DEPARTMENT OF ENERGY

10 CFR Parts 429 and 431

[EERE–2019–BT–TP–0027]

RIN 1904–AE65

Energy Conservation Program: Test Procedure for Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps

AGENCY: Office of Energy Efficiency and Renewable Energy, Department of Energy.

ACTION: Notice of proposed rulemaking and request for comment.

SUMMARY: The U.S. Department of Energy (''DOE'') proposes to amend the test procedures for Packaged Terminal Air Conditioners (''PTACs'') and Packaged Terminal Heat Pumps (''PTHPs'') to establish seasonal energy efficiency metrics for heating and cooling. DOE also proposes to revise the current test procedure to measure dehumidification energy use of make-up air PTACs and PTHPs. DOE is seeking comment from interested parties on the proposal.

DATES: DOE will accept comments, data, and information regarding this proposal no later than July 11, 2023. See section V, ''Public Participation,'' for details. DOE will hold a webinar on Tuesday, June 6, 2023, from 1:00 p.m. to 4:00 p.m. See section V, ''Public Participation,'' for webinar registration information, participant instructions, and information about the capabilities available to webinar participants.

ADDRESSES: Interested persons are encouraged to submit comments using the Federal eRulemaking Portal at *www.regulations.gov* under docket number EERE–2019–BT–TP–0027. Follow the instructions for submitting comments. Alternatively, interested persons may submit comments, identified by docket number EERE–2019–BT–TP–0027, by any of the following methods:

Email: PTACHP2019TP0027@ee.doe.gov. Include the docket number EERE–2019–BT–TP–0027 in the subject line of the message.

Postal Mail: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, Mailstop EE–5B, 1000 Independence Avenue SW, Washington, DC, 20585–0121. Telephone: (202) 287–1445. If possible, please submit all items on a compact disc (''CD''), in which case it is not necessary to include printed copies.

Hand Delivery/Courier: Appliance and Equipment Standards Program, U.S. Department of Energy, Building Technologies Office, 1000 Independence Ave SW, Washington, DC 20585. Telephone: (202) 287–1445. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

No telefacsimiles (''faxes'') will be accepted. For detailed instructions on submitting comments and additional information on this process, see section V of this document.

Docket: The docket for this activity, which includes **Federal Register** notices, public meeting attendee lists and transcripts (if a public meeting is held), comments, and other supporting documents/materials, is available for review at *www.regulations.gov.* All documents in the docket are listed in the *www.regulations.gov* index. However, not all documents listed in the index may be publicly available, such as information that is exempt from public disclosure.

The docket web page can be found at *www.regulations.gov/docket/EERE-2019-BT-TP-0027.* The docket web page contains instructions on how to access all documents, including public comments, in the docket. See section V for information on how to submit comments through *www.regulations.gov.*

FOR FURTHER INFORMATION CONTACT:

Mr. Lucas Adin, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE–5B, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 287–5904. Email: *ApplianceStandardsQuestions@ee.doe.gov*

Ms. Amelia Whiting, U.S. Department of Energy, Office of the General Counsel, GC–33, 1000 Independence Avenue SW, Washington, DC 20585–0121. Telephone: (202) 586–2588. Email: *Amelia.Whiting@hq.doe.gov.*

For further information on how to submit a comment, review other public comments and the docket, or participate in a public meeting (if one is held), contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: *ApplianceStandardsQuestions@ee.doe.gov.*

SUPPLEMENTARY INFORMATION:

DOE proposes to maintain material previously approved for incorporation by reference in part 431: AHRI 310/380–2014, and update ANSI/ASHRAE Standard 16–1983 (RA 2014), ANSI/ASHRAE Standard 37–2009 and ANSI/ASHRAE Standard 58–1986. DOE incorporates by reference the following industry standards into 10 CFR part 431:

AHRI Standard 310/380–2017, ''Standard for Packaged Terminal Air-Conditioners and Heat Pumps,'' July 2017 (''AHRI 310/380–2017''). ANSI/ASHRAE Standard 16–2016, ''Method of Testing for Rating Room Air Conditioners, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps for Cooling and Heating Capacity,'' ANSI approved November 1, 2016 (''ANSI/ASHRAE 16–2016'').

Copies of AHRI 310/380–2014 and AHRI 310/380–2017 can be obtained from the Air-Conditioning, Heating, and Refrigeration Institute (''AHRI''), 2311 Wilson Blvd., Suite 400, Arlington, VA 22201 (703) 524–8800, or online at: *www.ahrinet.org/standards.*

See section IV.M of this document for a further discussion of these standards.

Table of Contents

I. Authority and Background

Package terminal air conditioners (''PTACs'') and package terminal heat pumps (''PTHPs'') (collectively ''PTAC/HPs'') are included in the list of ''covered equipment'' for which DOE is authorized to establish and amend energy conservation standards and test procedures. (42 U.S.C. 6311(1)(I)) DOE's current test procedures for PTACs and PTHPs are currently prescribed at title 10 of the Code of Federal Regulations (''CFR''), part 431, section 96(g) ''Test Procedures for Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps,'' with additional provisions provided in section 96 paragraphs (c) and (e). The following sections discuss DOE's authority to establish test procedures for PTACs and PTHPs and relevant background information regarding DOE's consideration of test procedures for this equipment.

A. Authority

The Energy Policy and Conservation Act, as amended (''EPCA''),[1] authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part C[2] of EPCA, added by Public Law 95–619, Title IV, § 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes PTACs and PTHPs, the subject of this document. (42 U.S.C. 6311(1)(I))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA include definitions (42 U.S.C. 6311), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), energy conservation standards (42 U.S.C. 6313), and the authority to require information and reports from manufacturers (42 U.S.C. 6316; 42 U.S.C. 6296).

The Federal testing requirements consist of test procedures that manufacturers of covered equipment must use as the basis for: (1) certifying to DOE that their equipment complies with the applicable energy conservation standards adopted pursuant to EPCA (42 U.S.C. 6316(b); 42 U.S.C. 6296), and (2) making other representations about the efficiency of that equipment (42 U.S.C. 6314(d)). Similarly, DOE uses these test procedures to determine whether the equipment complies with relevant standards promulgated under EPCA. Federal energy efficiency requirements for covered equipment established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(a) and 42 U.S.C. 6316(b); 42 U.S.C. 6297). DOE may, however, grant waivers of Federal preemption for particular State laws or regulations, in accordance with the procedures and other provisions of EPCA. (42 U.S.C. 6316(b)(2)(D))

Under 42 U.S.C. 6314, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered equipment. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use, or estimated annual operating cost of a given type of covered equipment during a representative average use cycle and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)) With respect to small, large, and very large commercial package air-conditioning and heating equipment, packaged terminal air conditioners, packaged terminal heat pumps, warm air furnaces, packaged boilers, storage water heaters, instantaneous water heaters, and unfired hot water storage tanks (collectively ''ASHRAE equipment''), EPCA requires DOE to use industry test procedures developed or recognized by the Air-Conditioning, Heating, and Refrigeration Institute (''AHRI'') or the American Society of Heating, Refrigerating, and Air-Conditioning Engineers (''ASHRAE''), as referenced in ASHRAE/IES Standard 90.1, ''Energy Standard for Buildings Except Low-Rise Residential Buildings.'' (''ASHRAE Standard 90.1'') (42 U.S.C. 6314(a)(4)(A)) Further, if such an industry test procedure is amended, DOE is required to amend its test procedure to be consistent with the amended industry test procedure, unless it determines, by rule published in the **Federal Register** and supported by clear and convincing evidence, that the amended test procedure would be unduly burdensome to conduct or would not produce test results that reflect the energy efficiency, energy use, and estimated operating costs of that equipment during a representative average use cycle. (42 U.S.C. 6314(a)(4)(B))

EPCA also requires that, at least once every seven years, DOE evaluate test procedures for each type of covered equipment, including PTACs and PTHPs, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 6314(a)(1)(A))

In addition, if the Secretary determines that a test procedure amendment is warranted, the Secretary must publish proposed test procedures in the **Federal Register** and afford interested persons an opportunity (of not less than 45 days' duration) to present oral and written data, views, and arguments on the proposed test procedures. (42 U.S.C. 6314(b))

DOE is publishing this notice of proposed rulemaking (''NOPR'') in satisfaction of the seven-year review requirement specified in EPCA. (42 U.S.C. 6314(a)(1)(A)(ii))

B. Background

DOE's existing test procedures for PTACs and PTHPs appear at title 10 of

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020), which reflect the last statutory amendments that impact Parts A and A–1 of EPCA.

[2] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

the CFR part 431, subpart F, section 96(g).

For PTACs and PTHPs, DOE currently specifies the energy efficiency ratio (''EER'') as the energy efficiency descriptor for cooling efficiency. Table 1 to 10 CFR 431.96. EER is the ratio of the produced cooling effect of the PTAC or PTHP to its net work input, expressed in Btu/watt-hour, and measured at standard rating conditions. 10 CFR 431.92. For PTHPs, DOE specifies the coefficient of performance (''COP'') as the energy efficiency descriptor for heating efficiency. Table 1 to 10 CFR 431.96. COP is the ratio of the produced heating effect of the PTHP to its net work input, expressed in watts/watts, and measured at standard rating conditions. 10 CFR 431.92.

The test procedures were most recently amended after AHRI published AHRI Standard 310/380–2014, ''Standard for Packaged Terminal Air-Conditioners and Heat Pumps'' (''AHRI 310/380–2014'') in February 2014. The 2014 version of the standard updated and superseded AHRI Standard 310/380–2004. In a final rule published on June 30, 2015 (''June 2015 TP final rule''), DOE amended the test procedures for PTACs and PTHPs. 80 FR 37136, 37136–37149. In the June 2015 TP final rule, DOE incorporated by reference certain sections of AHRI 310/380–2014. *Id.* at 80 FR 37148. DOE also incorporated by reference (1) American National Standard Institute (''ANSI'')/ASHRAE Standard 16–1983 (RA 2014), ''Method of Testing for Rating Room Air Conditioners and Packaged Terminal Air Conditioners'' (''ASHRAE 16–1983''); (2) ANSI/ASHRAE Standard 58–1986 (RA2014), ''Method of Testing for Rating Room Air Conditioner and Packaged Terminal Air Conditioner Heating Capacity'' (''ASHRAE 58–1986''); and (3) ANSI/ASHRAE Standard 37–2009, ''Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment'' (''ASHRAE 37–2009''). *Id.* Additionally, DOE amended the PTAC and PTHP test procedures to specify an optional break-in period; explicitly require that wall sleeves be sealed; allow for the pre-filling of the condensate drain pan; require that measurements of cooling capacity be conducted using electrical instruments accurate to ± 0.5 percent of reading; and require testing with 14-inch deep wall sleeves and the filter option most representative of a typical installation. *Id.* at 80 FR 37149.

In July 2017, AHRI published AHRI Standard 310/380–2017, ''Packaged Terminal Air-Conditioners and Heat Pumps'' (''AHRI 310/380–2017''). The 2017 version of the standard updated and superseded AHRI Standard 310/380–2014. The 2017 version of the standard incorporated DOE's additional PTAC and PTHP test procedure specifications listed previously. The current DOE test procedures for PTACs and PTHPs are therefore consistent with AHRI 310/380–2017.

EPCA requires DOE to use industry test procedures developed or recognized by AHRI or ASHRAE as referenced in ASHRAE Standard 90.1. The latest update to ASHRAE Standard 90.1, published on October 24, 2019 (''ASHRAE Standard 90.1–2019'') updated the AHRI Standard 310/380 reference to the 2017 edition. As discussed, the DOE test procedures for PTACs and PTHPs are already consistent with AHRI 310/380–2017. (42 U.S.C. 6314(a)(4)(A))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including PTACs and PTHPs, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 6314(a)(1))

Under this seven-year lookback provision, DOE initiated a test procedure rulemaking for PTACs and PTHPs to collect data and information to determine whether there is clear and convincing evidence that would justify the adoption of procedures other than those referenced in ASHRAE 90.1–2019. On December 8, 2020, DOE published an early assessment request for information (''RFI'') in which it sought data and information pertinent to whether amended test procedures would (1) more accurately or fully comply with the requirement that the test procedure produces results that measure energy use during a representative average use cycle for the equipment without being unduly burdensome to conduct, or (2) reduce testing burden. See 85 FR 78967 (''December 2020 Early Assessment RFI'').

Based on the comments received on the December 2020 Early Assessment RFI and DOE's review of the test procedures for PTACs and PTHPs, DOE determined it appropriate to continue the test procedure rulemaking after the early assessment process. On May 25, 2021, DOE published in the **Federal Register** a RFI (''May 2021 RFI'') in which DOE requested comments, information, and data about a number of issues, including (1) the market size of PTAC and PTHP units that include make-up air dehumidification, the equipment designs of PTACs and PTHPs that provide make-up air dehumidification, and the energy use associated with this function of PTACs and PTHPs; (2) the market size of PTAC and PTHP units that are capable of part-load operation and the energy use associated with part-load operation of PTACs and PTHPs; (3) the power use associated with fan-only mode operation of PTACs and PTHPs and whether fan-only operation reflects energy use during a representative average use cycle; and (4) low-temperature performance for cold climate PTHPs and whether and how the test procedure should be updated for such equipment. 86 FR 28005.

DOE received comments in response to the May 2021 RFI from the interested parties listed in Table I.1. Discussion of the relevant comments, and DOE's responses, are provided in the appropriate sections of this document. A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.[3]

TABLE I.1—LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE MAY 2021 RFI

Commenter(s)	Reference in this NOPR	Commenter type
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	Trade Association.
Appliance Standards Awareness Project, Natural Resources Defense Council.	Joint Advocates	Efficiency Organizations.
California Investor Owned Utilities	CA IOUs	Utility.

[3] The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop test procedures for PTACs and PTHPs. (Docket NO. EERE–2019–BT–TP–0027, which is maintained at *www.regulations.gov*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

TABLE I.1—LIST OF COMMENTERS WITH WRITTEN SUBMISSIONS IN RESPONSE TO THE MAY 2021 RFI—Continued

Commenter(s)	Reference in this NOPR	Commenter type
Northwest Energy Efficiency Alliance	NEAA	Efficiency Organizations.
LG Electronics USA	LG	Manufacturer.

