0, maximum 60 in</td>
<td></td>
</tr>
<tr>
<td>Number of Slabs in the Coil</td>
<td>Whole Number, minimum 1, maximum 10</td>
<td></td>
</tr>
<tr>
<td>Finned Material Type</td>
<td>Options: Copper, Aluminum</td>
<td></td>
</tr>
<tr>
<td>Tube Material Type</td>
<td>Options: Copper, Aluminum</td>
<td></td>
</tr>
<tr>
<td>Total Number of Active Tubes</td>
<td>Whole Number, minimum 1, maximum 1000</td>
<td></td>
</tr>
</tbody>
</table>
Table E2: ICM BMG Bucket – Coil Capacity

<table>
<thead>
<tr>
<th>BMG Bucket – Coil Capacities</th>
<th>Min Capacity (in Btu/h)</th>
<th>Max Capacity (in Btu/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6000</td>
<td>11900</td>
</tr>
<tr>
<td>2</td>
<td>12000</td>
<td>17900</td>
</tr>
<tr>
<td>3</td>
<td>18000</td>
<td>23900</td>
</tr>
<tr>
<td>4</td>
<td>24000</td>
<td>29900</td>
</tr>
<tr>
<td>5</td>
<td>30000</td>
<td>35900</td>
</tr>
<tr>
<td>6</td>
<td>36000</td>
<td>41900</td>
</tr>
<tr>
<td>7</td>
<td>42000</td>
<td>47900</td>
</tr>
<tr>
<td>8</td>
<td>48000</td>
<td>53900</td>
</tr>
<tr>
<td>9</td>
<td>54000</td>
<td>59900</td>
</tr>
<tr>
<td>10</td>
<td>60000</td>
<td>64900</td>
</tr>
</tbody>
</table>

Definitions:

I. **Fin Definitions.**
   a. **Flat.** A flat surface without amplitudes.
   b. **Corrugated.** A flat surface modified with angular amplitudes.
   c. **Hi-performance.** A flat surface modified with sine wave amplitudes, but no lances or louvers.
   d. **Lanced/Louvered.** A surface modified with raised lances or louvers.

II. **Slab:** An independent tube coil assembly or module, used for heat transfer between refrigerant and air. For example, an A Coil consists of two (2) slabs; a pleated coil has three (3) or more slabs.

III. **Active Tubes:** Tubes in the slab intended to carry refrigerant.
APPENDIX F – SETUP, COMMISSIONING AND OPERATING CHECKLIST FOR LABORATORY PERSONNEL

Setup Checklist and Operating Procedures for the Laboratory Personnel:

1. Verify that 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.
      i. For heat pumps, determine the IRV of the test coil from the Directory. Follow the System Manufacturer’s charging instructions for a coil (whether ICM or a different System Manufacturer coil) with the closest IRV. If no instructions are available, consult the coil manufacturer for specific charging instructions.
   b. Tubing sizing.
   c. Airflow tap 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 deviation from the Participant’s published installation instructions.
   g. Verify that the unit is physically installed per the installation instructions.
3. Verify the ductwork meets ASHRAE 37 requirements.
4. Inspect indoor ductwork for leaks.
5. Verify that the indoor coil is sitting in the housing and is positioned correctly.
6. Inspect the trap for condensate is clear of obstructions and check if the condensate is leaving.
7. Verify that the correct nozzles are selected for the given airflow range.
8. Verify that the voltage to be applied matches the voltage listed on nameplate.
9. Verify major components are of compatible voltage.
10. Compare the indoor fan watts against known values (if available).
11. Verify installation to the manufacturer’s supplemental checklist (if available). (AHRI shall approve)
12. Verify the refrigerant line length between Outdoor and Indoor Units against the manufacturer’s published installation instructions.
13. Verify airflow rates of Indoor Units.

Additional Procedures and Checks Following a Failure:

1. For high stage and low stage compressor operation:
   a. Indoor (ID) airflow;
   b. ID watts;
   c. ID static;
   d. Outdoor (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. Record the temperatures leaving the circuits.
3. Photos of test setup.
4. ID airflow speed tap. List all speed tap changes.
5. Time between defrost.
6. Report any error messages or abnormally flashing lights.
7. Last date that the LEAP (Appendix H) was conducted.
APPENDIX G – COIL GEOMETRY SCREENING

1. Information regarding the mixed Indoor Unit may be verified by the matched System Manufacturer.

2. Single-Speed & Single-Stage Mixed Coil Requirements
   
   A. ICM ratings shall be subject to the flowchart shown in Figure G1, G2 and G3.
   
   B. If the sample’s ratings pass the criteria of the flowchart, the ratings are subject to the coil geometry screening program. The program shall generate a rating based on submitted data from the ICM. This rating is then compared with the System Manufacturer’s inputted data. The ratings of the mixed coil shall not exceed 6% of the output rating generated by the coil geometry screening program.
   
   C. Participants have the option to perform an AHRI test at the Laboratory in addition to their yearly testing requirements, to add a rating that does not meet the aforementioned criteria.
Figure G1: Part 1 of the ORNL Flowchart
Figure G2: Part 2 of the ORNL Flowchart
Calculate Face Area Ratio SEER Effect:
\[ \frac{(\text{Face Area Ratio} - 1)}{10} \]  
[10% Face Area = 1% SEER]

Determine Flow Control Difference SEER Effect from chart

Calculate Total SEER effect:
\[ \text{ICM SEER difference} \times (1 + \text{Total SEER effect}) / \text{ICM Rated SEER} \]

Figure G3: Part 3 of the ORNL Flowchart
APPENDIX H. UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF CENTRAL AIR CONDITIONERS AND HEAT PUMPS – NORMATIVE

Foreword: This appendix to the AHRI USE OM is the "LEAP Process" referred to in Section 3.2.2.

Appendix to OM-210/240
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</thead>
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<td>66</td>
</tr>
<tr>
<td>K2</td>
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<td>75</td>
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CERTIFICATION OF LABORATORY FACILITIES USED TO DETERMINE PERFORMANCE OF UNITARY AIR-CONDITIONING & AIR-SOURCE HEAT PUMP EQUIPMENT

Preface

The Laboratory Evaluation and Adjustment Plan (LEAP) has been developed upon direction of the AHRI Select Committee as a result of the 2011 White Paper. The intent of LEAP is to provide validation that results from a given laboratory are as accurate as current technology permits. LEAP is required for all Third Party Laboratories that perform Laboratory Certification Test functions for Unitary Air-Conditioning and Air-Source Unitary Heat Pump equipment rated below 65,000 Btu/h [19,000 W] at AHRI Standard Rating Conditions per AHRI Standard 210/240. LEAP may be used by Original Equipment Manufacturers (OEMs) to validate their Laboratory Facilities as dictated by the Unitary Small Equipment Operations Manual.

LEAP is based on scientific principles and the tolerances of individual tests are considered achievable by a test facility that common to the industry. The AHRI USE Engineering Committee Certification Subcommittee (Committee) reserves the right to review and adjust individual test tolerances as new information becomes available. The setting of tolerances may be dynamic for the first year or two of the program. It is highly advised that the laboratory that wishes to perform LEAP should obtain the latest copy from the AHRI web site prior to execution. Tolerance changes may be made by the Committee by providing a request to the AHRI USE Compliance Committee and shall be performed with the authority of the Committee only.

Section 1. Purpose

1.1 Purpose. The purpose of the appendix is to establish, for laboratory facilities used to determine performance of Unitary Air-Conditioners and Air-Source Unitary Heat Pumps, definitions, test requirements, certification requirements and documentation requirements that provide a uniform method to evaluate and adjust the quality of test data produced for the AHRI USE Certification Program.

1.1.1 Intent – Third Party Laboratories. This appendix is intended to be the minimum requirement, along with ISO 17025 accreditation, to qualify a Laboratory Facility for use as a third party partner in the AHRI 210/240 certification program.

1.1.2 Intent – Original Equipment Manufacturer (OEM) Laboratories. This appendix is intended to be a guideline, along with ISO 17025 compliance, to qualify a test facility for use as an OEM in the AHRI USE Certification Program.

1.1.3 Review and Amendment. This appendix is subject to review and amendment as technology advances.

Section 2. Scope

2.1 Scope. This standard applies to any laboratory facility that performs tests used to determine performance of Unitary Air-Conditioners and Air-Source Unitary Heat Pumps within the AHRI USE Certification Program, as defined in Section 3.

Section 3. Definitions

All terms in this document will follow the standard industry definitions in the ASHRAE Wikipedia website (http://wiki.ashrae.org/index.php/ASHRAEwiki) unless otherwise defined in this section.
3.1 *Air-Source Unitary Heat Pump.* One or more factory-made assemblies which normally include: indoor conditioning coil(s), compressor(s), and outdoor coil(s), including means to provide a heating function. 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.