II. Synopsis of the Notice of Proposed Rulemaking

In this NOPR, DOE is proposing to relocate the existing test procedures for PTACs and PTHPs from 10 CFR 431.96(g) to a new appendix H to subpart F of part 431, ''Uniform test method for measuring the energy consumption of package terminal air conditioners and heat pumps,'' (''appendix H'') that would include the relevant test procedure requirements for measuring existing efficiency metrics: (1) EER for cooling mode and (2) COP for heating mode. DOE is also proposing to establish a new appendix H1 to subpart F of part 431, ''Uniform test method for measuring the energy consumption of package terminal air conditioners and heat pumps,'' (''appendix H1'') that would include the relevant test procedure requirements for PTACs and PTHPs for measuring seasonal cooling and heating efficiency via new efficiency metrics: (1) seasonal cooling performance (''SCP'') for cooling mode and (2) seasonal heating performance (''SHP'') for heating mode and provide test procedure requirements for making representations of dehumidification energy use via a new efficiency metric, dehumidification efficiency (''DE''). The current DOE test procedures for PTACs and PTHPs would be relocated from § 431.96(g) to appendix H without change, and the new test procedures would be established at appendix H1. Appendix H1 would provide the test procedure for representations based on SCP, SHP and DE and would be mandatory at such time as compliance is required with amended energy conservation standards based on SCP and SHP, should DOE adopt standards using such metrics. In conjunction, DOE is proposing to amend Table 1 of 10 CFR 431.96 to identify the newly added appendices H and H1 as the applicable test procedures for PTAC/HPs.

DOE's proposed actions are summarized in Table II.1 compared to the current test procedure as well as the reason for the proposed change.

TABLE II.1—SUMMARY OF CHANGES IN PROPOSED TEST PROCEDURE RELATIVE TO CURRENT TEST PROCEDURE

Current DOE test procedure	Proposed test procedure	Attribution
Located at 10 CFR 431.96(g)	Current test procedure unchanged but relocated to appendix H. The proposed new test procedure would be located in appendix H1.	Improves readability.
Incorporates by reference AHRI 310/380–2014, ANSI/ASHRAE 16–1983, ANSI/ASHRAE 58–1986, ANSI/ASHRAE 37–2009.	Updates incorporation by reference to AHRI 310/380–2017 and maintains other existing references in appendix H.. In appendix H1 incorporates by reference AHRI 310/380–2017, ANSI/ASHRAE 16–2016 and ANSI/ASHRAE 37–2009.	Updates to the applicable industry test procedures.
Includes provisions for determining full-load efficiency metrics, EER and COP.	Maintains existing metrics in appendix H. In appendix H1, includes provisions for determining seasonal efficiency metrics, SCP and SHP.	More representative test procedure.
Does not define make-up PTAC/HPs nor includes provisions to measure dehumidification energy use of these units.	Maintains existing approach in appendix H. In appendix H1, defines make-up PTAC/HPs and includes provisions to measure dehumidification energy use.	More representative test procedure.

DOE has tentatively determined that the proposed amendments described in section III of this NOPR regarding the establishment of appendix H would not alter the measured efficiency of PTAC/HPs or require retesting solely as a result of DOE's adoption of the proposed amendments to the test procedure, if made final. DOE has tentatively determined, however, that the proposed test procedure amendments in appendix H1 would, if adopted, alter the measured efficiency of PTAC/HPs. DOE has tentatively determined that these amendments will provide efficiency measurements more representative of the energy efficiency of PTACs and PTHPs and are not unduly burdensome to conduct. Further, use of the proposed appendix H1 would not be required until the compliance date of amended standards denominated in terms of SCP and SHP. Discussion of DOE's proposed actions are addressed in further detail in section III of this NOPR.

III. Discussion

A. Scope of Applicability

This rulemaking applies to PTACs and PTHPs. DOE defines PTAC as a wall sleeve and a separate un-encased combination of heating and cooling assemblies intended for mounting through the wall. 10 CFR 431.92. It includes a prime source of refrigeration, separable outdoor louvers, forced ventilation, and heating availability by builder's choice of hot water, steam, or electricity. *Id.* DOE defines PTHP as a PTAC that utilizes reverse cycle refrigeration as its prime heat source and has a supplemental heat source available, including hot water, steam, or electric resistant heat. *Id.*

B. Proposed Organization of the PTAC/HP Test Procedure

The current DOE test procedures for PTACs and PTHPs appear at 10 CFR 431.96(g). The current test procedure for cooling mode incorporates by reference AHRI 310/380–2014, with the following sections applicable to the DOE test procedure: sections 3, 4.1, 4.2, 4.3, and 4.4; ANSI/ASHRAE 16–1983 and ANSI/ASHRAE 37–2009. 10 CFR 431.96(g)(1). The current test procedure for heating mode testing incorporates by reference AHRI 310/380–2014, with the following sections applicable to the DOE test procedure: sections 3, 4.1, 4.2 (except sections 4.2.1.2(b)), 4.3, and 4.4; and

ANSI/ASHRAE Standard 58–1986. 10 CFR 431.96(g)(2).

The current test procedures also include additional provisions in paragraphs (c) and (e) of 10 CFR 431.96. Paragraph (c) of 10 CFR 431.96 specifies provisions for an optional compressor break-in period, and paragraph (e) of 10 CFR 431.96 details what information sources can be used for unit set-up and provides specific set-up instructions for refrigerant parameters (*e.g.,* superheat) and air flow rate.[4]

DOE is proposing to relocate and centralize the current test procedure for PTACs and PTHPs from 10 CFR 431.96(g) to a new appendix H. As proposed, appendix H would not amend the current test procedure. DOE's current test procedure incorporates by reference AHRI 310/380–2014, but the most recent version of ASHRAE Standard 90.1, ASHRAE Standard 90.1–2019, recognizes AHRI 310/380–2017 as the test procedure for PTACs and PTHPs. AHRI 310/380–2017 differs from AHRI 310/380–2014 only in that it includes the additional test provisions that DOE has already prescribed at 10 CFR 431.96(c), (e) and (g). Therefore, the current DOE test procedures for PTAC/HPs are already consistent with AHRI 310/380–2017. However, to improve readability, DOE is proposing to update the incorporate by reference from AHRI 310/380–2014 to AHRI 310/380–2017 and to remove the redundant test provision references to 10 CFR 431.96(c), (e) and (g).

The test procedure as proposed for appendix H would be updated to reference AHRI 310/380–2017 and provide instructions for determining EER and COP. Consistent with the existing test procedure, DOE is proposing to continue to reference ANSI/ASHRAE 16–1983, ANSI/ASHRAE 58–1986 and ANSI/ASHRAE 37–2009 in the proposed appendix H. As proposed, DOE would require that PTACs and PTHPs be tested according to appendix H until the compliance date of any future amended energy conservation standards for PTACs and PTHPs.

DOE also is proposing in parallel an amended test procedure for PTACs and PTHPs in a new appendix H1 to subpart F of 10 CFR part 431. Appendix H1 would include test instructions for determining the new seasonal cooling and heating metrics, SCP and SHP, respectively, and provide test instructions for making representations of dehumidification energy use in terms of the dehumidification metric, DE. As proposed, DOE would not require that PTACs or PTHPs be tested according to the test procedure in proposed appendix H1 until the compliance date of any future amended energy conservation standards for PTACs and PTHPs.

C. Updates to Industry Standards

1. AHRI 310/380–2017

As noted previously, DOE's current test procedure for PTACs and PTHPs is codified at 10 CFR 431.96 and incorporates by reference AHRI 310/380–2014, with additional test provisions at 10 CFR 431.96(c), (e) and (g). The most recent version of ASHRAE Standard 90.1, ASHRAE Standard 90.1–2019, recognizes AHRI 310/380–2017 as the test procedure for PTACs and PTHPs.

In response to the May 2021 RFI, AHRI expressed their view that ASHRAE Standard 90.1–2019 and AHRI Standard 310/380–2017 are reasonably designed to measure energy use during a representative use cycle and that the design of PTACs and PTHPs and their usage patterns have not changed significantly since the last DOE rulemaking. (AHRI, No. 14 at p. 2) AHRI commented that AHRI 310/380–2017 was incorporated by reference into the 2019 edition of ASHRAE 90.1, and that DOE must now act to incorporate AHRI Standard 310/380–2017 by reference without any modifications. *Id.* AHRI noted that the Secretary has discretion to consider modifications to the test procedure cited in ASHRAE, but similar to energy conservation standards, for ''ASHRAE products'' any deviation from the industry test procedure must be, ''supported by clear and convincing evidence'' that the industry procedure was (a) not reasonably designed to produce test results which reflect energy efficiency; or (b) unduly burdensome to conduct. *Id.* AHRI asserted that AHRI 310/380–2017 met neither of these criteria since no manufacturer has submitted a waiver to DOE for use of a modified version of the current test procedure, which indicates that the results of the existing test procedure remain representative of actual energy use or efficiency; and all products defined as PTACs and PTHPs are able to be tested in accordance with AHRI 310/380. *Id.*

DOE notes that the only difference between AHRI 310/380–2014 and AHRI 310/380–2017 is that AHRI 310/380–2017 includes the same additional test provisions that DOE has already prescribed at 10 CFR 431.96(c), (e) and (g). Therefore, the current DOE test procedure, which incorporates by reference AHRI 310/380–2014 and includes these additional provisions, is consistent with AHRI 310/380–2017. However, as discussed in section III.B of this proposed rule, to improve readability, DOE is proposing to update the existing incorporation by reference provisions in 10 CFR 431.95 to reference AHRI 310/380–2017 and to remove the applicability of the redundant test provisions at 10 CFR 431.96(c), (e) and (g). Appendix H would reference AHRI 310/380–2017 and provide instructions for determining EER and COP that are consistent with the existing DOE test procedure.

As mentioned previously, DOE is undertaking this rulemaking to satisfy the seven-year review requirement for test procedures in 42 U.S.C. 6314(a)(1)(A). Under this process, if DOE determines that an amended test procedure would more fully or accurately comply with the requirements in 42 U.S.C. 6314(a)(2) and (3), DOE shall prescribe an amended test procedure. Further, as PTACs are subject to the provisions in EPCA for ASHRAE equipment, DOE's determination must be supported by clear and convincing evidence.

Based on an evaluation of the current test methodology and products on the market, DOE has tentatively determined that an amended test procedure may produce test results that more fully or accurately reflect energy efficiency and energy use of PTAC/HPs during a representative average use cycle and would not be unduly burdensome to conduct. In particular, DOE notes that AHRI 310/380–2017 does not include test provisions to measure the potential benefit of designs that can operate at part load (*i.e.,* variable speed products). As discussed in more detail in section III.E of this notice, DOE is aware of several variable-speed PTAC/HP models on the market that can provide efficiency benefits at part-load conditions which are not captured by the test conditions in AHRI 310/380–2017. AHRI 310/380–2017 also does not provide a measure of seasonal cooling and heating efficiency, but instead relies on the single-point ratings of EER and COP—at 95 °F outdoor temperature for EER and at 47 °F outdoor temperature for COP. As PTACs and PTHPs in the field operate year round in cooling or heating mode, seasonal performance, which considers more than one outdoor temperature and the potential for part-load operation when the building load is low at moderate outdoor temperatures, would be more

[4] The amendatory instructions in the June 2015 TP final rule for PTACs and PTHPs includes the reference to AHRI Standard 310/380–2014 in paragraphs (c) and (e), indicating that the requirements do apply to this equipment, even though the current CFR does not include this reference. 80 FR 37136, 37149 (June 30, 2015).

representative of average use as compared to a single-point rating. However, AHRI 310/380–2017 does not include test conditions or provisions to capture either of these factors, which would affect seasonal cooling or heating efficiency. Finally, AHRI 310/380–2017 does not address PTAC/HPs that provide ''make-up air,'' *i.e.,* outside air brought in to provide ventilation, or provide test instructions to determine the dehumidification energy use associated with these units.

While DOE is proposing to incorporate by reference certain sections of AHRI 310/380–2017 into appendix H1 (sections 3, 4 and 5), DOE has additionally tentatively determined that there is clear and convincing evidence to propose deviations from AHRI 310/380–2017 and to establish amended test procedures at appendix H1.

2. ANSI/ASHRAE 16–2016

As mentioned, the current test procedure for cooling mode incorporates by reference ANSI/ASHRAE 16–1983 and the current test procedure for heating mode incorporates ANSI/ASHRAE 58–1986. On October 31, 2016, ASHRAE published ANSI/ASHRAE 16–2016, ''Method of Testing for Rating Room Air Conditioners, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps for Cooling and Heating Capacity'' ('ANSI/ASHRAE 16–2016''). ANSI/ASHRAE 16–2016 is substantively the same as ANSI/ASHRAE Standard 16–1983 but also incorporates the method of test for obtaining heating capacity for rating room air-conditioners and PTAC/HP heating capacity as prescribed in ANSI/ASHRAE Standard 58–1986.

For appendix H, DOE is proposing to maintain the reference to ANSI/ASHRAE 16–1983 and ANSI/ASHRAE 58–1986. For appendix H1, DOE is proposing to incorporate by reference the updated ANSI/ASHRAE 16–2016 for both the cooling and heating test procedures.

D. Definitions

DOE currently defines PTAC as a wall sleeve and a separate un-encased combination of heating and cooling assemblies intended for mounting through the wall. 10 CFR 431.92. It includes a prime source of refrigeration, separable outdoor louvers, forced ventilation, and heating availability by builder's choice of hot water, steam, or electricity. *Id.*

DOE defines PTHP as a PTAC that utilizes reverse cycle refrigeration as its prime heat source and has a supplemental heat source available, including hot water, steam, or electric resistant heat. *Id.*

In the May 2021 RFI, DOE requested comment on the definitions of PTACs and PTHPs and whether any of the terms should be amended, and if so, how. 86 FR 28005, 28007. In particular, DOE requested comment on whether the terms are sufficient to identify which equipment is subject to the test procedure and whether any test procedure amendments are required to ensure that all such equipment can be appropriately tested in accordance with the test procedure. *Id.*

In response, AHRI stated that they have no recommended changes to the definitions of PTACs and PTHPs. (AHRI, No. 14 at p. 4) NEEA recommended that DOE amend the definition of PTACs and PTHPs to include 'dual-ducted' units, which the commenter explained are units that use two through-the-wall ducts in place of an outdoor mounted section. NEAA further noted that these products are marketed as replacements for PTAC/HPs and are similarly permanently installed through-the-wall air conditioners or heat pumps. NEEA provided product literature for two such units. (NEAA, No. 17 at p. 1–2)

DOE reviewed the product literature provided by NEEA and tentatively concludes that these products do not meet the PTAC and PTHP definitions because they do not have a separate un-encased assembly of heating/cooling, do not have a wall sleeve and have no separable outdoor louvers. *See* 10 CFR 431.92. While the two unit ducts go 'through the wall', the unit itself is mounted on the inside of the conditioned space. Additionally, DOE considers that broadening the PTAC and PTHP definitions to include these products is not appropriate since the product literature for these two units indicates that these are covered under other air conditioning product categories. Therefore, DOE is not proposing to include the units identified by NEEA within the definitions of PTAC and PTHP.

E. Operation at Part Load Conditions and Integrated Metrics

As stated, EPCA requires that the test procedures for PTACs and PTHPs be the generally accepted industry testing procedures developed or recognized by AHRI or ASHRAE, as referenced in ASHRAE Standard 90.1. (42 U.S.C. 6314(a)(4)(A)) EPCA also requires that test procedures prescribed by DOE be reasonably designed to produce test results which reflect energy efficiency during a representative average use cycle, and must not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2))

DOE's current test procedures for PTACs and PTHPs do not have provisions to measure the potential benefit of designs that can operate at part load, nor does the test address unit cooling performance at part-load outdoor temperature conditions that represent many of the hours of the cooling season. Additionally, the current DOE test procedures do not have provisions to measure performance at low-ambient outdoor temperature conditions for the heating season. For PTACs and PTHPs, ASHRAE Standard 90.1–2019 specifies minimum efficiency levels expressed in terms of the full-load metrics of EER and COP. ''Full-load'' refers to testing at a single test condition, under which the compressor operates continuously at 100 percent of its full capacity. Under DOE's current test procedure, full load efficiency is measured at the standard rating conditions as prescribed in AHRI 310/380–2014. In contrast, for cooling, ''part-load'' refers to testing at a reduced-temperature test condition in which the cooling load of the space would generally be less than the full cooling capacity of the compressor. Any temperatures below the standard rating condition could potentially be considered part-load cooling conditions. For heating, ''part-load'' refers to testing at a temperature test condition in which the heating load of the space is less than the full heating capacity of the compressor. Any temperatures which do not require the full heating capacity could potentially be considered part-load heating conditions.

1. Market Size of PTACs and PTHPs With Part-Load Operation Capability

DOE is aware of several variable-speed PTAC and PTHP models on the market that can provide an efficiency benefit at part-load conditions. In the May 2021 RFI, DOE requested information on the market availability and market size for PTACs and PTHPs that incorporate two-stage, multi-stage, or fully variable-speed compressors that enable more efficient part-load operation. 86 FR 28005, 28009–28010.

AHRI commented that it surveyed its members to determine the relative market share of PTACs and PTHPs that incorporate two-stage, multi-stage, or fully variable-speed compressors and that their data, which constituted a representative sample of the PTAC and PTHP market, indicated that 0.7 percent of PTAC and PTHP shipments incorporate these enhanced compressors. (AHRI, No. 14 at p. 7)

The CA IOUs commented there has been an increase in variable-speed compressor technology across a whole host of commercial and residential air conditioner products and PTACs and PTHPs are no exception to the growth of variable-speed compressor technology. (CA IOUs, No. 15 at p. 2) The CA IOUs noted that at least five manufacturers already sell variable speed products, and that number is likely to grow. *Id.* Additionally, they stated that the hotel industry has also published articles speaking to the benefits of new PTAC/HPs that incorporate variable-speed compressors. *Id.*

The Joint Advocates asserted that PTACs and PTHPs are rarely required to operate at full load and an amended test procedure that captures part-load performance would thus be more representative and would also capture the potential efficiency gains associated with variable-speed compressors. (Joint Advocates, No. 16 at p. 1) The Joint Advocates encouraged DOE to adopt efficiency metrics that reflect annual energy consumption including part-load operation. *Id.*

DOE notes that while the shipments data provided by AHRI suggests that only a small fraction of PTACs and PTHPs incorporate variable speed compressor technology currently, DOE's review of its compliance certification management system (''CCMS'') [5] database and current product literature indicates that these products are already present in the market and may continue to increase in market share. As a result, inclusion of part-load performance in the test procedure may provide a more representative measure of unit performance over the cooling or heating season. The next section discusses potential part-load cooling and heating efficiency metrics for PTACs and PTHPs.

2. Potential Part-Load Efficiency Metrics

For measurement of part-load performance for PTACs and PTHPs, the proposed DOE test procedure at appendix H1 would require a part-load or seasonal efficiency metric. Several categories of air conditioning and heating equipment are already rated under DOE test procedures using metrics that account for cooling part-load or seasonal performance. For example, commercial unitary air conditioners (''CUACs'') are rated using the part-load metric integrated energy efficiency ratio (''IEER'') (see appendix A to subpart F of 10 CFR part 431); and central air conditioners (''CACs'') and heat pumps(''CHPs'') (''collectively CAC/HPs'') are rated using the seasonal energy efficiency ratio (''SEER2'') (see appendix M1 to subpart B of 10 CFR part 430 (''appendix MI'')). Room air conditioners (''RACs'') are rated using the combined energy efficiency ratio (''CEER'').[6] While the CEER metric is not a part-load or seasonal metric, amendments to the DOE test procedure provide for the application of a performance adjustment factor to a variable-speed model's CEER rating (*i.e.,* ''performance-adjusted CEER'') that reflects seasonal efficiency benefits (see appendix F to subpart B of 10 CFR part 430).[7]

Similar to the EER cooling metric, the COP heating metric for PTHPs measures heating efficiency only at full load operation. For the reasons described previously with regard to cooling efficiency, using a heating efficiency metric that accounts for only full-load operation does not measure the part-load operation in PTHPs that may be enabled by the incorporation of two-stage, multi-stage, or variable-speed compressors. Heating Season Performance Factor (''HSPF2'') is a metric that serves as a counterpart to SEER2 and accounts for seasonal performance in the heating season for residential central heat pumps. It reflects seasonal performance by averaging test results from multiple load points, depending on system configuration (single-speed, two-capacity, or variable-speed), with varying outdoor conditions and staging levels to represent the product's average efficiency throughout the heating season (see appendix M1).

In the May 2021 TP RFI, DOE requested comment on how to best measure part-load cooling performance for PTACs and PTHPs, specifically the number of tests that are appropriate to represent the part-load capabilities of the unit; the outdoor ambient conditions that best represent real world performance; the averaging weights that should be applied to each condition; whether a cyclic test component should be incorporated and whether an optional test for multi-capacity rating should be incorporated. 86 FR 28005, 28010. DOE also requested feedback on the appropriateness and potential applicability of the IEER, SEER [8] and performance-adjusted CEER as appropriate metrics for PTACs and PTHPs and whether a test procedure for PTACs and PTHPs that uses any of these would produce test results that reflect the energy efficiency of that equipment during a representative average use cycle. *Id.* DOE also requested information on the costs that would be associated with a test procedure that uses any of these metrics. *Id.* Additionally, DOE requested comment on whether any other seasonal efficiency metrics that incorporate part-load performance would produce test results that reflect the energy efficiency of PTACs and PTHPs during a representative average use cycle, and if so, which outdoor temperature rating conditions would be appropriate for testing PTACs and PTHPs. *Id.*

For the heating metric, DOE requested comment on how to best measure part-load and seasonal heating performance for PTHPs, specifically the number of tests that are appropriate to represent the part-load capabilities of the unit; the outdoor ambient conditions that best represent real world performance; the averaging weights that should be applied to each condition; whether a cyclic test component should be incorporated; whether an optional test for multi-capacity rating should be incorporated; and whether a test to evaluate the PTHP in defrost cycles is required 86 FR 28005, 28011. DOE also requested information on whether HSPF [9] would be an appropriate metric for PTHPs, or if any other seasonal heating efficiency metrics that would produce test results that reflect the energy efficiency of PTHPs during a representative average use cycle would be appropriate, and if so, which outdoor temperature rating conditions would be appropriate for testing PTHPs. *Id.* DOE also requested comment on the costs that would be associated with the use of any such seasonal heating efficiency metric to rate PTHP performance. *Id.*

The Joint Advocates encouraged DOE to adopt cooling and heating efficiency metrics that attempt to reflect the annual energy consumption of PTACs

[5] DOE's Compliance Certification Management System Database is available at *www.regulations.doe.gov/ccms.*

[6] CEER is an energy efficiency metric for room air conditioners that integrates standby/inactive and off mode energy use with the active mode energy use. 10 CFR 430.23(f)(3); appendix F to subpart B of 10 CFR part 430 sections 2 and 5.2.2.

[7] DOE published a final rule on March 29, 2021, amending the test procedure for room air conditioners to establish test provisions for measuring the energy use of variable-speed units during a representative average use cycle. 86 FR 16446.

[8] In the May 2021 RFI, DOE referred to SEER instead of SEER2. SEER2 has the same definition as SEER but reflects the amendments made to the test procedure in appendix M1, which change the measured efficiency values compared to appendix M to subpart B of 10 CFR part 430.

[9] In the May 2021 RFI, DOE referred to HSPF instead of HSPF2. HSPF2 has the same definition as HSPF but reflects the amendments made to the test procedure in appendix M1, which change the measured efficiency values compared to appendix M.

and PTHPs in typical applications and to adopt an amended test procedure that tests all PTACs and PTHPs the same way, regardless of whether a unit is single-speed, two-stage, multi-stage or variable speed as this will provide comparable efficiency ratings. (Joint Advocates, No. 16 at p. 1)

NEEA suggested that DOE adopt part-load metrics aligned with the AHRI Standard 210/240 as referenced in appendix M1. (NEEA, No. 17 at p. 2) NEAA stated that aligning with appendix M1 is the best course of action in the current rulemaking as PTACs and PTHPs are most likely to be substitutes for smaller residential products of similar capacities. *Id.* NEEA further stated that multiple manufacturers are already making representations of SEER and HSPF for PTAC/HPs, showing the market demand for a residential part-load metric. *Id.* NEEA noted that a part-load metric would allow for the benefits of inverter driven, variable speed PTACs and PTHPs to be more accurately represented and that there were several variable speed products on the market from at least six manufacturers. (NEEA, No. 17 at p. 3) NEEA asserted that the fact that these variable speed products have emerged in the absence of a part-load test procedure shows strong market demand for these products and shifting to a part-load metric would allow for these products to fairly compete with single speed products and would likely lead to the introduction of more variable speed products. *Id.*

The CA IOUs also recommended that DOE utilize appendix M1 to measure the cooling and heating efficiencies of PTACs and PTHPs. The CA IOUs asserted that consumers often compare PTAC/HPs with CAC/HPs when choosing a method to cool or heat and cool a single space such as multifamily housing or lodging facilities because there are models with similar capacities in both product types and that these products are typically selected in the construction design process to provide conditioning year-round. (CA IOUs, No. 15 at p. 2) The CA IOUs stated that manufacturers recognize the similarity of these products and provide ''SEER equivalent'' performance information for their PTAC and PTHPs. *Id.* The CA IOUs highlighted that a survey of more than 160 buildings in Manhattan found that in new buildings more PTAC and PTHPs were installed compared to RACs, and that PTAC and PTHPs were more likely to be designed into the building rather than part of a retrofit to address a need for cooling—which is similar to the selection and installation of CAC/HPs and indicates that PTAC/HPs and RACs are less likely to be substituted for each other. *Id.* The CA IOUs stated that they therefore believe it is most important to be able to compare PTAC/HPs with CAC/HPs. *Id.* Additionally, the CA IOUs commented that the test procedures for CUACs and RACs only measure cooling capacity and efficiency, but PTHPs need a test procedure for both cooling and heating, noting that appendix M1 provides both the SEER2 metric for cooling and HSPF2 for heating, as well as part-load conditions. *Id.*

LG also recommended the DOE adopt AHRI Standard 210/240 as referenced in appendix M1, but recommended using this test procedure only for part-load cooling performance and not for heating performance, because PTACs and PTHPs contain electric heat. (LG, No. 18 at p. 1) LG stated that while DOE categorized PTACs and PTHPs as commercial products, these products are usually installed in hotel rooms and people consider the hotel room as a vacation home—therefore their usage was close to the residential air conditioner. *Id.*

NEAA recommended that DOE adopt a load-based test procedure for all heat pumps and air conditioners including PTHPs and PTACs, stating that while a part-load test procedure aligned with appendix M1 will be a step towards better accounting for the performance of PTHPs and PTACs, it will not account for the effectiveness of the unit's controls or fully reflect how these units are likely to perform in the real world. (NEEA, No.17 at p.4). The Joint Advocates also encouraged DOE to investigate a load-based test procedure, which they stated would provide a realistic representation of how all units perform in the field, including capturing the importance of control strategies. (Joint Advocates, No. 16 at p. 2).

In response to NEEA, the CA IOUs and LG's suggestion regarding the use of appendix M1 for PTACs and PTHPs, DOE's notes that there are differences between PTAC/HPs and CAC/HPs that suggest that the direct use of appendix M1 as the test procedure for PTAC/HPs is inappropriate. The primary application for CAC/HPs is residential single-family homes which may have multiple zones, whereas the primary application for PTAC/HPs is lodging, typically serving single zones (*i.e.,* each individual hotel room). This difference in the use cases results in substantially different cooling and heating building load lines for these two air-conditioning and heating categories. As such, the test conditions and weighting factors in appendix M1 are not suitable to capture PTAC and PTHP operation. DOE agrees that SEER2 and HSPF2 are comprehensive metrics that provide efficiency ratings representative of an entire season, and the publication of 'SEER-equivalent' and 'HSPF-equivalent' ratings for PTAC/HPs suggest a desire for similar seasonal ratings for PTAC/HPs. However, DOE has provisionally determined that seasonal cooling and heating metrics for PTACs and PTHPs, even if similar to the SEER2 and HSPF2 metrics, respectively, should reflect the different average use operation for PTAC/HP applications. This is further discussed in sections III.F and III.G of this document.

In response to NEEA and the Joint Advocates' suggestions that DOE investigate a load-based test procedure, DOE notes that it is unaware of a comprehensive evaluation of load-based testing of PTACs or similar equipment that satisfactorily demonstrates repeatability and reproducibility. DOE is aware of ongoing work addressing questions about whether the current DOE and industry test procedures for several air conditioning and heat pump equipment are fully representative of field operation and would be better served by a load-based test procedure.[10] These efforts have been largely focused on residential CAC/HPs, where the market presence of variable-speed units has considerably more history and greater market share, and therefore a load-based test procedure may hold potential value. In comparison, the increased test burden resulting from a load-based test procedure would not be appropriate for PTAC/HPs, given the modest share of variable-speed PTAC/HPs in the market. As such, on the basis of insufficient test procedure development leading to repeatability and reproducibility concerns, and the increased test burden associated with a load-based test procedure, DOE has provisionally determined that introducing a load-based test procedure for PTAC/HPs would not be appropriate at this time. However, DOE will continue to investigate load-based

[10] A dynamic load-based test method differs from the steady-state test method currently used in DOE test procedures for air conditioning and heat pump equipment. In a steady-state test method, the indoor room is maintained at a constant temperature throughout the test. In this type of test, any variable-speed or variable-position components of air conditioners and heat pumps are set in a fixed position, which is typically specified by the manufacturer. In contrast, a dynamic load-based test has the conditioning load applied to the indoor room using a load profile that approximates how the load varies for units installed in the field. In this type of test, an air conditioning system or heat pump is allowed to automatically determine and vary its control settings in response to the imposed conditioning loads, rather than relying on manufacturer-specified settings.

testing and monitor future efforts related to this topic.