3.1.1 **Functions.** They shall provide the function of air heating with controlled temperature, and may include the functions of air-cooling, air-circulating, air-cleaning, dehumidifying or humidifying.

3.2 *Code Tester.* A chamber with one or more nozzles, diffusion baffles and mixing plates used to measure air flow rate (reference ASHRAE Standard 37 Section 6); sometimes referred to as a wind tunnel.

3.3 *Degradation Coefficient (CD).* The measure of the efficiency loss due to the cycling of the units as determined in the latest edition of Appendices C and D of AHRI Standard 210/240.

3.4 *Design Heating Requirement (DHR).* This is the amount of heating required to maintain a given indoor temperature at a particular outdoor design temperature.

3.5 *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).

3.6 *Heating Seasonal Performance Factor (HSPF).* The total space heating required during the space heating season, expressed in Btu’s, divided by the total electrical energy consumed by the heat pump system during the same season, expressed in watt-hours.

3.7 *Laboratory Certification Tests.* Any test used in the determination of capacity and efficiency of an Unitary Air-Conditioner or Unitary Heat Pump; these tests are listed in AHRI Standard 210/240 Section 6.1.4. This includes tests during development of performance ratings or tests during auditing of performance ratings.

3.8 *Laboratory Facility.* Any organization that has psychrometric test rooms, data acquisition, and other equipment necessary to determine the performance of an Unitary Air-Conditioner or Unitary Heat Pump, with the intent of using the facility for Laboratory Certification Tests or qualifying new product under the penalty mode in the latest edition of AHRI USE Operations Manual. An AHRI member, a non-AHRI member, or any other independent organization may be a Laboratory Facility.

3.8.1 **Authorized Laboratory Facility.** A Laboratory Facility that has completed all tests in compliance with this appendix and has been provided with a letter of approval from AHRI for use of their facility for AHRI certification testing.

3.8.2 **OEM Laboratory Facility.** A laboratory facility utilized by an Original Equipment Manufacturer to develop certified ratings.

3.9 *Laboratory Evaluation & Adjustment Plan (LEAP).* A program to evaluate Laboratory Facilities use in performance testing of the AHRI USE Certification Program; the program provides the Laboratory with directions to adjust testing process and results in order to conform to the requirements of AHRI USE Operations Manual.

3.10 *Psychrometric Test Facility.* A pair of test chambers used to separately simulate indoor and outdoor ambient conditions, in which each chamber has the capability of separately controlling dry-bulb temperature and wet-bulb temperature within the chamber, and measuring various parameters of a unit under test.

3.10.1 **Indoor Room.** A test chamber specifically intended for installation of an indoor section of a Unitary Air-Conditioner or Unitary Heat Pump, and designed to control ambient air in the range as specified in AHRI Standard 210/240 Section 6.1.4 indoor conditions.

3.10.2 **Outdoor Room.** A test chamber specifically intended for installation of an outdoor section, or complete single package unit, of a Unitary Air-Conditioner or Unitary Heat Pump, and designed to control ambient air in the range as specified in AHRI Standard 210/240 Section 6.1.4 indoor conditions.
3.11 **Seasonal Energy Efficiency Ratio (SEER).** The total heat removed from the conditioned space during the annual cooling season, Btu/h, divided by the total electrical energy consumed, W, by the air conditioner or heat pump during the same season, Btu/(W·h).

3.12 **“Shall” or “Should.”** "Shall" or "should" shall be interpreted as follows:

- **Shall.** Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

- **Should.** "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

3.13 **Standard Air.** Air weighing 0.075 lb/ft\(^3\) which approximates dry air at 70°F and at a barometric pressure of 29.92 in Hg.

3.14 **Test.** The time during which all required operating parameters are maintained within specification and measurements of the Psychrometric Test Facility ambient air conditions and Unit Under Test performance are recorded. For steady state operation Test time is typically 30 minutes. All Standard Tests prescribed in AHRI Standard 210/240 Section 6.1.3 are considered a Test.

- **Pre-conditioning Test.** The time during which all required operating parameters are brought within Standard Rating Conditions. For steady state operation, the last 30 minutes are typically required to have operating parameters within required operating parameters.

3.15 **Test Condition Tolerance.** The maximum variation permitted of a mean value measured during a Test from the nominal set point for that value.

3.16 **Test Operating Tolerance.** The difference between the maximum temperature and the minimum temperature measured during a Test.

3.17 **Third Party Laboratory.** An independent, non-AHRI member, laboratory facility that operates under contract with AHRI to perform Laboratory Certification Tests on Unitary Air-Conditioners and Unitary Heat Pumps under the scope of the AHRI Unitary Small Equipment Section Operations Manual.

3.18 **Unitary Air-Conditioner.** One or more factory-made assemblies which normally include an evaporator or cooling coil(s), compressor(s), and condenser(s). Where such equipment is provided in more than one assembly, the separated assemblies are to be designed to be used together, and the requirements of rating outlined in this standard are based upon the use of these assemblies in operation together.

- **Functions.** Either alone or in combination with a heating plant, the functions are to provide air-circulation, air cleaning, cooling with controlled temperature and dehumidification, and may optionally include the function of heating and/or humidifying.

3.19 **Unit Under Test (UUT).** The indoor section of a split system with electric heat; the system used for round robin testing; or the static pressure reference device.

### Section 4. Test Requirements

All Laboratory Certification Tests shall be conducted in accordance with modifications as dictated by the test methods and procedures as described in this appendix (Section 5 and Appendices). Each Psychrometric Test Facility that a Laboratory Facility is qualifying for use in the AHRI 210/240 certification program shall be tested using the following procedures. Laboratory Certification Tests shall be performed in accordance with the latest DOE test procedure, ASHRAE Standard 37 and ASHRAE Standard 116 unless expressly modified by this appendix.
Section 5. Certification Requirements

5.1 Sensible Heat Capacity Evaluation of Code Tester.

5.1.1 Purpose of the Test. The purpose of the sensible heat capacity calibration of the code tester test is to compare the psychrometric measured sensible heat capacity to the total electrical energy input of the unit under test. This provides a Laboratory Facility with the ability to validate that its psychrometric measurement apparatus can measure the sensible heat capacity, prior to calibration, within 4% of the actual electrical energy input to the unit under test. After calibration, these tests will allow for only nozzle selections for a given code tester that measure air flow rate within 2% after correction.

5.1.2 Selection of Equipment.

5.1.2.1 Equipment Classification. The UUT for sensible heat capacity evaluation shall be a production split system air-handler with capability of having electric resistance heat installed internal to the UUT.

5.1.2.2 Equipment Size and Configuration. The production equipment design shall be fitted with an electric heat module of at least 2 kW per maximum ton. The heater shall be made of at least two (2) separate elements, oriented side by side, and shall be located at the outlet of the air-handler. The UUT wiring must be modified so that electrical energy supplied to the heater may be varied separately from electrical energy supplied to the rest of the UUT. Typically the psychrometric Outdoor Room power supply and measurement equipment will need to be used due to relatively high power requirements. Individual banks shall have the capability of being switched independently.

5.1.3 Test Setup.

5.1.3.1 The UUT shall be set up in the Indoor Room in accordance with ASHRAE Standard 37 Section 6.4 through Section 6.6.

5.1.3.2 All indoor electrical energy shall be measured with instrumentation which is in accordance with Section 5.4 of ASHRAE Standard 37.

5.1.3.3 If an indoor volatile refrigerant coil is present in the UUT it shall be void of refrigerant charge in order to eliminate any thermal siphoning.

5.1.3.4 At the outlet sampler, nine (9) individual thermocouples shall be placed in accordance with ASHRAE Standard 116-2010 Section 7.4.3.4.1 in order to assess the ability of the Code Tester to properly mix UUT outlet air. These thermocouples shall be out of the line of sight of the electric heat in order to avoid radiation effects. All thermocouples shall be compliant with ASHRAE Standard 41.1 Section 10.

5.1.4 Test Procedure.

5.1.4.1 Indoor air inlet conditions shall be maintained at 70.0 ± 0.5°F dry-bulb temperature and 65.0 ± 0.3°F wet-bulb temperature.

5.1.4.1.1 The Test Operating Tolerance for dry-bulb temperature shall not exceed 0.5°F and for wet-bulb temperature shall not exceed 0.3°F during the test.

5.1.4.2 The Laboratory Facility shall select appropriate (commonly used) nozzle combinations to cover the air flow rate range for any foreseen Laboratory Certification Test (this range is typically 400 scfm to 2450 scfm for Unitary Small Equipment products). The selected nozzle combinations shall be referred to as the potential combinations, a subset of all nozzle combinations. Any such nozzle combination shall be in accordance with ASHRAE Standard 37, Section 6.3.1.
5.1.4.2.1 Prior to running any electric heat tests, it is necessary to verify that the entering and leaving RTD match when no load exists. Select an air flow between 1000 to 1400 range and allow the unit and facility to pre-condition for at least one (1) hour. Run a test for 30 minutes using normal sample rates. Average the entering and leaving RTD temperatures and calculate the difference in the averages. If the difference exceeds 0.03 degrees then calibration of the facility RTDs or test setup investigation is required. An error at the upper end of this tolerance will result in heat balance errors of up to ¼ percent.

5.1.4.2.2 Over the various air flow rates to be tested, the voltage to the electric heat shall be varied in order to maintain a nominal 12 °F differential temperature across the indoor unit. Power to the heater shall be set within the range of 3.8 kW to 4.0 kW per 1000 SCFM measured.

5.1.4.2.3 For each potential nozzle combination at least three (3) air flow rates shall be tested, as described in Table K1. For the purpose of this Section 5.1, “test” shall be construed to be a single air flow rate for a given nozzle combination.

5.1.4.3 Test data for each air flow rate shall be recorded at equal intervals, with a maximum interval period of one (1) minute, over a 30 minute period. Upon completion of the Test, test data shall be averaged. For each air flow rate Test, there shall be a minimum 30 minute Pre-conditioning Test.

5.1.4.4 For sensible heat balance calibration, the blower shall not be powered and the UUT shall have all joints and seams taped or sealed (internally and externally as required) for all tests to eliminate air from leaking past the heater.

5.1.4.5 For each potential nozzle combination, at least one (1) Test of a previously run air flow rate shall be retested with the blower energized.

5.1.4.6 For each potential nozzle combination, at least one (1) Test of a previously run air flow rate shall be retested with one (1) bank of electric heaters turned off and one (1) bank on.
Figure K1: Nozzle Combination Tests

Nozzle Delta P is limited between 0.6 and 3.0 inches of water column at Nozzle Plate.

<table>
<thead>
<tr>
<th>Target Nozzle Delta P*</th>
<th>Target DT</th>
<th>Nozzle Dia 1</th>
<th>Nozzle Dia 2</th>
<th>Nozzle Dia 3</th>
<th>Nozzle Dia 4</th>
<th>Nozzle Dia 5</th>
<th>Static Press Across Nozzle Plate</th>
<th>Static Press At Supply Inlet</th>
<th>Measured SCFM</th>
<th>Fan WATTS</th>
<th>Heater Watts</th>
<th>Total Watts</th>
<th>Electrical Heat BTUH Input</th>
<th>Delta T</th>
<th>Measured Sensible Capacity</th>
<th>Sensible Capacity</th>
<th>Heat Balance</th>
<th>Barometer</th>
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<tr>
<td>~0.8</td>
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</tbody>
</table>

* Typical values required to evaluate full range of operation.
5.1.5  Data to Collect.

5.1.5.1  The following data is the minimum to be collected for each test performed:

- $B_{SH}$ = sensible heat energy balance, %
- $E_i$ = power input, indoor, W
- $E_h$ = electric heat module power input, W
- $E_t$ = power input total, W
- $L/S$ = instrument induced latent to sensible capacity ratio, $q_{li}/q_{sh}$
- $P_a$ = pressure, barometric, in. Hg
- $P_n$ = pressure at nozzle throat, in. H₂O
- $P_v$ = velocity pressure at nozzle throat or static pressure difference across the nozzle, in. H₂O
- $R^2$ = coefficient of determination
- $t_{a1}$ = temperature, air entering indoor side, dry bulb, °F
- $t'_{a1}$ = temperature, air entering indoor side, wet bulb, °F
- $t_{a2}$ = temperature, air leaving indoor side, dry bulb, °F
- $t'_{a2}$ = temperature, air leaving indoor side, wet bulb, °F
- $t_{g(1-9)}$ = leaving grid individual thermocouples 1 through 9, °F
- $t_n$ = nozzle temperature (if different than $t_{a2}$), °F
- $q_{li}$ = instrument induced latent capacity, indoor, Btu/h
- $q_{sh}$ = sensible heating capability, indoor, Btu/h
- $q_{em}$ = electric heat module capacity, Btu/h
- $Q_i$ = measured airflow, indoor, ACFM
- $Q_S$ = measured airflow, SCFM
- $Q_t$ = target nozzle air flow rate, SCFM
- $v'_n$ = specific volume of air at the nozzle, ft³/lbm of air-water vapor mixture
- $\Delta t_a$ = actual differential temperature, °R
- $\Delta t_t$ = target differential temperature, °R

5.1.5.2  The following data is the minimum to be collected for each nozzle chamber, for validation of conformance with ASHRAE 37 Section 6.2, Section 6.3 and Figure 5):

- $D_{1x,y}$ = distance from center of 1st nozzle to inside edge of nozzle chamber, in both horizontal (x) and vertical (y) directions., in.
- $D_{2x,y}$ = distance from center of 2nd nozzle to inside edge of nozzle chamber, in both horizontal (x) and vertical (y) directions., in.
- $D_{3x,y}$ = distance from center of 3rd nozzle to inside edge of nozzle chamber, in both horizontal (x) and vertical (y) directions., in.
- $D_{4x,y}$ = distance from center of 4th nozzle to inside edge of nozzle chamber, in both horizontal (x) and vertical (y) directions., in.
- $D_{5x,y}$ = distance from center of 5th nozzle to inside edge of nozzle chamber, in both horizontal (x) and vertical (y) directions., in.
- $D_{i,j}$ = distance from center of nozzle $i$ to center of nozzle $j$, in.
- $D_1$ = 1st nozzle throat diameter for current nozzle combination, in.*
- $D_2$ = 2nd nozzle throat diameter for current nozzle combination, in.*
- $D_3$ = 3rd nozzle throat diameter for current nozzle combination, in.*
- $D_4$ = 4th nozzle throat diameter for current nozzle combination, in.*
- $D_5$ = 5th nozzle throat diameter for current nozzle combination, in.*

* The nozzle diameter reported is the average of four (4) separate nozzle throat diameter measurements (refer to ASHRAE 37 Section 5.3.3).

5.1.5.3  A data input template is located in Appendix C.
5.1.6 Interpretation and Application of the Data.

5.1.6.1 Sensible Capacity Energy Balance. $B_{SH}$, the sensible capacity energy balance, is defined as follows:

$$B_{SH} = \frac{q_{sri} - q_{thi}}{q_{sri}} \times 100$$  \hspace{1cm} \text{K1}$$

Where;

$q_{thi} = \text{sensible capacity as calculated in ASHRAE Standard 37 (7.3.4.1)}$

If blower is not powered then $q_{sri}$ is calculated as follows,

$$q_{sri} = E_h \cdot 3.413$$  \hspace{1cm} \text{K2}$$

If blower is powered then $q_{sri}$ is calculated as follows,

$$q_{sri} = (E_i + E_h) \cdot 3.413$$  \hspace{1cm} \text{K3}$$

5.1.6.2 Application of Code Tester Correction Factors. Each nozzle combination selection shall be evaluated per Section 5.1.4 with at least three (3) unique air flow rates with the indoor blower off.

5.1.6.2.1 If the energy balance, $B_{SH}$, for each air flow rate tested with a given nozzle combination is within $\pm 2.0\%$ then no nozzle combination air flow rate correction is required.

$$C_{nz} = 1$$  \hspace{1cm} \text{K4}$$

Where;

$C_{nz} = \text{nozzle correction factor}$

5.1.6.2.2 If the energy balance, $B_{SH}$, for each air flow rate tested with a given nozzle combination falls between either $-2.1\%$ and $-4.0\%$ or $+2.1\%$ and $+4.0\%$ then a nozzle combination air flow rate correction factor shall be assigned to that particular nozzle combination in that particular Room.

5.1.6.2.2.1 If a first order trend line reasonably matches the data ($R^2 \geq 0.5$) and the slope is less than 0.0025 %/SCFM the correction shall be a single value at the mean of the test heat balances.

$$C_{nz} = 1 + \frac{B_{SH}}{100}$$  \hspace{1cm} \text{K5}$$

Where;

$C_{nz} = \text{nozzle correction factor}$

$R^2 = 1 - \frac{(SS_{Residual}/SS_{Total})}{SS} = \text{sum of the squares of the curve fit errors}$

5.1.6.2.2.2 If a first order trend line reasonably matches the data ($R^2 \geq 0.5$) and the slope is greater than 0.0025 %/SCFM the correction shall
be a first order equation with respect to the calculated air flow rate. This is not an iterative process.

\[ C_{nz} = 1 + (A + BQ_s) \times \frac{B_{SH}}{100} \]

Where;

\[ A = \text{intercept constant from first order trend line} \]
\[ B = \text{slope constant from first order trend line} \]
\[ C_{nz} = \text{nozzle correction factor} \]

5.1.6.2.2.3 If the first order trend line does not reasonably match the data \((R^2 < 0.5)\) then a repeat of Section 5.1.4 shall be required.