AHRI noted that it was unreasonable for DOE to expect stakeholders to develop a procedure in 30 days through a response to the RFI and were unable to any provide information on how to measure part-load performance of PTACs and PTHPs. (AHRI, No. 14 at p. 7) AHRI urged DOE to join the ASHRAE Standard 16 committee and engage in the consensus-standards development process for the method of test for PTACs and PTHPs. *Id.* AHRI noted that all cooling metrics suggested in the May 2021 RFI would carry with them a significant increase in the test burden when compared to the full load EER metric of AHRI Standard 310/380. (AHRI, No. 14 at p. 8) AHRI attached a table comparing the required tests for each metric. *Id.* AHRI also stated that the residential metrics, SEER for CAC/HPs and performance-adjusted CEER for RACs, present the potential to cause confusion if applied to commercial products and that perhaps the best option would be to develop an entirely new part-load metric suited to PTAC/HPs, through a consensus standards process. *Id.* AHRI agreed that variable speed products may benefit from a part load metric, but stated that the additional test burden required by a part load metric for single stage products is unwarranted. *Id.* AHRI asserted that the PTAC and PTHP market is overwhelmingly single stage, where a full load rating is most appropriate. *Id.* AHRI noted that full load metrics have not been eliminated in ASHRAE Standard 90.1 as new part load metrics, such as IEER, have been introduced and federally regulated. Instead, through building standards, states have regulated both full and part-load metrics for a single product for those in which both metrics have been published in ASHRAE Standard 90.1. *Id.* AHRI also stated that a part-load metric for any piece of equipment should be specific to the unit's average use operation for the most common applications and that no cooling metric DOE suggested in May 2021 RFI is primarily for use in hotels—the application where the majority of PTACs and PTHPs are used. AHRI commented that some metrics, including SEER and performance-adjusted CEER, are for residential applications and that PTACs and PTHPs are commercial products and have vastly different operating hours and use patterns than residential equipment. (AHRI, No. 14 at p. 9). For the heating metric, AHRI did not provide a response on the appropriateness of HSPF or any other seasonal metric. (AHRI, No. 14 at p. 10) AHRI stated that it was not possible to quantify the cost implications for a new test procedure prior to the test procedure being developed. *Id.*

In response to AHRI's statement that the PTAC and PTHP market is overwhelmingly single stage where a full-load rating is most appropriate and that the additional test burden required by a part load metric for single stage products is unwarranted, DOE notes that EPCA requires DOE to amend a test procedure if DOE determines that the amended test procedure would more fully or accurately reflect energy use during a representative average use cycle and not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(1)(A)) Comments received on the May 2021 RFI suggest that the current full-load cooling and heating metrics (EER and COP) may not effectively capture the energy efficiency during a representative average use cycle, regardless of whether a PTAC/HP is single-stage, multi-stage or variable capacity, because PTAC/HPs often operate at part-load and at several different temperature conditions during the cooling or heating season. Therefore, a full-load standard rating condition may not fully capture the performance of a PTAC/HP. However, DOE also recognizes that EPCA requires that test procedures must not be unduly burdensome to conduct and DOE understands that a new test procedure incorporating multiple test conditions will introduce more test burden when compared to the full load single condition EER or COP metric of AHRI Standard 310/380. As described in section III.K of this NOPR, DOE has tentatively determined that the increase in test procedure costs will not be unduly burdensome to manufacturers, especially given the flexibility to utilize alternate efficiency determination methods (''AEDMs'') to rate models. DOE agrees with AHRI that the part-load metric for any piece of equipment should be specific to the unit's average use operation for the most common applications. Accordingly, DOE initially determines that the best option would be to develop an entirely new part-load metric for PTACs and PTHPs, which would be specific to the use cases for PTAC/HPs and would include consideration of different load levels and outdoor temperature conditions.

In summary, DOE is proposing cooling and heating metrics which incorporate part-load seasonal performance and are appropriate based on the use case for PTACs and PTHPs. Sections III.F and III.G of this NOPR detail DOE's proposed cooling and heating metrics, respectively.

3. Low-Ambient Heating

Heat pumps generally perform less efficiently at low ambient outdoor temperatures than they do at moderate ambient outdoor temperatures. DOE is aware of residential CAC/HP models that are optimized for operation in cold climates and can operate at temperatures as low as −20 degrees Fahrenheit (''°F''). DOE understands that there has been interest in cold-climate PTHPs. For example, the New York State Clean Heat Program (''NYS Clean Heat'') requires a manufacturer-reported COP greater than 1.75 at 5 °F [11] and the Northeast Energy Efficiency Partnership (''NEEP'') recently included a PTAC/HP cold climate specification requiring a COP of 1.5 at 5 °F.[12] DOE is aware of at least one PTHP model that is optimized for cold climates and can operate at temperatures as low as −5 °F.

A conventional PTHP model switches its heat source from reverse-cycle vapor compression heating to electric resistance heating, which is less efficient than vapor compression heating, at an outdoor ambient temperature of around 32 °F. A PTHP design that is optimized for operation in cold climates could provide energy savings compared to conventional PTHP models by enabling the use of the more efficient vapor compression heating, rather than electric resistance heating, at lower ambient temperatures. However, DOE's current COP test metric for heating efficiency requires testing only at the standard rating condition of 47 °F dry bulb for the outdoor side. Thus, DOE's COP metric does not account for the efficiency improvement that could result from using reverse-cycle heating at low ambient temperatures.

In the May 2021 RFI, DOE requested information on several issues related to low-ambient heating, specifically information on the comparison of the seasonal heating load and seasonal cooling load for a typical PTAC/PTHP installation; information on the range of low-temperature cutout for compressor operation of PTHPs, including the percentage of PTHPs that continue to operate the compressor at outdoor temperatures below 32 °F, below 20 °F, and below 10 °F; information on the design changes necessary for a typical PTHP (that has a 32 °F low-temperature cutout) to be converted for satisfactory field performance operation at a 17 °F

[11] *See: https://ma-eeac.org/wp-content/uploads/NYS-Clean-Heat-Manual-NEGPA.pdf.*

[12] *See: https://neep.org/sites/default/files/media-files/ccpthp_spvhp_specification_v1.pdf.*

outdoor test condition and whether the design optimization of PTHPs for cold-climate operation impacts the COP as measured under the DOE test procedure; and feedback on any other test methods that would produce test results that reflect the energy efficiency of these units during a representative average use cycle, as well as information on the test burden associated with such test methods. 86 FR 28005, 28011.

AHRI commented that it is aware of units operating down to 25 °F, and other manufacturers have published the low-temperature cutout for compressor operation of PTHPs at 42 °F, 38 °F, and 32 °F. (AHRI, No. 14 at p. 11–12) Regarding the design changes necessary for a PTHP to be converted to operate at a 17 °F condition, AHRI stated that the PTHP standard wall sleeve size limits component sizing such as a heat exchanger and fan, but one possibility would to be to install variable speed compressors and to further optimize by installing electronic expansions valves (''EEV'') in place of capillary tubes. (AHRI, No. 14 at p. 12) They stated that additional changes would include the addition of an inverter board, enclosure for new board, wire harness, software, compressor, and possibly additional thermistors. *Id.* AHRI commented that these design changes have not been demonstrated as a valid methodology at this writing to their knowledge. *Id.* AHRI also stated that if the test procedure were to be amended to require testing at the 17 °F test condition it would negatively impact COP for single speed units as the capillary tubes can only be optimized for a single set point—however, variable speed units with electronic expansion valves would be able to be optimized for multiple outdoor conditions. *Id.* AHRI stated that heating testing at very low temperatures can become quite costly. Based on their analysis conducted to review the costs associated with Natural Resources Canada's proposal to make the $H4_2$ (5 °F heating mode) test in appendix M1 for residential heat pumps mandatory as part of evaluating HSPF2, AHRI found that the cost to upgrade a laboratory to test to the new condition will require significant investment and imposes new testing costs to manufacturers. (AHRI, No. 14 at p. 12) AHRI stated that currently laboratories do not have the capacity to test equipment to the proposed test condition of 5 °F and estimated that the cost to upgrade one laboratory could reach $75,000 USD and needs to be repeated across each laboratory intending on testing to 5 °F heating mode test condition. *Id.* They further noted that the total costs to upgrade labs necessary to test equipment to this new condition in a timely manner is between $7.5 to $13.1M USD. (AHRI, No. 14 at p. 10–11)

The CA IOUs, Joint Advocates and NEEA encouraged DOE to capture performance at lower ambient temperatures. The CA IOUs noted that results from their market research aligned with DOE's assessment that, while there are products that operate below freezing, it is a small subset of the market. (CA IOUs, No. 15 at p. 3). The CA IOUs highlighted three products that operate in vapor compression mode below freezing, two of which switch to an electric resistant heater at 25 °F while the other is able to operate in vapor compression mode down to −5 °F. *Id.* The CA IOUs reiterated their suggestion that PTHPs be tested per appendix M1 which requires single-speed and variable-speed products to be tested at 47 °F, 35 °F, and 17 °F to calculate HSPF2. *Id.* The CA IOUs recommended that units that cannot be tested at the lower temperatures use a default COP of 1.0, the efficiency of electric resistant heat, for the lower temperatures to calculate HSPF2. *Id.* They stated that requiring testing and reporting of performance at these three additional temperatures would also allow designers to know the temperature at which the PTHP will switch over to electric resistance heat, especially if the PTHP is also providing makeup air to the room. *Id.* NEEA recommended a part-load test aligned with appendix M1 at an outdoor test condition of 17 °F. (NEEA, No. 17 at p. 3) Additionally, NEEA suggested that DOE account for energy used in defrost and energy used in electric resistance boost functionality, which the commenter described as a feature which turns on the electric resistance at outdoor temperatures where the heat pump can provide adequate heating, thus resulting in unnecessary energy use. *Id.* The Joint Advocates also encouraged DOE to capture defrost performance, which they said would differentiate the performance of different defrost strategies. (Joint Advocates, No. 16 at p. 2).

In response to AHRI's comment that design changes to operate below a 17 °F condition have not been demonstrated as a valid methodology for PTHPs, as noted earlier in this section, DOE is aware of at least one commercialized PTHP that can operate at temperatures as low as −5 °F. Additionally, while the required design changes to operate at low ambient conditions may not yet be widely present in PTHPs, other categories of heat pumps (such as central HPs) have demonstrated that these design changes are possible. Regarding AHRI's comment that heating testing at very low temperatures can become quite costly and that currently laboratories do not have the capacity to test equipment to the proposed test condition of 5 °F, DOE notes that several CAC/HP manufacturers already conduct testing at this temperature for the $H4_2$ test in appendix M1 and provide ratings in the CCMS. Additionally, DOE notes that commercial equipment, which includes PTACs and PTHPs, can benefit from AEDMs to rate their equipment and therefore do not need to physically test more than 2 units per basic model. However, DOE understands the significant increase in burden associated with mandating tests at low temperatures.

Based on the comments received, DOE tentatively concludes that while there are PTAC/HPs that can operate below freezing (32 °F), they represent only a small subset of the market and most of these cut-off heat pump operation around 25 °F. If contemporary PTAC/HPs would be required to operate at conditions below freezing, for example at 17 °F, they would require significant design changes or complete re-design. Therefore, testing at low ambient heating conditions may not be appropriate as a requirement for all PTHPs. However, DOE also understands that for those PTHPs that are designed for cold climate operation (as noted, DOE is aware of at least one such PTHP), it may be beneficial to provide a means within the test procedure to make representations of operational performance at low-ambient conditions, similar to the approach currently used for low-temperature operation for central heat pumps. Section III.G details DOE's heating test procedure incorporating optional low-ambient heating and an adjustment to account for defrost performance degradation.

F. Proposed Cooling Metric and Test Procedure

As noted, several categories of air conditioning and heating equipment are already rated under DOE test procedures using metrics that account for part-load or seasonal performance. As discussed in section III.E.2 of this document, several commenters suggested that DOE adopt appendix M1, and subsequently the SEER2 metric for PTAC/HPs. In the May 2021 RFI, DOE noted that PTACs and PTHPs may be considered as an alternative to CAC/HPs and products and equipment rated with SEER2 are generally used in residential or small commercial applications, often with smaller internal loads that require minimal or no cooling at low ambient outdoor air temperatures. 86 FR 28005, 28010. SEER2 reflects seasonal performance by averaging test results from up to five different load points, depending on system configuration (single-speed, two-capacity, or variable-speed), with varying outdoor conditions and staging levels to represent the product's average efficiency throughout the cooling season (see appendix M1). The test procedure also includes optional cyclic testing to evaluate cycling losses. Based on comments received by stakeholders that manufacturers are interested in making 'SEER-equivalent' representations, DOE has initially determined that a cooling metric that incorporates seasonal performance similar to the SEER2 metric is appropriate for PTAC/HPs.

However, DOE considers that the test conditions, cooling building load line, hours of cooling, methods of calculations, cycling losses and other aspects of the test procedure will differ for PTAC/HPs as compared to CAC/HPs and are better informed by use cases specific to PTAC/HPs. Additionally, test burden associated with CAC/HP testing per appendix M1 may be higher than appropriate for the relatively lower national energy use associated with PTAC/HPs as compared to CAC/HPs. DOE is therefore proposing to define a new seasonal cooling metric for PTAC/HPs, seasonal cooling performance (''SCP''), which presents a better match of PTAC/HP performance rather than CAC/HP and reduces test burden as compared to CAC/HP testing. The proposed definition of this new metric, which would be included in 10 CFR 431.92, reads as follows:

Seasonal cooling performance (SCP) means the total heat removed from the conditioned space during the cooling season, expressed in Btu's, divided by the total electrical energy consumed by the package terminal air conditioner or heat pump during the same season, expressed in watt-hours. SCP is determined in accordance with appendix H1 to this subpart.

The following sections detail the key differences for the SCP metric as compared to the SEER2 metric.

1. Test Conditions

As discussed previously, DOE recognizes that throughout the cooling season, PTACs and PTHPs operate under various outdoor temperature conditions. DOE also understands that these varying outdoor conditions present a range of reduced cooling loads in the conditioned space. To effectively capture performance at these varying outdoor conditions and associated loads, DOE proposes a test procedure with three test conditions at dry-bulb outdoor temperatures of 95 °F, 82 °F and 75 °F. These are denoted as the ''A'', ''B'' and ''C'' conditions, respectively. DOE notes that these additional temperatures were informed by weather analysis conducted for 16 cities representing ASHRAE climate zones 1 through 7. For each condition, DOE established a temperature range and then evaluated a representative temperature within that range. This representative temperature was evaluated as a weighted average by multiplying the mean temperature in the respective temperature range for each city, by the prevalence of the commercial buildings energy consumption survey (''CBECS'') small hotel prototype in that city, which is the primary application for PTAC/HPs.

Issue 1: DOE requests comment on its proposed A (95 °F), B (82 °F) and C (75 °F) test conditions to represent reduced cooling conditions experienced by PTACs and PTHPs in the field.

These conditions are paired with three compressor speeds to denote the different cooling capacities at which the unit will run to modulate to the required cooling load: full, intermediate, and low. For example, a B_{low} test would mean a test conducted at the ''B' condition (82 °F) and set to a low compressor speed.