If the retest demonstrates that the data is not repeatable (any retested point more than 1% different from the previously tested point) then the nozzle combination is disallowed from rating tests. Other combinations can be qualified to cover the disqualified range of air flows. No Laboratory Certification Tests shall be performed with a disqualified or un-calibrated nozzle combination.

5.1.6.2.2.4 The instrument inducted latent capacity shall be calculated using ASHRAE 37 - 2005 Section 7.3.3.1. The value shall be reported and the Instrument Induced Latent/Sensible Capacity Ratio shall be calculated, \(L/S\), and reported as a percentage. If this ratio exceeds 5% an investigation into the humidity measurement error should take place.

5.1.6.2.2.5 No correction, either single or equations will be allowed that exceeds a 4% correction. Nozzle combinations that have a \(B_{SH}\) greater than 4.0% shall not be used during Laboratory Certification Tests.

5.1.6.2.3 Corrective actions such as adding baffles, replacement or rearrangement of nozzles, or correction of instrumentation problems are acceptable practices. Any modification requires that Section 5.1.4 tests be re-run for all nozzle combinations and the analysis in this section be performed on the new test data.

5.1.6.2.4 For the test where half of the heater banks is turned off and half is turned on, any of the nine \((9)\) grid thermocouples shall meet the following criteria (refer to ASHRAE Standard 116 Section 7.4.3.4.2):

\[ t_{g(1-9)} = t_{gaverage} \pm 0.75 \, ^\circ F \]

5.1.6.2.5 For all Laboratory Certification Tests, air flow rates used in all calculations shall be with \(Q_{SC}\) substituted in place of \(Q_s\) or \(Q_{mi}\) as appropriate.

\[ Q_{mi} = (C_{nz} \times C) \times A_n \times \sqrt{\frac{2P_v v'_n}{}} \]
\[ [= 775.9(C_{nz} \times C) \times A_n \sqrt{\frac{2P_v v'_n}{}} = 1097(C_{nz} \times C) \times A_n \sqrt{P_v v'_n} ] \]

\[ Q_{SC} = Q_s \times C_{nz} \]

or

\[ Q_{SC} = Q_{mi} \times C_{nz} \]
Where;

\[ Q_{sc} = \text{corrected air flow rate} \]

5.1.7 **Reporting and Retention of the Data.**

All data identified in Section 5.1.5 and all calculations in Section 5.1.6 shall be reported for each test. Data shall be retained for a minimum of seven (7) years.

5.2 **Evaluation of Thermal Energy Storage Effect for \( C_D \) Testing.**

5.2.1 **Purpose of the Test.** This Thermal Energy Storage Effect Test measures the thermal energy storage of the air flow rate measuring apparatus in order to accurately determine the cyclic capacity of the dry coil as specified in Section 9.2 of ASHRAE Standard 116 (e.g. the cyclic test for single stage product in AHRI Standard 210/240).

5.2.2 **Selection of Equipment.**

5.2.2.1 **Equipment Classification.** The UUT for the Thermal Energy Storage Effect Test shall be the same split system air-handler with electric heat capability used in Section 5.1 or the purpose built heater box.

5.2.2.2 **Equipment Size and Configuration.** The production equipment design shall be fitted with an electric heat module of at least 2 kW per maximum ton located at the outlet of the air-handler. A purpose built heater box with the same electrical specification may be used. The UUT wiring must be modified so that electrical energy supplied to the heater may be varied separately from electrical energy supplied to the rest of the UUT. Typically the psychrometric Outdoor Room power supply and measurement equipment will need to be used due to relatively high power requirements. Individual banks shall have the capability of being switched “on” and “off” independently.

5.2.3 **Test Setup.**

5.2.3.1 The UUT shall be set up in the Indoor Room in accordance with ASHRAE Standard 37 Section 6.4 through Section 6.6.

5.2.3.2 All indoor electrical energy shall be measured with instrumentation which is in accordance with Section 5.4 of ASHRAE Standard 37.

5.2.3.3 If an indoor volatile refrigerant coil is present in the UUT it shall be void of refrigerant charge in order to eliminate any thermal siphoning.

5.2.3.4 The leaving thermocouple grid (or thermopile) must not be affected by the radiant energy coming from the heater element. Verified by the following:

5.2.3.4.1 Set the room temperature to 90°F. Run the air through the apparatus with no electric heat energized and record the difference in temperatures between the leaving grids and RTDs in the psychrometers (four independent readings shall be taken).

5.2.3.4.1.1 For thermocouple grids or thermopiles, set the room temperature to 70°F. Apply enough power to the heater to raise the air temperature approximately 20°F. If the difference between the grids and the RTDs vary by more than 1°F, then shield or block the line of sight between the heater and thermocouples.
5.2.3.5 At least one (1) thermocouple shall be attached via solder method per ASHRAE Standard 41.1 Section 7.2.10; or mechanically attach thermocouples to each potential large thermal mass between the outlet of the UUT and the grid of thermocouples specified in Section 5.2.3.4. Thermocouples shall be connected in parallel.

5.2.4 Running the Test Procedure.

5.2.4.1 The indoor blower motor shall be left unpowered throughout this Thermal Energy Storage Effect Test.

5.2.4.2 Indoor air inlet conditions shall be maintained at 70.0 ±0.5°F dry-bulb temperature and 65.0 ±0.3°F wet-bulb temperature.

5.2.4.2.1 The Test Operating Tolerance for dry-bulb temperature shall not exceed 0.5°F and for wet-bulb temperature shall not exceed 0.3°F during the test.

5.2.4.3 The airflow shall be set to 1200 SCFM and will run continuously throughout the test. The heater will be powered to produce between 8 and 10 kW. The heater will be cycled “on” for 6 minutes then “off” for 6 minutes. Ten “on”/”off” cycles (2 hours) shall constitute a complete test.

5.2.4.4 Care must be taken to assure the voltage to the heater remains constant at the level of the test described in Section 5.2.4.3. It is highly recommended that the active variac voltage control be disabled during the cyclic part of this test.

5.2.4.5 The thermocouple or thermocouples attached to the largest thermal mass in the test facility, out of line of sight of the heater, shall be recorded on a minimum of ten-second intervals for the duration of the six-minute “on” time. Note that if more than one (1) large thermal mass is expected, then the temperature shall be monitored on each expected large thermal mass and proceed with calculations based on the experimentally determined largest thermal mass.

5.2.5 Data to Collect.

5.2.5.1 The following data is the minimum to be collected for Thermal Energy Storage Effect testing:

All of the data from Section 5.1.5 and the following additional data:

\[ t_m = \text{thermal mass, } ^\circ F \]
\[ t_m(0) = \text{temperature of largest thermal mass between the UUT and the measurement grid (likely the mixer) at the start of the “off” cycle, } ^\circ F \]
\[ t_m(\Theta I) = \text{temperature of largest thermal mass between the UUT and the measurement grid (likely the mixer) at end of the integration time within the “off” cycle, } ^\circ F \]
\[ q_{cyc.h} = \text{integrated capacity based on the measured watts of the heater, Btu/h} \]
\[ q_{cyc.hoff} = \text{integrated capacity based on the measured kW of the heater during an off cycle, Btu/h} \]
\[ q_{ts} = \text{cyclic thermal storage capacity correction, Btu/h} \]
\[ mc_{pm} = \text{mass times the specific heat of the thermal storage device per ASHRAE Standard 116 Section 9.2.2, Btu/}^\circ F \]
5.2.6 Interpretation and Application of the Data.

Specifically, this Thermal Energy Storage Effect Test is measuring \( q_{ts} \) and integrated thermal mass change in temperature of the cyclic cooling or heating capacity per ASHRAE Standard 116 Section 9.2.2 to determine the \( m_{c\text{pm}} \) term.

5.2.6.1 Since Thermal Energy Storage Effect Test is being performed with electric heaters as the source of capacity and electric heaters for all practical purposes are instantly “on,” the “off” cycle integrated capacity (Btu/h) is the measure of heat storage in the thermal mass. Therefore:

\[
q_{ts} = q_{\text{cyc,off}}
\]  

K11

5.2.6.2 The integrated change in temperature of the thermal mass, from the beginning of the Thermal Energy Storage Effect test to the end of the six-minute “on” cycle shall be considered thermal storage potential.

5.2.6.3 Record the integrated cyclic single or multiple thermocouple average temperature, representative of the bulk temperature of the largest thermal mass of the test equipment (usually the mixer).

5.2.6.4 Determine \( m_{c\text{pm}} \) from ASHRAE Standard 116 sections 7.4.3.4.5, and 9.2.2, for each of the last 6 to 8 cycles.

\[
m_{c\text{pm}} = \frac{q_{ts}}{[t_{m}(0) - t_{m}(\Theta)]}
\]

K12

5.2.6.5 Report \( m_{c\text{pm}} \) as the mean of \( m_{c\text{pm}} \) for last 6 to 8 cycles. Cycle equilibrium is defined in ASHRAE 116 8.2.4.2 as three (3) consecutive cycles in which the integrated \( \Delta T \) for the “on” portion of the cycle does not vary by more than 0.3°F and the total watts for the complete “on”/“off” cycle does not vary by more than 10 watts.

5.2.6.6 For \( m_{c\text{pm}} \) sufficiently low (4.0 Btu/°F or less), no adjustments to cyclic data is required. For \( m_{c\text{pm}} \) greater than 4.0 Btu/°F, thermocouples shall remain on the device with the greatest thermal energy storage effect and adjustment made to all cyclic Laboratory Certification Test as per ASHRAE 116 Section 9.2.2 and 9.2.3.

5.2.6.7 Example of data reporting.

<table>
<thead>
<tr>
<th>Time Stamp (s)</th>
<th>Temp Entering Grid (°F)</th>
<th>Temp Leaving Grid (°F)</th>
<th>Air Flow (SCFM)</th>
<th>Specific Heat (BTU/lbmâ*-°F)</th>
<th>Specific Volume (ft³/lbmâ*)</th>
<th>Heater Power (W)</th>
<th>Air Measured Capacity (Btu/h)</th>
<th>Mass Temp (Btu/h-°R)</th>
</tr>
</thead>
<tbody>
<tr>
<td>3590</td>
<td>70</td>
<td>90</td>
<td>1200</td>
<td>0.2405</td>
<td>0.075</td>
<td>8000</td>
<td>25974</td>
<td>90</td>
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<td>0.075</td>
<td>0</td>
<td>129</td>
<td>71.0</td>
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</table>

Average 2435
5.2.7 Reporting and Retention of the Data.

All data identified in Section 5.2.5 saved in a spreadsheet reporting both the steady state test and cycles 2 through 5 of the cyclic test. Data shall be retained for a minimum of seven (7) years.

5.3 Evaluation of External Static Pressure Measurement System.

5.3.1 Purpose of the Test. The External Static Pressure Measurement test compares the external static pressure measurement instrumentation to a known passive pressure drop device, comparing standard ASHRAE 37 duct configurations to ASHRAE 116 duct configurations, in order to validate ASHRAE 116 duct configurations provide accurate external static pressure measurements.

5.3.2 Selection of Equipment.

5.3.2.1 Equipment Classification. A passive pressure drop device is a box with nominal outside dimensions approximating a cased coil (see Table K2 and Figure K2 below) shall be constructed with fixed restrictor plates to simulate the pressure drop associated with an indoor coil at nominal airflows. An outlet duct shall be sized according to ASHRAE Standard 37 Section 6.4 and shall be used to measure the outlet pressure.

5.3.2.2 Equipment Size and Configuration. The passive pressure drop device cabinets shall be constructed without internal insulation and shall be sealed to prevent any external or internal air leakage. The cabinets shall be fitted with a fixed restrictor plate in the position of the coil condensate pan. Each restrictor plate has been developed with an opening size to create 0.30 in. H₂O external static pressure with a tolerance of ±0.02 in. H₂O at 1200 SCFM.

<table>
<thead>
<tr>
<th>Cabinet</th>
<th>Width (in)</th>
<th>Depth (in)</th>
<th>Minimum Height (in)</th>
<th>Nominal Airflow Test Points (SCFM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>17.5</td>
<td>21</td>
<td>24</td>
<td>600 800 1000 1200 1400 1600 1800</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Static Pressure – Standard (*To be recorded at each airflow) (in H₂O)</th>
</tr>
</thead>
<tbody>
<tr>
<td>*</td>
</tr>
</tbody>
</table>
Refer to Figure 8 in ASHRAE 37 for inlet and outlet duct dimensions.

5.3.3 Test Setup.

5.3.3.1 The passive pressure drop device shall be set up in accordance with ASHRAE Standard 37 Section 6.4 through Section 6.6, except as noted below in Section 5.3.3.2.

5.3.3.2 The passive pressure drop device shall be tested in all of the following configurations:

5.3.3.2.1 Exact ASHRAE Duct Configuration Baseline. Per ASHRAE Standard 37 Section 6.4.4, the passive pressure drop device shall be set up with an entering and leaving duct with the dimensions outlined in Figure 8 of ASHRAE Standard 37. The entering duct shall have free flow of air and shall not be on top of a bottom damper system employed for cyclic testing.

5.3.3.2.2 Conventional Psychrometric Testing Configuration. This testing will utilize the bottom damper system and whatever means (pressure skirt with four manifolded pressure taps on top of the damper, entering ASHRAE duct, etc.) the Laboratory Facility utilizes for measuring inlet air pressure to the UUT. The outlet duct between the upper damper and the outlet of the UUT will be whatever conventional configuration that will be utilized by the test facility for certification testing.
5.3.3.2.3 *Height Constrained Psychrometric Testing Configuration.* If the Laboratory Facility has height constraints when testing equipment with the full outlet ASHRAE ducts, then whatever alternate configuration the Laboratory Facility may utilize to measure these systems shall also be tested to validate against the setup in Section 5.3.3.2.1.

5.3.4 *Running the Test Procedure.*

5.3.4.1 Indoor air inlet conditions shall be those specified for the A test in AHRI Standard 210/240 Section 6.1.4.1 Table 3. These nominal conditions are 80°F DB and 67°F. Tolerances shall also be per AHRI Standard 210/240.

5.3.4.2 Run each nominal standard airflow rate in Table K2 using only qualified nozzle combinations for each of the configurations identified in Section 5.3.3.2 above. Airflow rate shall be set to the test point and the measured reading shall be within ±1% of the airflow rate set point, as specified in Table K2.

5.3.4.3 Test data for each point shall be recorded at equal intervals, with a maximum interval period of one (1) minute, over a 30 minute period. Data will be averaged. For each set of test data, there shall be a 30 minute pre-conditioning time.

5.3.5 *Data to Collect.*

5.3.5.1 The following data is the minimum to be collected for this testing:

- $B_{ST}$ = static pressure drop balance, %
- $P_a$ = pressure, barometric, in. Hg
- $P_n$ = pressure at nozzle throat, in. H$_2$O
- $P_v$ = velocity pressure at nozzle throat or static pressure difference across the nozzle, in. H$_2$O
- $Q_S$ = measured airflow rate, SCFM
- $t_{a1}$ = temperature, air entering indoor side, dry bulb, °F
- $t_{a2}$ = temperature, air entering indoor side, wet bulb, °F
- $t_n$ = nozzle temperature (if different than $t_{a2}$), °F
- $\Delta P_{st,A}$ = pressure drop, in. H$_2$O

5.3.5.2 A data input template is located in Appendix D.

5.3.6 *Interpretation and Application of the Data.*

5.3.6.1 Static pressure drop balance shall be calculated using the following formula:

$$B_{ST} = (\Delta P_{st,A} - \text{Static Pressure from Table K2}) / \text{Static Pressure from Table K2} \times 100$$

5.3.6.2 The external static pressure balance $B_{ST}$ for each airflow rate shall be within ±7% of the calibrated restrictor plate.

5.3.6.3 If $B_{ST}$ is not within ±7%, then the code tester, instrumentation, etc. must be evaluated and improvements made to the facility to bring it into compliance. All tests in Table K2 must be re-run after any changes have been made.

5.3.6.3.1 If there are problems meeting this tolerance, then it is recommended that Laboratory Facility run with the entering ASHRAE duct with the outlet configuration that did not meet the tolerance, and then repeat the tests with the ASHRAE outlet configuration and the inlet configuration that failed to meet the tolerance in order to
isolate which portion of the external static pressure measurement apparatus is out of tolerance.

5.3.6.4 All Laboratory Certification Tests shall be performed only in Psychrometric Test Facilities that have been verified to have $B_{ST}$ less than ±7%.

5.3.7 Reporting and Retention of the Data.

All data identified in Section 5.3.5 and calculated in Section 5.3.6 shall be reported for each run, and shall be retained for a minimum of seven (7) years.

5.4 Full System Psychrometric Round Robin Testing.

5.4.1 Purpose of the Test. The purpose of the Full System Psychrometric Round Robin Testing is to verify that all Psychrometric Test Facilities that may be used by a Laboratory yield consistent results. Authorized Laboratory Facilities shall be required to perform this Round Robin Testing on an annual basis.

5.4.2 Selection of Equipment.

5.4.2.1 Equipment Classification. In order to qualify the Laboratory Facility for both cooling and heating, a single stage heat pump system shall be selected from the categories identified in Table 2 of AHRI Standard 210/240. Initial testing preference would be given to either a split system (HRCU-A-CB) or a single package system (HSP-A). For repeat Round Robin Testing, alternate types of systems shall be selected.