For tests run at the full compressor speed, the test will require the room thermostat to be set at a lower temperature than the indoor condition *i.e.,* 75 °F. DOE understands that for setting the low and intermediate compressor speeds, special control override instructions will be required from manufacturers. Therefore, because maintaining fixed compressor speeds is critical to the repeatability of the PTAC/HP cooling test procedure, DOE may, in a separate rulemaking addressing certification, require manufacturers to provide in each certification report for a two-speed or variable-speed system basic model, all necessary instructions to maintain the low and intermediate compressor speeds required for each test condition when testing that basic model. This approach is similar to the DOE requirements for RACs and CAC/HPs when testing with reduced compressor speeds. However, DOE is not addressing certification in this rulemaking and may address this issue in a separate future rulemaking.

Issue 2: DOE requests comment on whether setting the unit thermostat down to 75 °F (*i.e.,* a 5 °F differential to the indoor condition of 80 °F) is sufficient to ensure that the compressor runs at full speed. DOE requests comment on whether manufacturers will be able to provide override instructions to ensure operation at the low and intermediate compressor speeds.

DOE's review of several PTAC/HP models suggests that PTAC/HPs offer at least two user-selectable indoor fan speeds: high and low, and two user-selectable modes: cycling (or auto) fan and constant fan modes. In the cycling fan mode, the indoor fan cycles with the compressor while in the constant fan mode, the indoor fan runs continuously regardless of the compressor operation. DOE is proposing to require that all tests be done with the fan control selections that set the fan speed to high and the indoor fan to cycle with the compressor. However, DOE understands that fan staging may also vary based on compressor staging for two-stage and variable speed PTAC/HPs, and may need to be fixed.

Issue 3: DOE requests comment on whether fan speed may vary with staging and whether it may have to be ''fixed'' at the right speed.

2. Cooling Tests

DOE understands that the PTAC/HP market has a mixed presence of single-speed, two-speed, or variable-speed systems, with most units employing a single-speed compressor. Therefore, DOE is proposing that each of these systems be tested with a different subset of conditions to effectively measure performance. DOE is using appendix M1 as the basis for the required cooling tests for each system type, but with necessary modifications to reduce test burden as appropriate. For example, as discussed in section III.F.3 of this document, DOE is not proposing cyclic tests but instead requiring the use of a default degradation coefficient.

To prevent confusion between two-speed and variable-speed systems, DOE is proposing to define variable speed PTAC/HP as follows:

Variable speed PTAC/HP means a packaged terminal air-conditioner or heat pump with a compressor that uses a variable-speed drive to vary the compressor speed to achieve variable capacities or three or more capacities for any operating condition for which the compressor would be running.

For units having a single-speed compressor, and consequently one compressor speed, DOE is proposing to require two full-speed tests conducted at the A and C conditions, with the compressor running at its nominal, full speed. Table III.1 sets out the test condition for systems employing single-speed compressors. DOE considers that the A and C conditions would be sufficient to develop a performance curve for the purpose of interpolation.

In order to reduce test burden, DOE is not proposing to require testing at the B condition.

TABLE III.1—COOLING MODE TEST CONDITIONS FOR UNITS HAVING A SINGLE-SPEED COMPRESSOR

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
A_{full} Test—required	80	67	95	75	Full.
C_{full} Test—required	80	67	75	60	Full.

For units having a two-speed compressor or a variable-speed compressor that operate at two speed levels at any given outdoor temperature, DOE is proposing to require two full-speed tests conducted at the A and B conditions, and two low-speed tests conducted at the B and C conditions. These pairings of test conditions and speeds are intended to be representative of actual field operation. Table III.2 sets out the test condition for systems employing two-speed compressors or a variable-speed compressor that operate at two speed levels at any given outdoor temperature.

TABLE III.2—COOLING MODE TEST CONDITIONS FOR UNITS HAVING A TWO-SPEED COMPRESSOR *

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
A_{full} Test—required	80	67	95	75	Full.
B_{full} Test—required	80	67	82	65	Full.
B_{low} Test—required	80	67	82	65	Low.
C_{low} Test—required	80	67	75	60	Low.

* This includes units with compressors that achieve no more than two capacity levels using variable speed technology for any one of the test conditions used for the tests.

For units having variable-speed compressors with three or more speed levels at any given outdoor temperature, the same tests as set for the two-speed systems will apply—but with an additional optional intermediate speed test at the B condition *i.e.,* the B_{int} test. This optional intermediate test is included to provide an opportunity for a variable-speed unit to test improved performance as compared to the performance interpolated between the low speed and the high speed at the B condition. Table III.3 sets out the test condition for systems employing variable-speed compressors with three or more speed levels at any given outdoor temperature.

TABLE III.3—COOLING MODE TEST CONDITIONS FOR UNITS HAVING A VARIABLE-SPEED COMPRESSOR WITH THREE OR MORE SPEED LEVELS AT ANY GIVEN OUTDOOR TEMPERATURE

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
A_{full} Test—required	80	67	95	75	Full.
B_{full} Test—required	80	67	82	65	Full.
B_{low} Test—required	80	67	82	65	Low.
B_{int} Test—optional	80	67	82	65	Intermediate.
C_{low} Test—required	80	67	75	60	Low.

Issue 4: DOE requests comment on its proposed cooling tests for single-speed, two-speed and variable-speed compressor systems.

3. Cyclic Losses

Under part-load operation, in which the cooling load of the space is less than the full cooling capacity of the compressor and the compressor cannot modulate compressor speed to match capacity to the required load, the compressor cycles on and off (for single-speed systems) or operates between different compressor speeds (for two-stage or variable speed systems). This cycling behavior introduces inefficiencies, *i.e.,* ''cycling losses.'' In appendix M1 and AHRI Standard 210/240–2023, ''Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment'' (''AHRI 210/240–2023''), the inefficiencies associated with cycling losses in CAC/HPs are represented by a degradation coefficient (C_D). The cooling degradation coefficient is denoted by $C_D{}^c$ and heating degradation coefficient is denoted as $C_D{}^H$. In appendix M1 and AHRI 210/240–2023, this degradation coefficient can be optionally evaluated via cyclic testing, or a default degradation coefficient can be used.[13]

As ASHRAE Standard 16–2016 does not include test provisions to conduct cyclic tests, DOE is not proposing to include cyclic tests as part of the new test procedure at appendix H1. To represent the cycling losses of a PTAC/HP, a degradation coefficient is required. CAC/HP systems are differently configured as compared to PTAC/HPs and therefore, the use of the default degradation coefficients from appendix M1 and AHRI 210/240–2023 may not be appropriate for PTAC/HPs.

To investigate cycling losses and evaluate a default degradation coefficient particular to PTAC/HPs, DOE conducted testing with several single-speed PTHPs and one variable-speed PTHP under different cooling conditions at reduced loads. DOE installed each PTHP in a calorimetric test chamber, set the unit thermostat just below 80 °F, and applied a range of fixed cooling loads to the indoor chamber.[14 15] The calorimeter chamber was configured so that the indoor chamber temperature could vary but averaged out at the standard indoor condition of 80 °F/67 °F (dry-bulb/wet-bulb), thereby allowing the test unit to maintain the target indoor chamber temperature by adjusting its cooling operation in response to the changing temperature of the indoor chamber. Figure III–1 shows the efficiency losses for each unit at varying cooling loads at an outdoor condition of 82 °F/65 °F, relative to the performance of each unit as tested at the full-load condition at 82 °F/65 °F.

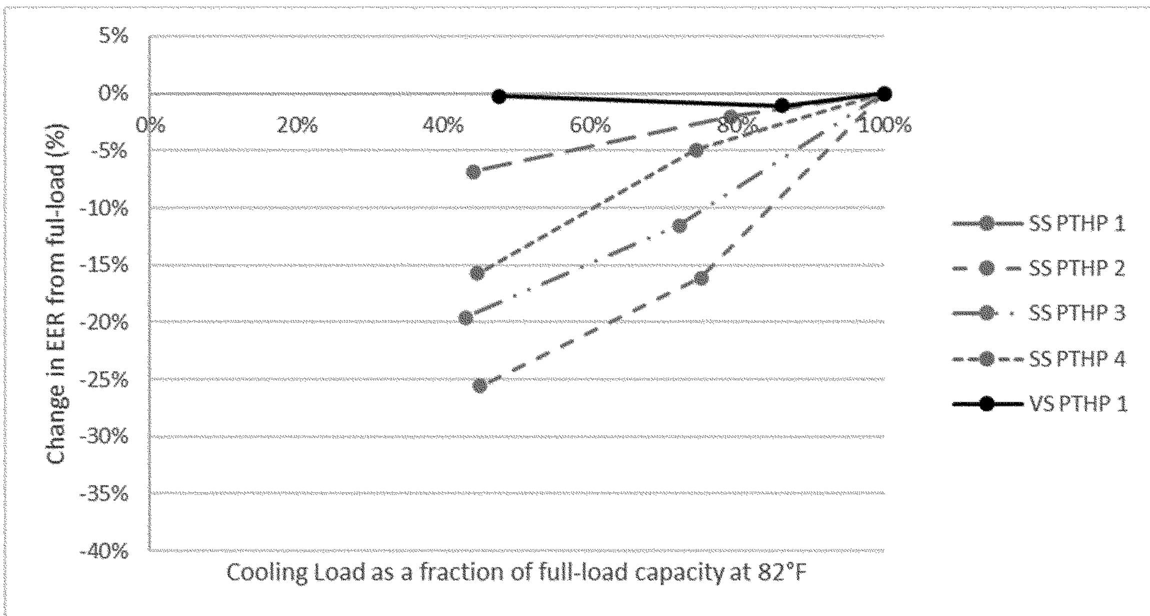

Figure III-1. Change in EER for Reduced Cooling Loads at an outdoor test condition of 82°F

In Figure III–1, the distance of each data point from the x-axis represents the change in efficiency relative to the full-load efficiency for each unit at an outdoor condition of 82 °F/65 °F. The single-speed PTHP efficiency decreases in correlation with a reduction in cooling load, reflecting cycling losses that become relatively larger as the cooling load decreases. In contrast, the efficiency of the variable-speed PTHP remains steady as the cooling load decreases, reflecting the lack of cycling losses associated with lower compressor speeds.

Based on this data, DOE evaluated the cooling degradation coefficient for each single-speed PTHP unit as defined in Appendix M1,[16] and then obtained an average, as shown in Table III.4.

TABLE III.4—COOLING DEGRADATION COEFFICIENTS FOR DIFFERENT SINGLE-SPEED UNITS

Unit identifier	Cooling degradation coefficient ($C_D{}^C$)
PTHP 1	0.12
PTHP 2	0.47
PTHP 3	0.35
PTHP 4	0.26
Average	0.30

[13] Previous versions of AHRI Standard 210/240, including the version referenced in Appendix M1, AHRI 210/240–2008, also address the degradation coefficient in the same manner.

[14] A cooling load is ''applied'' by adjusting and fixing the rate of heat added to the indoor test chamber to a level at or below that of the nominal cooling capacity of the test unit.

[15] This approach aims to represent a consumer installation in which the amount of heat added to a room may be less than the rated cooling capacity of the room AC (*e.g.,* electronics or lighting turned off, people or pets leaving the room, and external factors such as heat transfer through walls and windows reducing with outdoor temperature).

[16] *See* section 3.5.3—Cooling-Mode Cyclic-Degradation Coefficient Calculation.

Based on the observed data, the average value of the cooling degradation coefficients is different from the default value (0.2) assigned in appendix M1 and AHRI 210/240–2023 for single-speed systems. DOE did not conduct similar testing for heating mode, but considers that a similar degradation in performance would be observed. Therefore, DOE is proposing that the default cooling and heating degradation coefficient for the PTAC/HP test procedure be 0.30, as calculated based on DOE's testing.

Issue 5: DOE requests comment on its proposed value of the cooling and heating degradation coefficients.

4. SCP Calculation

As mentioned, DOE's proposed cooling metric, SCP, represents a measure of cooling efficiency across the entire season, as opposed to a single test condition. The SCP metric involves the evaluation and summation of the total cooling provided and the power consumed using a binned analysis similar to the one used for the SEER2 metric for CACs. These quantities are calculated for each individual temperature bin using the appropriate calculation methods depending on the operating characteristics of the type of system *i.e.,* single-speed, two-speed or variable-speed. Bin temperatures and bin hours are discussed in section III.F.5 of this document.

Similar to appendix M1, DOE is also proposing a relationship to represent the cooling building load line for PTAC/HPs, which enables the calculation of the quantities mentioned previously. The PTAC/HP cooling building load line is specific to the use cases for PTAC/HPs, primarily small hotels and midrise apartments, and represents the averaged cooling load at different temperatures evaluated as a national average. For this analysis, DOE considered an equal weighting of the small hotel and the midrise apartment use cases. Similar to the cooling building load line in appendix M1, the building load line for PTAC/HPs includes a 10 percent assumption for oversizing.

Issue 6: DOE requests comment on its proposed approach to calculate SCP using a similar binned analysis as that of SEER2. DOE also requests comment on the proposed cooling building load line; specifically, whether an equal weighting of the small hotel and midrise apartment use cases is appropriate.

5. Cooling Temperature Bins and Weights

As mentioned, the values of the total cooling provided and the power consumed are evaluated for each individual temperature bin. Table III.5 shows DOE's proposed temperature bins and associated weighting factors to represent the number of cooling hours per year spent at each bin. These temperature bins and fractional hours are based on DOE's analysis of building energy use associated with PTAC/HP use cases, primarily the small hotel and the midrise apartment prototypes and are a national average.

TABLE III.5—DISTRIBUTION OF FRACTIONAL HOURS WITHIN COOLING SEASON TEMPERATURE BINS

Bin number, j	Bin temperature range °F	Representative temperature for bin °F	Fraction of total temperature bin hours, n_j/N
1	65–69	67	0.229
2	70–74	72	0.238
3	75–79	77	0.220
4	80–84	82	0.150
5	85–89	87	0.094
6	90–94	92	0.047
7	95–99	97	0.014
8	100–104	102	0.007

Issue 7: DOE requests comment on its proposed temperature bins and associated fractional bin hours for cooling.

G. Proposed Heating Metric and Test Procedure

Similar to the cooling metric discussed in section III.F, DOE has initially determined that a heating metric that incorporates seasonal heating performance (similar to the HSPF2 metric) for CAC/HPs is appropriate for PTAC/HPs. HSPF2 reflects seasonal performance by averaging test results from different load points, depending on system configuration (single-speed, two-capacity, or variable-speed), with varying outdoor conditions and staging levels to represent the product's average efficiency throughout the heating season (*see* appendix M1).

However as noted earlier, DOE considers that the direct adoption of HSPF2 as detailed in appendix M1 is not suitable for PTAC/HPs, as there are differences in the use cases for PTAC/HPs and the test burden associated with CAC/HP testing per appendix M1 may be much higher than appropriate to gauge heating performance of PTAC/HPs. DOE is proposing to define a new heating metric for PTAC/HPs called seasonal heating performance (SHP) as follows:

Seasonal Heating Performance (SHP) means the total heat added to the conditioned space during the heating season, expressed in Btu's, divided by the total electrical energy consumed by the package terminal heat pump during the same season, expressed in watt-hours. SHP is determined in accordance with appendix H1 to this subpart.