5.4.2.2 Equipment Size and Configuration. The system to be tested shall be selected from AHRI 210/240 Certification Program samples previously tested at an existing Authorized Laboratory Facility operating under contract with AHRI. The selected audit system shall be an OEM system and shall have passed all certified values with at least 95% of the certified rating and if a split system, be within ±10% on all condenser curves. The system type shall be a simple base model without proprietary controls or other features that would complicate the testing. The nominal capacity of the initial system would preferably be 3 tons. The size of the round robin system shall be rotated on a yearly basis to ensure the entire application range is covered.

5.4.3 Test Setup.

Contact with the equipment manufacturer is permitted, and preferred, to validate correct set up prior to conducting any Tests.

5.4.3.1 Test System Preparation/Charge. If the system is not pre-charged (e.g. a split system), then during the cooling Tests the UUT shall be charged to match the previous audit data. In order to match operating conditions, the refrigerant charge may be adjusted once during the heating H1 Tests to match the outdoor subcooling results of the existing Authorized Laboratory Facility if refrigerant subcooling leaving the condenser is greater than 1°F different from the subcooling value during the baseline test. The difference in charge, if any, shall be recorded in each case.

5.4.3.2 Test System Preparation/Cyclic. Cyclic testing shall be conducted using the same time delays as used during the baseline testing, and shall use the $mc_{pm}$ determined in Section 5.2.6.

5.4.3.3 Secondary Capacity Check Type. For split systems, the preferred secondary energy balance is the refrigerant enthalpy method as outlined in ASHRAE Standard 37 Section 7.5. For single package systems, the outdoor air enthalpy method as outlined in ASHRAE Standard 37 Section 7.3. If the psychrometric rooms are capable of both methods, then both energy balances should be collected during the testing.

5.4.4 Running the Test Procedure.
5.4.4.1 Each Room in which the Laboratory Facility may use for AHRI 210/240 performance Tests shall undergo the full battery of tests outlined below with the same round robin system:

5.4.4.1.1 AHRI 210/240 Standard Tests. The full set of tests from AHRI Standard 210/240 Tables 3 through Table 10 as appropriate shall be performed. Cyclic tests must be performed.

5.4.4.1.2 Evaluation of Latent Capacity Measurement. See Section 5.5 for full details. These tests shall be run at the same time as the steady state cooling Tests from Section 5.4.4.1.1.

5.4.5 Minimum Data Collection Requirements.

5.4.5.1 All data required by ASHRAE Standard 37 Section 9 shall be required for all Tests in Section 5.4.4. SEER and HSPF shall be determined using the BIN method only.

5.4.5.2 In addition, all data identified in Section 5.5.4 shall be collected to evaluate the latent capacity measurement.

5.4.6 Interpretation and Application of the Data.

5.4.6.1 In order to be qualified as an Authorized Laboratory Facility, the following criteria must be met:

1. Each individual measured value (cooling capacity, heating capacity, SEER and HSPF) shall be within 2% of the mean of all individual measured values.
2. The latent capacity balance shall be within the tolerances specified in Section 5.5.6 of this appendix.
3. System state points shall be within:
   a. 5 psig for any high-side pressure
   b. 2 psig for any low-side pressure
   c. 1°F superheat at charging location (for piston expansion systems)
   d. 1°F subcooling at charging location (for expansion valve systems)

Any questions on the testing process shall be referred to the Committee.

5.4.7 Reporting and Retention of the Data.

All data and results identified in Sections 5.4.5 and 5.4.6 shall be reported for each test. Data and results shall be retained for a minimum of seven (7) years. All Round Robin Test Data shall be reported in both the laboratory standard report format, as well as XML format (if available), as required by the AHRI USE Operations Manual.

5.5 Evaluation of Latent Capacity Measurement.

5.5.1 Purpose of the Test. This test compares the psychrometric measured latent capacity against the calculated latent capacity using the measurement of condensate draining from the indoor coil of the system. This is to provide a Laboratory Facility the ability to validate that its psychrometric measurement apparatus can measure the latent capacity within 5% of the actual condensed water removed from the airstream by the indoor coil.

5.5.2 Selection of Equipment.

5.5.2.1 The equipment for latent capacity measurement is the same as that required previously by Section 5.4.2.

5.5.3 Test Setup.
5.5.3.1 ASHRAE Standard 37 Section 7.8 outlines a method for calculating the latent capacity based on the mass flow rate of the cooling condensate draining from the indoor coil for equipment with a rated capacity of 135,000 Btu/h or higher that use an indirect method for determining airflow rate. This appendix shall apply the same methodology to equipment with a rated capacity of 65,000 Btu/h or less with a direct measurement of airflow rate.

5.5.3.2 The required setup for running the latent capacity test is to connect tubing between the condensate drain on the indoor coil and a secondary reservoir. A drain trap shall be used in the tubing between the outlet of the condensate pan and the secondary reservoir. The drain trap shall be installed per the manufacturer’s installation instructions. The secondary reservoir shall be placed upon a scale capable of measuring weight to the nearest 0.01 lb or in a container capable of measuring volume to the nearest 0.1 oz.

5.5.4 Running the Test Procedure.

5.5.4.1 The Tests required in Sections 5.1 through 5.3 of this appendix shall be performed prior to the latent capacity testing.

5.5.4.2 The blower fan speed shall be set to the lowest airflow setting.

5.5.4.3 The system shall be run at the A or A2 condition for at least five (5) consecutive A tests during the cooling Tests of the Full System Psychrometric Round Robin Testing (see Section 5.4).

5.5.4.4 The condensate mass flow rate draining off of the indoor coil shall be measured during each of the five (5) consecutive A or A2 Tests.

5.5.4.4.1 At a minimum, measure the weight or volume at the beginning and at the end of each individual A or A2 Test. Calculate the difference and divide it by the total time (0.5 h in this case) to obtain the condensate mass flow rate.

5.5.4.4.2 A preferred method is to connect the scale to the lab’s data acquisition system to log the data for the entire A or A2 Test. The reservoir should be emptied as needed between tests to avoid overflowing.

5.5.4.4.3 If the condensate mass flow rates from the last three (3) A or A2 Tests meet the requirements of Section 5.5.6.3, then the Latent Capacity Measurement testing is complete. If the requirements are not met, then either a) adjustment to or re-calibration of the Laboratory Facility equipment shall be performed, or b) consecutive A or A2 Tests shall be continued until the requirement is met, with a maximum of 10 consecutive Tests. Any and all tests required by this Standard that may potentially have been affected by adjustments or re-calibration shall be re-run.

5.5.5 Minimum Data Collection Requirements

5.5.5.1 All of the data from Section 5.4.5 and the following additional data shall be recorded:

\[ w_c = \text{condensate mass flow rate, lbm/h} \]

\[ B_{LC} = \text{latent capacity energy balance, %} \]
5.5.6  

*Interpretation and Application of the Data.*

5.5.6.1 Calculate the latent capacity based on the measured condensate flow rate:

\[ q_{\text{occ}} = 1061 \times w_c \]  

Where:

\[ q_{\text{occ}} = \text{latent capacity based on condensate flow, Btu/h} \]
\[ w_c = \text{condensate mass flow rate, lbm/h} \]

5.5.6.2 Calculate the latent capacity based on the measured condensate flow rate:

\[ B_{\text{LC}} = \frac{(q_{\text{occ}} - q_{\text{ci}})}{q_{\text{occ}}} \times 100 \]  

5.5.6.2 The latent capacity energy balance \( B_{\text{LC}} \) for each of the last 3 A or \( A_2 \) Tests shall be within ±5% of the measured psychrometric latent capacity.

5.5.6.2.1 If the latent capacity balance between the psychrometric and the measured condensate are outside of these tolerances it could possibly indicate a psychrometer inaccuracy issue (either control or measurement) or a mixing issue that would require improvements to the facility. If changes are made to any test apparatus, set-up or calibration, this battery of tests must be re-run in their entirety.

5.5.6.3 In addition, the latent capacity \( q_{\text{occ}} \) based on condensate flow for each of the last three (3) consecutive A or \( A_2 \) Tests shall be within ±6% of each other to verify the repeatability of the facility.

5.5.7  

*Reporting and Retention of the Data.*

All data and results identified in Sections 5.4.5 and 5.4.6 shall be reported for each test. Data and results shall be retained for a minimum of seven (7) years. All Round Robin Test Data shall be reported in both the laboratory standard report format, as well as XML format (if available) as required by the AHRI USE Operations Manual.
APPENDIX I: SECONDARY CAPACITY CHECK REQUIREMENTS

Section 1. Purpose

The purpose of this appendix is to specify the requirements for secondary capacity checks that any independent third party laboratory must comply with during AHRI USE Certification Program testing.