1. Test Conditions

Similar to the cooling season, PTACs and PTHPs operate under various outdoor temperature conditions and load points in the heating season. To effectively capture performance at these varying outdoor conditions and associated loads, DOE proposes a test procedure with three heating test conditions at dry-bulb temperatures of 47 °F, 17 °F and 5 °F. These are denoted as the ''H_1'', ''H_3'' and ''H_4'' conditions, respectively. As discussed in section III.E.3 of this document, DOE understands that very few PTHPs are able to operate in heat pump mode at temperatures below freezing, and therefore could not be tested at the ''H_3'' and ''H_4'' conditions. Therefore, DOE is proposing that (1) tests at the H_4 condition be optional and (2) for those units that are unable to test at the ''H_3'' condition, a substitute test, denoted as ''H_L'' be utilized. The H_L test is conducted at a target dry-bulb temperature equal to the average of the cut-out[17] and cut-in[18] temperatures for a particular PTHP unit. The corresponding wet-bulb temperature is chosen such that it corresponds to a maximum of 60 percent relative humidity (''RH'') level. DOE considers that a maximum 60 percent RH level would be low enough to prevent significant frost build up, but high enough that it would not be unduly burdensome for test labs to achieve. Details on evaluating the cut-in and cut-out temperatures is presented in section III.G.3 of this document. Tolerances as set in Table 2B of ANSI/ASHRAE 37–2009 apply to these test conditions.

Depending on compressor capacity control attributes, the three test conditions (H_1, H_3 or H_L and H_4) are paired with up to three compressor speeds to denote the different heating capacities that the unit will run at to modulate to the required heating load: full, intermediate, and low. For example, a $H_{1,low}$ test would denote a test conducted at the ''H_1' condition (47 °F) and set to a low compressor speed for variable-speed and two-capacity compressor systems.

The full compressor speed for the heating mode tests would be evaluated by setting the room thermostat at a higher temperature than the required indoor condition *i.e.,* at 75 °F. Manufacturers will need to provide special control override instructions to set the low and intermediate compressor speeds for heating. Similar to the cooling tests, DOE is proposing to require that all heating tests be done with the fan control selections that set the fan speed to high and the indoor fan to cycle with the compressor.

Issue 8: DOE requests comment on its proposed H1 (47 °F), H3 (17 °F) or HL and H4 (5 °F) test conditions to represent different heating outdoor conditions experienced by PTACs and PTHPs in the field.

Issue 9: DOE requests comment on whether setting the unit thermostat up to 75 °F (*i.e.,* a 5 °F differential to the indoor condition of 70 °F) is sufficient to ensure that the compressor runs at full speed for heating mode.

2. Heating Tests

Similar to the cooling tests in section III.F.2 of this document, DOE is using appendix M1 as the basis for the required heating tests for each system type—single-speed, two-speed, variable-speed, but with necessary modifications to reduce test burden as appropriate. Firstly, as discussed in more detail in section III.G.4 of this document, DOE is not including tests in the temperature range which presents a potential for heavy frost accumulation—for example, at 35 °F. Additionally, while Appendix M1 includes heating tests at lower ambient conditions (17 °F and 5 °F), these conditions can either be substituted *i.e.* using the H_L test instead of testing at 17 °F, or are optional (5 °F).

For units having a single-speed compressor, and consequently one compressor speed, DOE is proposing to require two full-speed tests conducted at the H_1 and H_3 (or H_L) conditions, with the compressor running at its nominal, full speed. Table III.6 sets out the test condition for systems employing single-speed compressors.

TABLE III.6—HEATING MODE TEST CONDITIONS FOR UNITS HAVING A SINGLE-SPEED COMPRESSOR

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
$H_{1,\ full}$ Test—required	70	60 max	47	43	Full.
$H_{3,\ full}$ Test—required	70	60 max	17	15	Full.
$H_{L,\ full}$ Test[1]	70	60 max	See note 2	See note 3	Full.

[1] To be conducted only if the unit is unable to test at H_3 conditions.
[2] Use the average of the cut-in and cut-out temperatures.
[3] Use a wet-bulb temperature corresponding to a maximum 60% RH level.

For units having a two-speed compressor or a variable-speed compressor that operate at two speed levels at any given outdoor temperature, DOE is proposing three full-speed tests conducted at the H_1, H_3 (or H_L) and H_3 conditions, with the H_3 condition test optional. DOE is also proposing to require two low-speed tests conducted at the H_1 and H_3 (or H_L) conditions. Table III.7 sets out the test condition for systems employing two-speed compressors.

TABLE III.7—HEATING MODE TEST CONDITIONS FOR UNITS HAVING A TWO-CAPACITY COMPRESSOR *

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
$H_{1,full}$ Test—required	70	60 max	47	43	Full.
$H_{3,\ full}$ Test—required	70	60 max	17	15	Full.
$H_{L,\ full}$ Test[1]	70	60 max	See note 2	See note 3	Full.
$H_{4,\ full}$ Test—optional	70	60 max	5	4	Full.
$H_{1,low}$ Test—required	70	60 max	47	43	Low.
$H_{3,\ low}$ Test—required	70	60 max	17[1]	15[2]	Low.

[17] Cut-out temperature refers to the temperature at which the unit compressor stops *i.e.,* 'cuts out' operation to prevent compressor damage.

[18] Cut-in temperature refers to the temperature at which the unit compressor restarts *i.e.,* 'cuts in' operation after it has reached a cut-out event.

TABLE III.7—HEATING MODE TEST CONDITIONS FOR UNITS HAVING A TWO-CAPACITY COMPRESSOR *—Continued

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
$H_{L,\ low}$ Test [1]	70	60 max	See note 2	See note 3	Low.

* This includes units with compressors that achieve no more than two capacity levels using variable speed technology for any one of the test conditions used for the tests.
[1] To be conducted only if the unit is unable to test at H_3 conditions.
[2] Use the average of the cut-in and cut-out temperatures.
[3] Use a wet-bulb that corresponds to a maximum 60% RH level.

For units having variable-speed compressors with three or more speed levels at any given outdoor temperature, the same tests as set for the two-speed systems will apply—but with an additional optional intermediate speed test at the H_3 (or H_L) condition.

TABLE III.8—HEATING MODE TEST CONDITIONS FOR UNITS HAVING A VARIABLE-SPEED COMPRESSOR

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
$H_{1,full}$ Test—required	70	60 max	47	43	Full.
$H_{3,\ full}$ Test—required	70	60 max	17	15	Full.
$H_{L,\ full}$ Test [1]	70	60 max	See note 2	See note 3	Full.
$H_{4,\ full}$ Test—optional	70	60 max	5	4	Full.
$H_{1,low}$ Test—required	70	60 max	47	43	Low.
$H_{3,\ low}$ Test—required	70	60 max	17	15	Low.
$H_{L,\ low}$ Test [1]	70	60 max	See note 2	See note 3	Low.
$H_{3,int}$ Test—optional	70	60 max	17	15	Intermediate.
$H_{L,\ int}$ Test—optional [1]	70	60 max	See note 2	See note 3	Intermediate.

[1] To be conducted only if the unit is unable to test at H_3 conditions.
[2] lUse the average of the cut-in and cut-out temperatures.
[3] Use a wet-bulb that corresponds to a maximum 60% RH level.

Issue 10: DOE requests comment on its proposed heating tests for single-speed, two-speed and variable-speed compressor systems.

3. Evaluating Cut-In and Cut-Out Temperatures

As mentioned in section III.G.2 of this document, for those units that are unable to test at the H_3 condition, the H_L test would be required. The H_L test is conducted at a target dry-bulb temperature equal to the average of the cut-in and cut-out temperatures for a particular PTHP unit and the wet-bulb temperature is chosen such that it corresponds to a maximum 60 percent RH level.

To evaluate the cut-out and cut-in temperatures, DOE is proposing to utilize the verification test procedure used in the residential cold-climate heat pump technology challenge [19] (''CCHP Challenge''). DOE's proposal requires that the unit be set to operate in heating mode with the thermostat set at 75 °F and the conditioned space at the standard heating-mode test temperature of 70 °F. The outdoor chamber temperature is then reduced to a level that is 3 °F warmer than the expected cut-out temperature [20] and paused for 3 minutes to allow conditions to stabilize. The outdoor chamber temperature is reduced in steps or continuously at an average rate of 1 °F every 5 minutes. The average outdoor coil air inlet temperature when the HP operation stops is noted as the cut-out temperature. The outdoor temperature is held constant for 5 minutes where the cut-out occurred to allow for any compressor short cycle timer to expire—then the outdoor chamber temperature is increased by 1 °F every 5 minutes. The temperature ramp is continued until 5 minutes after the HP operation restarts. The average outdoor coil air inlet temperature when the HP operation restarts is noted as the cut-in temperature.

For this evaluation of the cut-out and cut-in temperatures, the outdoor chamber would need to be sufficiently dried out to prevent frost collection. A remotely controlled circulating fan would also be required to provide the temperature ramp after the cut-out occurs.

Issue 11: DOE requests comment on its proposed method to evaluate cut-out and cut-in temperatures.

4. Defrost Degradation

DOE's proposed heating test procedure does not include tests in the temperature range which presents a potential for heavy frost accumulation *i.e.,* (''frost zone''). Tests in the frost zone need to account for performance impact of frost accumulation and address unit energy use to operate a defrost cycle. When a PTHP unit operates a defrost cycle, it reverses the heating cycle *i.e.,* it operates in cooling mode, removing heat from the indoor space to supply to the outdoor coils and remove frost. This operation impacts the unit's efficiency because the effective heating capacity is reduced.

When testing CHPs, appendix M1 requires that one test be conducted at a frost zone temperature. Specifically, appendix M1 calls for testing at an

[19] Available at: *www.energy.gov/sites/default/files/2021-10/bto-cchp-tech-challenge-spec-102521.pdf.*

[20] This information is often indicated in the unit installation manual or product brochure.

outdoor condition of 35 °F DB temperature and 33 °F WB temperature. When operating at this condition, the frost accumulation is sufficiently rapid that performance can be affected noticeably before a full 30-minute test can be completed. In addition, capturing the full impact of frost on performance requires conducting a test that includes a full cycle of both heating with frost accumulation and defrost. As noted, such a test is specified in appendix M1 as the ''transient'' test, which follows the test method described for the 'T' test in ANSI/ASHRAE 37–2009. DOE understands that there is additional test burden associated with running a transient test as compared to a steady-state test and this burden may not be appropriate for PTHPs due to their relatively lower energy use as compared to CHPs. For these reasons, DOE is proposing not to include transient heating tests.

However, DOE understands that PTHPs in the field do operate in the frost zone and consequently, are impacted by frost. To ensure that the heating test procedure is reasonably designed to produce test results which reflect energy efficiency during a representative average use cycle, DOE has provisionally determined that it would be more appropriate to apply a representative defrost degradation to the seasonal heating efficiency metric than to require testing to determine the impact. Specifically, DOE is proposing to adjust the calculated capacity and power for the representative temperature bins associated with frost accumulation, *i.e.,* 17 °F to 40 °F. This will be achieved by applying defrost coefficients to the capacity and power obtained from the H_1 and H_3 (or H_L) tests.

DOE does not currently have defrost data for PTHPs. Thus, DOE is proposing to use an approach for defrost degradation based on the capacity and power adjustments from appendix M1 for CAC/HPs for determination of full-capacity performance of variable-speed CHPs in 35 °F conditions. Specifically, section 3.6.4.c of appendix M1 calls for calculation of full-speed performance at 35 °F by calculating capacity and power using the interpolation from the 17 °F and 47 °F tests, and then adjusting the evaluated heating capacity and power by 10 percent and 1.5 percent, respectively. Similarly, for PTHPs, DOE is proposing that the heating capacity and power at 35 °F be evaluated from the interpolation of H_1 (47 °F) and H_3 (17 °F), or H_L tests, with the same adjustments applied to capacity (10%) and power (1.5%). The evaluation of heating capacity and power at temperature bins associated with frost accumulation *i.e.,* 17 °F to 40 °F, would then be interpolated using the performance at 35 °F.

Issue 12: DOE requests comment on its proposed defrost adjustment coefficients; specifically, DOE requests feedback on its approach to use appendix M1 to inform the adjustment values for performance at 35 °F. DOE requests data on defrost degradation particular to PTHPs.

5. SHP Calculation

DOE's proposed heating metric, SHP, represents a measure of heating efficiency across the entire season, as opposed to a single test condition. The SHP metric involves the evaluation and summation of the total heating provided and the power consumed using a binned analysis similar to the one used for the HSPF2 metric. Similar to HSPF2, the SHP calculation determines energy use for each bin based on the heating load for the bin, whether the PTHP would be operating in heat pump mode, using electric resistance heat, or both—and the heat pump capacity, power input, and degradation (if applicable). These quantities are calculated for each individual temperature bin using the appropriate formula for each bin depending on the operating characteristics of the type of system *i.e.,* single-speed, two-speed or variable-speed. For each bin, it is assumed that the total heating provided would exactly match the building load. Bin temperatures and bin hours are discussed in section III.G.6 of this document.

DOE understands that some units would use the H_L test instead of testing at the H_3 condition (17 °F). Additionally, different units would undergo the H_L test at different temperatures, depending on their respective cut-in and cut-out temperatures. This may appear to present a concern of a non-standardized test condition impacting the SHP calculation. However, DOE notes that since the H_3 or H_L tests would be used in addition to the other test conditions to interpolate performance in the various bins, and electric heat would supplement unit capacity to ensure total heating matches the building load in all bins, the evaluated SHP values would still allow for a meaningful comparison between units. Specifically, for a unit that tests using the H_L test, heat pump performance would be determined down to the cutoff temperature using the performance at the ''L'' temperature, and all heating below the cut-out temperature would be calculated based on its being provided by electric resistance heating. This results in consistent comparison of PTHPs using the H_L test and other PTHPs using the H_3 test, because for all calculations the total delivered heating would match the building load, and energy input for bins below the cut-out temperature would be calculated assuming provision using electric resistance heat.

DOE is also proposing a relationship to represent the heating building load line for PTAC/HPs. Similar to the cooling building load line, the PTAC/HP heating building load line represents the averaged heating load at different temperatures evaluated as a national average and utilizes an equal weighting of the small hotel and the midrise apartment prototypes.

Issue 13: DOE requests comment on its proposed approach to calculate SHP using a similar binned analysis as that of HSPF2. DOE also requests comment on the proposed heating building load line; specifically, whether an equal weighting of the small hotel and midrise apartment use cases is appropriate.

6. Heating Temperature Bins and Weights

The values of the total heating provided and the power consumed are evaluated for each individual temperature bin. Table III.9 shows DOE's proposed temperature bins and associated weighting factors to represent the number of hours per year spent at each bin for heating. These temperature bins and fractional hours are based on DOE's analysis of building energy use associated with PTAC/HP use cases, primarily the small hotel and midrise apartment prototypes, and are a national average.

TABLE III.9—DISTRIBUTION OF FRACTIONAL HOURS WITHIN HEATING SEASON TEMPERATURE BINS

Bin number, j	Bin temperature range °F	Representative temperature for bin °F	Fraction of total temperature bin hours, n_j/N
1	39–35	37	0.337
2	34–30	32	0.298
3	29–25	27	0.192
4	24–20	22	0.108
5	19–15	17	0.051
6	14–10	12	0.008
7	9–5	7	0.006

Issue 14: DOE requests comment on its proposed temperature bins and associated fractional bin hours for heating.

H. Dehumidification of Fresh Air

In typical hotel installations, the PTAC or PTHP unit provides cooling and heating to individual rooms or suites within the hotel and the hotel hallways and common areas are usually serviced by a separate air conditioning system. In older building designs, fresh air ventilation is supplied to hotel rooms via the corridors to which the rooms are connected. In these designs, air is exhausted from each hotel room by a bathroom exhaust fan and is replaced by ''make-up'' air supplied via the corridor and conditioned by the heating, ventilation, and air conditioning (''HVAC'') system that serves the corridor. Make-up air from the corridor enters the hotel rooms by passing through an undercut or grill in the hotel room door.

Building designs that supply make-up air via corridors generally are no longer permissible under the building codes adopted in most U.S. states. Chapter 10, Section 1018.5 of the 2009 International Building Code (''IBC'') states that, with some exceptions, ''corridors shall not serve as supply, return, exhaust, relief or ventilation air ducts.'' [21] The International Code Council (''ICC'') tracks the adoption of the IBC by state. The ICC reports that, as of July 2022, only seven states had not fully adopted the 2009 version or a more recent version of the IBC.[22] These IBC code requirements have precipitated the introduction of PTAC and PTHP models that are designed to draw outdoor air into the unit, dehumidify the outdoor air, and introduce the dehumidified air into the conditioned space. These models are commonly referred to as ''make-up air PTACs'' or ''make-up air PTHPs.'' The following paragraphs discuss issues regarding the market size and energy consumption of make-up air PTACs and PTHPs.

1. Market Size of Make-Up Air PTACs and PTHPs

DOE has identified two different designs of make-up air PTAC and PTHP units on the market. In the first design, the PTAC or PTHP includes a dehumidifier module situated in the outdoor portion of the unit between the unit's outdoor heat exchanger and the panel that divides the indoor and outdoor portions of the unit. The dehumidifier module contains a compressor and refrigerant loop that are separate from the main refrigerant loop that the PTAC or PTHP uses to provide cooling to the conditioned space. In this design, outdoor air flows through the dehumidifier module, which removes moisture from the air, and into the conditioned space.

In the second identified design, the make-up air PTAC or PTHP does not include a dehumidifier module. Instead, the unit incorporates a variable-speed compressor that can operate at speeds less than full speed. In this design, outdoor air is drawn through the unit and across the unit's primary evaporator coil; dehumidification is provided by the unit's main refrigerant loop, and the unit's variable-speed compressor adjusts its capacity to provide humidity control by matching compressor operation to the required load of sensible [23] or latent [24] cooling, such that the unit removes moisture from the air without cooling the air to a temperature well below the setpoint.

In the May 2021 TP RFI, DOE requested comment on how ''make-up air PTAC'' and a ''make-up air PTHP'' could be defined, and what characteristics could be used to distinguish make-up air PTACs and PTHPs from other PTACs and PTHPs. 86 FR 28005, 28008. DOE also requested comment on the market size each of the PTAC and PTHP design options it has identified that provide dehumidification of fresh air and whether there were any other design pathways by which a PTAC or PTHP can provide dehumidification of outdoor air and, if alternative designs exist, the market size of these alternative designs. *Id.* DOE also requested data on the relative market share of make-up air PTACs/PTHPs within the three PTAC and PTHP capacity ranges: <7,000 Btu/h; ≥7,000 Btu/h and ≤15,000 Btu/h; and >15,000 Btu/h. 86 FR 28005, 28009.

AHRI stated that the market for PTACs and PTHPs introducing conditioned outside air is very small. (AHRI, No. 14 at p. 4) AHRI commented that based on the survey they conducted to determine the market size for units providing dehumidification of outdoor air, AHRI estimates between 2.9 and 8.6 percent of PTAC/HPs sold include conditioned outdoor air capabilities across the PTAC and PTHP entire market, irrespective of equipment capacity and of these, an even smaller percentage include dehumidification capabilities. *Id.* AHRI stated that their survey did not have enough data to aggregate the proportion among the capacity bins, but it constituted a representative sample of the PTAC and PTHP market and indicated 3.8 percent of PTAC and PTHP shipments include make-up air for all equipment capacities. (AHRI, No. 14 at p. 7) They stated that this small market share is not expected to increase significantly, and it was their belief that DOE's analysis of this issue relying solely on building codes fails to appropriately account for alternate methods of providing makeup air based on the shipment numbers that are likely dominant in the market. *Id.*

[21] International Code Council. 2009 International Building Code. Available at: *https://codes.iccsafe.org/content/chapter/4641/.*

[22] International Code Council (2022). ''International Codes—Adoption by State.'' Available at: *www.mitek-us.com/wp-content/uploads/2022/08/Master-I-Code-Adoption-Chart.pdf.*

[23] ''Sensible cooling'' refers to cooling that reduces air temperature without removing moisture from the air.

[24] ''Latent cooling'' refers to cooling that only removes moisture from the air.

Regarding definitions for make-up air PTACs and PTHPs, AHRI commented that they disagree that revisions are necessary, but offered information regarding different technologies that introduce makeup air through a PTAC or PTHP. (AHRI, No. 14 at p. 4–5) AHRI noted that the primary technologies for introducing outside air through a PTAC or PTHP are based on a separate module that includes a dehumidification coil—with air either being forced into the room or a vent damper introducing ventilation air into the unit through induction (*i.e.,* standard PTAC with open damper). *Id.* AHRI further noted that forced air introduction and induced air via a vent damper may or may not condition the outside air and may have a simple vent opening in its bulkhead which allows outside air to be drawn in by the negative pressure of the room caused by running the bathroom's exhaust fan. *Id.* AHRI commented that in the case of a dehumidification module, outdoor air is introduced through a module with its own compressor, fan, and dehumidification coils, with air being pushed through a module with a small fan(s) and an automated damper door will open and close to prevent draft while not in use. *Id.* AHRI further commented that most PTACs and their internal make-up air modules are equipped to accept signals from an occupancy detection system and that units with dehumidification modules are sometimes also referred to as ''two-stage systems.'' *Id.*

NEAA commented that PTAC/HPs with make-up air capabilities are already available from at least four manufacturers and are likely to become more prevalent as the new construction and retrofit markets shift to meet this code requirement. (NEAA, No. 17 at p. 2) NEEA stated that there are also products on the market that are not specifically marketed for their ventilation capabilities, but which do allow for the introduction of outside air when the unit is operating. *Id.* NEAA noted that the distinguishing characteristic of these products is the introduction and conditioning of outside air. *Id.*

In response to AHRI, DOE notes that while the market for make-up air PTACs and PTHPs may be small currently, new IBC code requirements and increased focus on ventilation, may lead to increased demand for these units. While there are other alternate methods of providing make up air, such as through a dedicated outdoor air system, DOE understands that implementing these alternate methods may require significant changes to existing buildings. As such, using make up air PTAC/HPs may be the preferred option to comply with new building codes. Therefore, DOE has initially determined that a test procedure to account for the dehumidification function of this equipment is appropriate.

2. Dehumidification Energy Use

As previously mentioned, neither the current DOE test procedure nor the industry test procedures, AHRI Standard 310/380–2014 or AHRI Standard 310/380–2017, account for any additional energy associated with the dehumidification of make-up air traversing the unit. When a unit is operating in cooling mode, the dehumidification function may add heat to the room, thus increasing the cooling load on the unit. In addition, introducing make-up air to the room while the unit is operating in heating mode could increase a unit's energy consumption if the unit uses electric resistance heating to heat the make-up air. The amount of energy consumed by a dehumidification function depends on a variety of factors, including the airflow rate, the amount of time the dehumidification function is engaged, how the dehumidification function is controlled, and the ambient air temperature, among others.

In the May 2021 TP RFI, DOE sought comment on the impacts on the energy consumption of PTACs and PTHPs that dehumidify incoming outdoor air for units that include a dehumidification module, a variable-speed compressor, or any other design that dehumidifies outdoor air and introduces it to the conditioned space, in both cooling and heating mode. 86 FR 28005, 28009. DOE also requested comment on how to quantify the energy consumption associated with the dehumidification function of make-up air PTACs/PTHPs for an average use cycle and what indoor and outdoor temperature and humidity conditions might be appropriate for this characterization. *Id.*

NEAA commented that the introduction of outside air will generally increase energy use and the conditioning of this air should be captured by the test procedure. (NEAA, No. 17 at p. 2) NEEA stated that it is important to include this energy use because designers may be comparing makeup air PTACs with other ventilation options and that if this energy use is not captured by the test procedure, it would lead to an unfair comparison between PTAC or PTHPs and other ventilation options by not fully reflecting the energy used by these units. *Id.* The Joint Advocates also encouraged DOE to incorporate the additional energy use associated with make-up air PTACs and PTHPs so that the test procedure is representative for these units (Joint Advocates, No. 16 at p. 1)

AHRI stated that there is no standard test procedure for measuring the energy component of a PTAC associated with the introduction and dehumidification of outdoor air. (AHRI, No. 14 at p. 5) They identified many factors to consider including, ambient environmental conditions, the quantity and the relative humidity of the outdoor air being supplied to the room, and the set of conditions that must be satisfied first before a dehumidification process is initiated. *Id.* AHRI stated that it was unreasonable to request stakeholders to essentially develop a test procedure through the notice and comment process for any product, much less an ''ASHRAE product'', and that these test procedures should be developed by a technical committee through consensus-process with relevant experts, including manufacturers, testing laboratory staff, and other experts present to discuss issues. *Id.*

DOE agrees with NEAA and Joint Advocates that the introduction of outside air will generally increase energy use and the conditioning of this air should be considered as part of the test procedure. However, DOE also recognizes the challenges identified by AHRI regarding the evaluation of the make-up air operation via a test procedure. DOE notes that it participates in the AHRI Standard 310/380 committee and has worked with stakeholders to develop industry test procedures for PTAC/HPs in the past and is willing to do so in the future, including for operation in dehumidification mode.

The next section presents DOE's proposed test procedure for measuring the dehumidification energy use of make-up air PTAC/HPs.

3. Proposed Test Procedure

To ensure that the test procedures prescribed by DOE are reasonably designed to produce test results which reflect energy efficiency during a representative average use cycle for PTAC or PTHP employing the make-up air function, DOE is proposing a test procedure for manufacturers to make representations of dehumidification energy use for make-up PTACs and PTHPs.

a. Definitions

Comments received in response to the May 2021 RFI suggest that the key feature of a make-up air PTAC or PTHP is the ability to introduce and condition outside air. While PTACs and PTHPs which do not have dehumidification capabilities also have provisions to bring in outside air through the unit bulkhead,[25] they do not condition the outdoor air before the outdoor air enters the conditioned space. Therefore, DOE considers that the conditioning of outside air is the defining aspect to distinguish make-up air PTAC/HPs from non make-up air PTAC/HPs. DOE is proposing to define make-up air PTACs and make-up PTHPs as follows:

Make-up Air PTAC means a PTAC for which a portion of the total airflow is drawn in from outside the conditioned space and in which this outside air passes through a dehumidifying or cooling coil, either before or after mixing with the air drawn into the unit from the conditioned space, but before being discharged from the unit.

Make-up Air PTHP means a PTHP for which a portion of the total airflow is drawn in from outside the conditioned space and in which this outside air passes through a dehumidifying or cooling coil, either before or after mixing with the air drawn into the unit from inside the conditioned space, but before being discharged from the unit.

As discussed in section III.H.1 of this document, DOE has identified two designs of make-up air units—the first design employs a separate dehumidifier module, *i.e.,* an ''add-on dehumidifier'' to provide dehumidification, while the second design relies on the main refrigeration circuit to provide dehumidification, *i.e.,* it utilizes an ''integrated dehumidifier''. DOE is proposing to define and include these terms in appendix H1 as follows:

Add-on Dehumidifier means a dehumidification system of a make-up air PTAC or PTHP that has its own complete dehumidification system and does not use the main PTAC/HP system indoor coil for any portion of the outdoor air dehumidification.

Integrated Dehumidifier means a dehumidification system of a make-up air PTAC or PTHP for which some of the dehumidification of the outdoor air is provided by the main PTAC/HP system indoor coil.

Issue 15: DOE requests comment on its proposed definitions for make-up air PTAC, make-up air PTHP, add-on dehumidifier and integrated dehumidifier.

b. Make-Up Air Setup

To help DOE evaluate a test procedure for make-up air operation, DOE requested information and data in the May 2021 TP RFI regarding various aspects of the make-up air function, including: the typical range of make-up air volume flowing through a make-up air PTAC/PTHP and whether this airflow varies while the dehumidification function is engaged; how make-up air flowing through the unit is heated while the unit is operating in heating mode; how make-up air dehumidification is controlled for units with a dehumidifier module and units without a dehumidifier module, specifically, what conditions trigger the unit to engage make-up air dehumidification and how do make-up air PTACs/PTHPs interact with variables like occupancy or exhaust fan controls; the typical amount of time that make-up air PTAC/HPs engage the dehumidification function; how the cooling and dehumidification modes are coordinated for make-up air PTACs/PTHPs, whether dehumidification and cooling are typically performed simultaneously or separately, and the impact that any such coordination has on energy consumption; and the range of dehumidification capacities (in pints of water/day) for make-up air PTACs/PTHPs in the market and the test conditions used to rate dehumidification capacity. 85 FR 28005, 28009. DOE also requested comment on what instructions the test procedures should provide regarding how to prepare and setup a PTAC or PTHP makeup air unit for testing under the current DOE test procedure, which does not test the makeup air function of the unit. *Id.*

AHRI stated that dehumidification modules typically introduce 25 to 50 cubic feet per min (''CFM'') of outdoor air, but airflow rates may vary depending on the design of the make-up air feature. (AHRI, No. 14 at p. 6) Regarding the time that the dehumidification mode is engaged, ARHI commented that there are different control strategies to control make-up air introduction and could be based on outdoor air conditions, room occupation, or other means and without some level of research, it is not possible to empirically determine what is ''typical''. *Id.* AHRI stated that they were unable to comment on dehumidification capacities (in pints of water/day) as there is currently no consensus method to measure dehumidification capacities for make-up air PTACs/PTHPs in the market. *Id.* DOE did not receive any further comments on other aspects of the make-up air function.

DOE's review of product literature suggests typical publicized dehumidification rates of 4–5 pints per day, although as AHRI noted there is currently no consensus method to measure dehumidification capacities for make-up air PTACs/PTHPs in the market. DOE also found that some make-up air PTACs or PTHPs use control schemes based on outdoor air temperature and relative humidity to decide when to engage the dehumidification function.