Section 2. Scope

2.1 The requirements of this appendix shall apply to all USE Certification Program testing of:

2.1.1 Unitary Small Air-Conditioners (Systems and Mixed-Match Coils) which are Air-Cooled

2.1.2 Unitary Small Air-Source Heat Pumps (Systems and Mixed-Match Coils) which are Air-Cooled

2.2 The requirements of this appendix are not applicable to:

2.2.1 Unitary Small Air-Conditioners (Systems and Mixed-Match Coils) which are Evaporatively or Water-Cooled.

Section 3. Definitions

3.1 Code Tester. A nozzle airflow measuring apparatus as defined by ASHRAE Standard 37 Section 6.2.

3.2 Flow Meter Assembly. A mass flow meter, associated tubing, associated valve assemblies, sight glasses and any other associated components that add internal volume to the operating system.

3.3 Pressure Transducer Assembly. A pressure transducer, associated tubing, associated valve assemblies, and any other associated components that add internal volume to the operating system.

Section 4. Symbols

4.1 \( q_{tia} = \) total capacity, indoor, air, Btu/h

4.2 \( q_{rir} = \) total capacity, indoor, refrigerant, Btu/h

4.3 \( q_{toa} = \) total capacity, outdoor, air, Btu/h

4.4 For coil-only applications, total capacity as defined in 4.1, 4.2 and 4.3 shall be defined as gross capacities.

4.5 For applications having a blower motor, total capacity as defined in 4.1, 4.2 and 4.3 shall be defined as net capacities.

4.6 \( HB = \) heat balance \[ \frac{(q_{tia}-q_{rir})}{q_{tia}} \] or \[ \frac{(q_{tia}-q_{toa})}{q_{tia}} \]
Section 5. Requirements

5.1 Usage of Refrigerant Mass Flow Method

5.1.1 All split systems, whether ducted or non-ducted, shall use the refrigerant mass flow method as the secondary capacity check for all steady state tests per Section 6 of this appendix.

5.1.2 The absolute value of heat balance (HB) shall be 4.0% or less on all tests, except for H3 which may be greater if:

- Tests B and H1 are 3.0% or less, and
- Subcooling leaving indoor unit is less than 3.0°F.

5.1.3 Excluded from Section 5.1.1 requirements are split system products with an expansion device located upstream of the liquid line mass flow meter. Such as a system with a cooling expansion device in the Outdoor Unit.

5.1.4 This method shall be not be used on specific tests if ASHRAE Standard 37 Section 7.5 cannot be met. The air enthalpy method shall be substituted in these cases.

5.2 Usage of Outdoor Air Enthalpy Method

5.2.1 All single package systems shall use outdoor air enthalpy method as the secondary capacity check for all steady state tests per Section 7 of this appendix.

5.2.1.2 The absolute value of HB shall be 6.0% or less on all tests, except for H3 which may be greater than 6.0% if all other tests are less than 6.0%.

5.3 For any products that meet the scope defined in Section 2, where the requirements of Section 6 or Section 7 cannot be met, the Unitary Small Equipment Engineering Committee shall be contacted for resolution.

Section 6. Refrigerant Mass Flow Method Requirements

6.1 Pressure measurements shall be:

6.1.1 Measured at the indoor coil, per ASHRAE Standard 37 Section 8.3 and ASHRAE Standard 41.3.

6.1.1.1 Vapor pressures at the Outdoor Unit may be measured and used as an alternate to vapor pressure at the Indoor Unit, if required, in order to achieve 5°F superheat, as long as appropriate adjustments are made per Section 6.4.3.1.

6.1.2 Taken within 12 inches of the field connection of the Indoor Unit.

6.1.3 Taken on the top half of the tube, unless tubing is vertical in which case any side is acceptable. Pressure taps shall not be installed such that oil may potentially fill the pressure tap line.

6.1.4 Made no closer than 10 tube diameters upstream or downstream of any bends that are greater than 30 degrees, or within 10 tube diameters of short radius bends. Tubing shall be inspected to verify there are no kinks or restrictions.
6.2 Temperature Measurement Requirements:

6.2.1 Temperature measurements shall be taken per the latest edition of ASHRAE Standard 41.1.

6.2.2 Temperature measurements shall be taken using the preferred method of refrigerant temperature measurement (resistance temperature devices (RTDs) per ASHRAE Standard 41.1 Section 8.1). If used, RTDs shall be installed with tubing arrangement such that pressure drops due to application do not exceed 0.5 psig.

6.2.3 When thermocouples (TC) are used for measurement of refrigerant temperature by application to the outside of tubing, the following requirements shall be met:

6.2.3.1 TC material used shall have special limits of error of 0.75°F or less.

6.2.3.2 Two (2) TCs (for each liquid and vapor, total of four) shall be applied within 3 inches of each other, with one TC at the 10 o’clock position and one TC at the 2 o’clock position, as there may be oil in the lower half. Each TC shall be measured individually. Average of the two temperatures on each liquid and vapor line shall be used for calculations.

6.2.3.3 Each and every TC shall be applied to the tubes per ASHRAE Standard 41.1 Section 10. This entails ensuring that:

- There are no more than three (3) turns of wires contacting each other;
- The wires are ‘tinned’ or soldered together before application to the tube;
- The wires are secured to the tube via soldering or welding (without burning insulation or melting wire); and
- The wires outside of the joint described in Section 6.2.3.3.3 are prevented from touching each other or other metallic surfaces, preferably by applying electrical tape between the wire and the tube outside of the solder bed.

6.2.3.4 Each and every TC shall be applied per ASHRAE Standard 41.1 Section 8.2, having insulation with R-value of at least 3.1, extending along the tube for at least six (6) inches on either side of the TC.

6.2.4 TCs shall be applied at the exiting side of the refrigerant mass flow meter assembly. For heat pumps, this means both sides of the refrigerant mass flow meter assembly shall have TCs applied.

6.2.5 It is preferred, but not required, that TCs are individually calibrated per ASHRAE Standard 41.1 Section 10.

6.3 Refrigerant Mass Flow/Refrigerant Properties

6.3.1 Use NIST REF PROP 7.0 or higher for reference to refrigerant properties (saturated and enthalpies)

6.3.2 Refrigerant mass flow rate calculation must account for the mass flow rate of oil in the refrigerant line, as oil contributes to the mass flow rate but not productive heat transfer.

6.3.2.1 If the quantity of oil circulating is not measured, a 1.0% oil circulation rate shall be assumed \(x = 0.99\)

6.3.2.2 If the quantity of oil circulation is measured, the calculation shall follow ASHRAE Standard 37, Section 7.5.2.3.

6.3.3 Mass flow rates must be measured by equipment meeting ASHRAE Standard 41.10 requirements.
6.4 *Mass Flow Procedure Requirements*

6.4.1 The actual internal volume of pressure transducer assemblies and flow meter assemblies shall be measured or calculated prior to setup and recorded with test report data. Either document hose diameters (OD and ID) and length of hoses used, or calculate internal volume (above). This information shall be recorded along with all other test data.

6.4.1.1 Entire length of liquid line outside of flow meter assembly connections must be the diameter specified by the Participant’s published installation instructions.

6.4.2 If a Participant specifies a refrigerant charge by weight, then charge shall be adjusted by adding the cumulative internal volume of the flow meter assemblies, and pressure transducer assemblies in cubic feet, ft³, times the liquid density of the refrigerant, lb*mass/ft³, used at the charging test condition.

6.4.3 Refrigerant side capacity \( q_{\text{tri}} \) shall be calculated per ASHRAE Standard 37, Section 7.5.4 for cooling mode and Section 7.5.5 for heating mode.

6.4.3.1 If vapor refrigerant at the indoor coil pressure tap is not superheated by at least 5°F, or the liquid refrigerant at the indoor coil pressure tap is not sub-cooled by at least 3°F, then refrigerant properties at the Outdoor Unit may be substituted, as long as refrigerant side capacity is adjusted by line loss calculations per ASHRAE Standard 37 Section 7.3.3.4. If the minimum superheat values are not met at the Outdoor Unit, then the outdoor air enthalpy method shall be used per Section 7 of this appendix.

6.4.4 If needed in order to improve HB, the following adjustments are permitted. If such adjustments are made the test report shall indicate the adjustments.

6.4.4.1 Pressures used may be adjusted for elevation differences between the actual pressure tap location and the pressure transducer. If the pressure transducer is located higher than the pressure tap location, then add the elevation head difference to the pressure transducer measurement. If the pressure transducer is located lower than the pressure tap location, then subtract the elevation head difference from the pressure transducer measurement.

6.4.4.2 If pressure transducers are located in the outdoor or indoor test environment, they may be temperature compensated in accordance with the Participant’s instrument instructions. Pressure transducer temperature range shall be suitable for the mounting location.

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**Section 7. Outdoor Air Enthalpy Method Requirements**

7.1 Pressures measurements:

7.1.1 Shall be made with instrumentation according to the latest edition of ASHRAE Standard 41.2.

7.1.2 Shall be measured at the service connections provided on the product.

7.1.2.1 Split systems that meet the requirements of Section 5.1 shall have pressures and temperatures measured at the Indoor Unit per Section 6.1 and 6.2.

7.1.3 Shall be taken with static pressure taps compliant with Figure 7A of ASHRAE Standard 41.2-1987.

7.2 Temperature measurements requirements:

7.2.1 Temperature measurements shall be made with instrumentation according to the latest edition of ASHRAE Standard 41.1.
Outdoor air inlet temperatures shall be measured with RTD using sampling device per the latest edition of ASHRAE Standard 41.1 and 41.6.

All air inlet temperature measurements shall be taken using a sampling tree.

Sampling trees shall cover at least ¾ of the inlet area of each face, and no air shall be sampled outside of the inlet face area.

Outdoor air outlet temperatures, when duct is connected, shall be measured with an RTD using a sampling device per the latest edition of ASHRAE Standard 41.1 and 41.6.

When thermocouples (TC) are used for measurement of refrigerant temperature by application to the outside of tubing, the following requirements shall be met:

The TC material used shall have special limits of error of 0.75°F or less.

For non-vertical tubes, the TCs shall be placed in the upper half of refrigerant tubes, as there may be oil in the lower half.

At the indoor coil, two TCs shall be applied within three (3) inches of each other, with one TC at the 10 o’clock position and one TC at the 2 o’clock position (for each liquid and vapor line, total of four TCs). Each TC shall be measured individually. Average of the two temperatures on each liquid and vapor line shall be used for calculations.

Each and every TC shall be applied to the tubes per ASHRAE Standard 41.1 Section 10.

There shall be no more than 3 turns of wires contacting each other.

The wires shall be ‘tinned’ or soldered together before application to the tube.

The wires shall be secured to the tube via soldering or welding (without burning insulation or melting wire).

The wires outside of the joint described in Section 7.2.4.4.3 shall be prevented from touching each other or other metallic surfaces, preferably by applying electrical tape between the wire and the tube outside of the solder bed.

Each and every TC shall be applied per ASHRAE Standard 41.1 Section 8.2, having insulation with an R-value of at least 3.1, extending along the tube for at least six (6) inches on either side of the TC. This requirement for 6’’ is not applicable to TCs applied to coil surfaces such as return bends used for determining refrigerant saturation temperature.

TCs may be applied at to the condenser coil tubing halfway between the vapor connection and the liquid connection of the individual circuit, in two (2) separate locations, in order to determine saturation temperature a midpoint of the circuit.

Fan Motor Properties

Fan speed measurements, when measured, shall be taken with an instrument accurate to ± 1 rpm.

Fan amps, when measured, shall be taken with an ammeter having an accuracy of 2.0%, or better, of the fan motor current being measured.
7.3.3 Fan power, when measured, shall be taken with an instrument having accuracy of 2.0% or better of the fan motor power being measured.

7.4 Airflow Rate/Air Properties

7.4.1 Airflow rate shall be measured using a code tester per the latest edition of ASHRAE Standard 37, Section 6.2.

7.4.2 Any code tester used must have completed Section 5.1 of the Laboratory Evaluation and Adjustment Plan, in AHRI USE OM for calibration.

7.4.2.1 Any correction factors used from the LEAP evaluation process as noted in Section 7.4.2 shall be recorded on the final test report.

7.4.3 Air properties shall be calculated per the latest edition of ASHRAE Fundamentals Handbook, using measurements of properties as specified in this appendix.

7.5 Ductwork

7.5.1 For units that discharge air completely vertically or completely horizontally: the inside dimensions of the duct shall be at least six (6) inches total greater than the discharge air opening of the unit and centered over the opening.

7.5.1.1 Exception #1 is units that have air outlet next to air inlet. In these cases the 6” minimum is not required.

7.5.1.2 Exception #2 Units that have air outlets next to the ground. In these cases the 6” minimum is not required.

7.5.1.3 Exception #3 Units with flanges, the duct shall be the same size as the duct flanges.

7.5.2 For units that discharge air partially horizontally: the outside dimensions of the duct shall be at least 2 feet greater than the air opening of the unit.

7.5.3 Rectangular ducts may be used on units with round openings, and round ducts may be used on units with rectangular openings. In either case, the 6 inch minimum applies to the smallest dimension and the ducts shall be centered over the opening.

7.5.4 For rectangular ducts, one (1) pressure tap per side shall be applied to the center of each duct face. For round ducts, four (4) pressure taps shall be applied at 90° spacing at a distance of 1 length of the greatest outlet dimension downstream of the unit discharge connection.

7.6 Outdoor air enthalpy calculation procedure requirements

7.6.1 Operational mode is identified as either cooling mode or heating mode, with additional modes in either cooling mode or heating mode in which the outdoor airflow rate changes. The most common operational mode is:

7.6.1.1 For single stage product with single speed outdoor fan:
  - Cooling mode
  - Heating mode

7.6.1.2 For two stage product with two speed outdoor fan:
  - Cooling mode high stage
  - Cooling mode low stage
• Heating mode high stage
• Heating mode low stage

7.6.1.3 For variable speed product, each individual stage shall be considered an operational mode.

7.6.1.4 The independent third party lab shall work with the Participant to identify any other test where free air may be required.

7.6.2 For each operational mode identified in Section 7.6.1, there shall be one (1) free air (FA) test performed with no ductwork or attachments added to the Unit Under Test (UUT). This FA test may be conducted on any test in a given operational mode. All steady state requirements per AHRI Standard 210/240, ASHRAE Standard 37 and 10 CFR 430 Appendix M to Subpart B shall be met. During this FA test, the following items shall be recorded along with all other data requirements:

7.6.2.1 Either Fan motor current, Fan motor speed or fan motor watts.

7.6.2.2 When applicable refrigerant pressures at the high side and low side unit service connections closest to compressor.

7.6.2.3 When pressures cannot be measured on round tube plate fin coils, the midpoint of the uppermost refrigerant circuit, and the midpoint of the lowermost refrigerant circuit of the outdoor coil.

7.6.3 Outdoor duct losses shall be calculated for all closed duct tests per ASHRAE Standard 37 Section 7.3.3.3 for cooling mode and ASHRAE Standard 37 Section 7.3.4.3 for heating mode. Net capacities shall be adjusted accordingly.

7.6.4 Immediately following the FA test conducted per Section 7.6.2 of this appendix, the ductwork meeting requirements of Section 7.5 shall be added to the Outdoor Unit, and a Closed Duct test shall be conducted. All steady state requirements per AHRI Standard 210/240, ASHRAE Standard 37 and 10 CFR 430 Appendix M to Subpart B shall be met. During this CD test the following parameters shall be met:

7.6.4.1 The average inlet indoor DB temperature must be within 0.25°F of the FA test.

7.6.4.2 The average inlet indoor WB temperature must be within 0.15°F of the FA test.

7.6.4.3 The average inlet outdoor DB temperature must be within 0.25°F of the FA test.

7.6.4.4 The average inlet outdoor WB temperature must be within 0.25°F of the FA test.

7.6.4.5 Fan motor current, if measured shall be within 3.0% of the value measured in Section 7.6.1.1.

7.6.4.6 Fan speed, if measured for Section 7.6.1.2, shall be within 5 rpm of the FA test.

7.6.4.7 Fan watts, if measured for Section 7.6.1.2, shall be within 3.0% of the FA test.

7.6.4.8 Refrigerant high side pressures of the closed duct test measured per Section 7.6.1.3 shall be within 2 psig of the FA test for systems using refrigerants R-410A or R-22.

7.6.4.8.1 For other refrigerants, the pressure of the closed duct test shall be within 0.5°F saturation temperature of the FA test.

7.6.4.9 Refrigerant low side pressures of the closed duct test measured per Section 7.6.1.3 shall be within 0.5 psig of the FA test for systems using refrigerants R-410A or R-22.
7.6.4.9.1 For other refrigerants, the pressure of the closed duct test shall be within 0.3°F saturation temperature of the FA test.

7.6.4.10 Pressure variation for both high side and low side shall be in the same direction, e.g. if high side pressure is higher in close duct test, low side pressures are not permitted to be lower than close duct test (when rounded to closest 0.1 psig).

7.6.4.11 Refrigerant tube temperatures measured per Section 7.6.1.4 shall be within 0.5°F of the FA test.

7.6.4.12 Measured indoor air enthalpy capacity shall be within 2.0% of the FA test.

7.6.4.13 Absolute value of HB shall be within 6.0%.

7.6.4.14 Outdoor duct static pressure during this closed duct test shall be recorded with all other parameters, including average, minimum and maximum.

7.6.5 All other tests in each operational mode may be made with the outdoor duct remaining connected to the Outdoor Unit as long as the same average outdoor duct static pressure recorded per Section 7.6.3.14 is maintained, within ±0.01 in.H₂O. Additionally, the total observed range (maximum value minus the minimum value) for each additional test may be no greater than the total observed range of the previous closed duct test.

7.6.5.1 It is preferred, but not required, that both FA and closed duct tests be performed for every steady state test.