DOE notes that the 2022 edition of the ASHRAE ventilation standard, ASHRAE 62.1, ''Ventilation and Acceptable Indoor Quality'' (''ASHRAE 62.1–2022'') prescribes minimum ventilation rates in Table 6–1 of the standard. The minimum ventilation rates include an occupancy-based outdoor air rate based on expected number of people in the space and/or an outdoor air rate based on floor area. For hotels, the occupancy-based outdoor air rate is 5 CFM per person and the floorspace based outdoor air rate is 0.06 CFM per square foot. Based on a typical hotel room occupancy of 2 persons and a floor area of 300 square feet, the total required ventilation airflow would amount to 28 CFM. DOE conducted a review of product literature marketing PTACs and PTHPs with make-up air capabilities and concluded that all such units are capable of introducing at least 30 CFM of air, with airflow ranges from 30 to 75 CFM. Therefore, DOE has tentatively concluded that 30 CFM is the appropriate representative airflow to use in the development of the test procedure.

DOE understands that a key challenge associated with the testing of make-up air PTAC/HPs is the introduction and measurement of the make-up air. Some make-up PTAC/HPs have fans to provide the make-up air, while others rely on a negative pressure differential within the room. To standardize the rate and means of make-up air intake, DOE's proposed test procedure requires the use of a makeup air inlet duct assembly to draw air into the make-up air intake for the PTAC/HP unit. The inlet duct assembly would include a nozzle airflow measuring apparatus and an inlet plenum, with interconnecting duct sections. The air flow measuring apparatus would be used to measure and feed air into the plenum. Figure III–2 details the setup of the inlet duct

[25] DOE's research indicates that this bulkhead opening is often sealed during installation to prevent moisture ingress.

assembly and the nozzle airflow measuring apparatus.

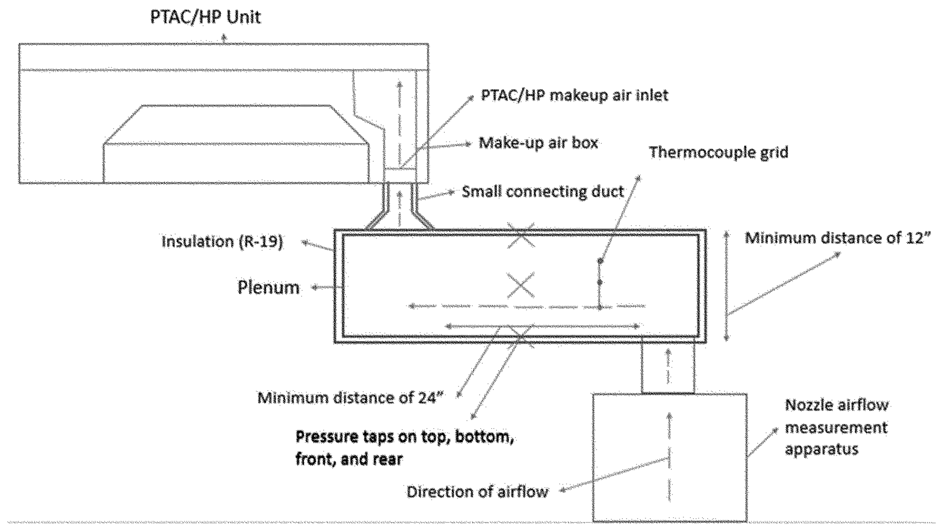

Figure III-2: Inlet Duct Assembly Setup for Make-up Air Dehumidification Test

DOE's proposal requires that the inlet plenum have interior dimensions of at least 12 inches high and at least 12 inches wide in the plane perpendicular to the air flow, and an interior dimension of at least 24 inches between the edges of the inlet and outlet ducts that are closest to each other. The inlet plenum would be insulated to prevent variance in the air temperature in the plenum as compared to the make-up air inlet. Nozzle airflow measuring apparatus as described in section 6.2 of ASHRAE 37–2009 in addition to an adjustable fan, would be used to adjust the inlet plenum pressure. The nozzle airflow measuring apparatus would take in outdoor room air and move it into the unit under test in a blow-through arrangement. Additionally, a transfer fan would transfer makeup air from the indoor room back to the outdoor room. The transfer fan would be adjustable to allow setting of the needed pressure differential when the target makeup air is passing through the test unit. Setting up of the 30 CFM make-up air flow rate would require adjustments of both the inlet plenum pressure and the transfer fan.

To measure the pressure differential between the outdoor room and the inlet air plenum, static pressure taps shall be placed at four locations around the inlet air plenum as shown in Figure III–2, and consistent with section 6.5 of ASHRAE 37–2009. The pressure taps would be manifolded together as indicated in section 6.5.3 of ASHRAE 37–2009. Temperature measurements of the outdoor inlet dry bulb and wet bulb temperatures would be made at the inlet of the nozzle airflow measurement apparatus, consistent with ASHRAE 16–2016.

Issue 16: DOE requests comment on the required make-up airflow rate of 30 CFM and the proposed test setup for the make-up inlet assembly.

c. Test Conditions and Measurements

DOE did not receive any comments regarding the test conditions for a dehumidification test. In the absence of any information, DOE considers that the standard test conditions used for DOE's current test procedure—80 °F/67 °F (dry-bulb/wet-bulb) in the conditioned space and 95 °F/6 °F (dry-bulb/dew point) for the outdoor entering air, are appropriate. These conditions ensure that the outdoor air would have a higher humidity ratio than the indoor air and would present the need for dehumidification. Table III.10 and Table III.11 set out the test conditions and tolerances.

TABLE III.10—DEHUMIDIFICATION TEST CONDITIONS

Air entering makeup air inlet temperatures (°F)		Air entering indoor side of unit temperature (°F)		Make-up air flow (scfm)
Dry bulb	Dew Point	Dry bulb	Wet bulb	
95	67	80	67	30

TABLE III.11—DEHUMIDIFICATION TEST TOLERANCES

Reading	Variation of arithmetic average from specified conditions (test condition tolerance)	Maximum observed range of readings (test operating tolerance)
Air entering makeup air inlet dry bulb (°F)	0.3	1.2
Dew point (°)	0.5	1.5
Add-on dehumidification system test:		
Air entering indoor side dry bulb (°)	3	5
Wet bulb (°)	3	5
Integrated dehumidification system test:		
Air entering indoor side dry bulb (°)	0.3	1.5
Wet bulb (°)	0.3	1.0
Makeup airflow (scfm)	1	
Makeup airflow Nozzle pressure drop (%)		5

The evaluation of dehumidification energy use requires the measurement of condensate removed by the make-up air unit and the power consumed during the operation *i.e.,* the liters of water removed per watt-hours (''Wh''). Moisture removal is part of the associated latent capacity of a PTAC/HP unit, and units which do not have make-up air capabilities also collect condensate. For most PTAC/HPs, the collected condensate is 'slung' back onto the condenser coils to provide an evaporative benefit and improve efficiency. Therefore, to collect and measure condensate that is strictly associated with the dehumidification portion of the make-up air unit, this slinging operation needs to be either bypassed or taken into account.

The two separate designs of make-up air PTAC/HPs discussed in section III.H.1 of this document necessitate different methodologies to measure dehumidification energy use. For systems that use an add-on dehumidifier, DOE's proposed test procedure requires isolating the add-on dehumidifier of the unit under test from the main refrigeration circuit, thereby also avoiding the slinging operation. This can be achieved by setting the unit thermostat to a high temperature setting, and if necessary, moving the sensor such that it is in sufficiently cool air to prevent main system start. A preliminary power measurement would be made with the PTAC/HP in fan-only mode or with the thermostat and fan controls set such that the indoor fan is energized, but the compressor and outdoor fan are not—this measurement would establish the background power to be subtracted from the test measurement including the dehumidifier operating. The unit is then operated at the test conditions mentioned previously and the thermostatic drain plug is removed to allow the collection and measurement of condensate—with measurements at intervals of no more than 10 minutes. Equilibrium test conditions would be maintained within tolerances shown in Table III.11 for not less than one hour before recording data for the test. The dehumidification test would then be conducted over a 1-hour period, with no parameter exceeding the allowable tolerances specified in Table III.11 of this document. Measurements of test conditions, input power and energy, and airflow are taken at least every 60 seconds and logged. The condensate is collected in a bucket placed on a scale with a mass measurement resolution of 1 gram. The collection bucket is covered to limit re-evaporation. This test will yield the value of collected condensate, $w_{d,add}$.

For systems that use an integrated dehumidifier, the measurement of dehumidification effciency would be based on a comparison of condensate collected and power consumed in a preliminary 'non-makeup air' test (*i.e.,* test without make-up air intake) and a 'make-up air' test (*i.e.,* test without make-up air intake).

For the 'non make-up air' test—the make-up airflow passage would be blocked, and to prevent use of the condensate for condenser cooling, the condensate will need to be drained before it reaches a level high enough for the slinger to spray it onto the condenser coil. Since this will affect performance by preventing the enhancement of condenser cooling, this test will be done at reduced outdoor air temperature conditions to compensate for the slinger de-activation. This would require measuring the average coil temperature during the A_{full} cooling test, using the temperature measuring setup in Figure III–2 of this document. For the 'non-make up air' test, the outdoor room dry bulb temperature will be reduced to a level for which the outdoor coil return bend temperature is within 0.5 °F of the temperature measured during the A_{full} test. The sensible and latent capacity would be measured as described in ASHRAE 16–2016, with condensate measurements at intervals of 10 minutes. When conditions have stabilized after a duration of 60 minutes, the performance test is conducted for a 60 minute test period. The test is considered valid when the energy balance requirements described in section 7 of ASHRAE 16–2016 have been met and the latent capacity calculated based on the condensate measurement is within 6 percent of the latent capacity measurement based on the psychrometric or calorimetric test method, whichever is used. This test will yield the value of collected condensate, $w_{d,pre.}$.

For the 'make-up air' test—the make-up airflow passage would be unblocked and will utilize the same reduced outdoor air temperature conditions, but to ensure a consistent comparison with other make-up systems (make-up air systems with add-on dehumidifiers), the incoming make-up air would need to be re-heated back to 95 °F. Part (or all) of this re-heating may be provided by the heat generated from the push-through code tester fan as depicted in Figure III–2 of this document. Supplemental re-heating may be required to provide the remaining re-heat. Similar to the 'non-make-up air test', a 60 minute stability period will be followed by a test duration of 60 minutes. The test is considered valid when the energy balance requirements are met. This test will yield the value of collected condensate, $w_{d,int}$.

The difference between the collected condensate for both tests: $w_{d,int.}$ and

$w_{d,pre.}$ and the difference between the power consumed in the two tests, will be evaluated to provide a measure of dehumidification efficiency for make-up air units with an integrated dehumidifier.

Issue 17: DOE requests comment on the proposed test conditions for the make-up air dehumidification test; specifically, whether the indoor air entering conditions, outdoor air entering conditions are appropriate.

Issue 18: DOE requests comment on its proposed test measurements and instructions for both make-up air system designs.

d. Metric

DOE is proposing that the dehumidification energy use for both designs of make-up air systems be measured using a separate metric, dehumidification efficiency (DE). DE is measured in liters per kWh, and is evaluated as a ratio of the collected condensate to energy consumed in dehumidification, as measured in section III.H.3.c of this document. DOE is proposing to define dehumidification efficiency of PTACs and PTHPs as follows:

Dehumidification Efficiency, or *DE,* means the quantity of water removed from the air divided by the energy consumed, measured in liters per kilowatt-hour (L/kWh).

DOE may as an alternative choose to integrate the dehumidification energy use of a make-up air unit with the cooling performance, by incorporating the liters per Wh into the SCP metric. DOE could implement such an integration by incorporating the capacity and power input impacts measured for the dehumidification test into the SCP. For each bin involved in the SCP calculation for which national-average humidity associated with the bin's dry bulb temperature represents more moisture than typical indoor humidity conditions, *e.g.,* associated with 75 °F dry-bulb temperature and 50 percent relative humidity conditions, the system would be assumed to be providing dehumidification at the capacity measured in the dehumidification test, with power input also as measured in the test. The additional thermal load associated with the dehumidification system's power input, less the latent capacity equivalent of the dehumidification, would be added to the cooling load for the bin to determine additional PTAC/HP primary cooling system energy use for the bin. Also, the measured dehumidification system's power input would be added to the PTAC/HP power input for the bin. The latent capacity associated with the measured dehumidification would also be added to the delivered cooling for the bin. Both delivered cooling and power input of these contributions would multiply by the bin hours, thus providing the integrated cooling and energy for the bin—by summing bin contributions for the cooling season, the calculations would in this way integrate the contributions to cooling and energy of the dehumidification system.

Issue 19: DOE requests comment on its proposed metric to evaluate dehumidification energy use.

Issue 20: DOE requests feedback on whether a separate metric is appropriate for evaluating dehumidification energy use, or whether dehumidification energy use should be integrated into the cooling metric. If integrated into the cooling metric, DOE requests comment on the approach outlined above to represent the dehumidification energy use.

I. Fan-Only Mode

The current DOE test procedures for PTACs and PTHPs do not address energy consumption during ''fan-only'' mode. In the May 2021 TP RFI, DOE described ''fan-only'' mode as a mode in which the fan is operating and providing ventilation or air circulation without active cooling or heating. 86 FR 28005, 28011.

In the May 2021 TP RFI DOE requested data and information related to the power consumption of PTAC and PTHP units during ''fan-only'' mode, specifically, whether the indoor and outdoor fans are powered by the same motor; whether the default fan control scheme dictates that the indoor fan cycles with the compressor or stays on; and whether the fan operates at a lower power if the fan remains on when the compressor cycles off. *Id.* DOE also requested data and information on the annual number of hours PTAC and PTHP units operate in ''fan-only'' mode. *Id.*

AHRI explained that power can be supplied to the indoor and outdoor fans using two different motors and both fans can be variable speed and operate at different set points given mode of operation and model type. (AHRI, No. 14 at p. 11) Alternately, AHRI noted that power can be supplied using a single motor operating both indoor and outdoor fans. *Id.* AHRI further explained that the indoor ''fan-only'' mode has two user-selectable speeds: high and low, and that the default settings for the indoor fan are to run continuously for cooling and to cycle for heating. *Id.* AHRI stated that there is no change in power consumption of the fan itself when running continuously compared to cycling with the compressor and there is no difference in fan speed during cooling, heating or ventilation operations. *Id.* AHRI did not provide any data regarding ''fan-only'' mode operating hours, but noted that it would be highly individualized to the individual staying in the hotel room. *Id.* They stated that the compressor is the dominant energy using component of a PTAC or PTHP and that many PTACs and PTHPs use brushless DC motors, which have comparatively low energy consumption. *Id.*

The Joint Advocates and NEEA encouraged DOE to capture energy use in fan-only mode. (Joint Advocates, No. 16 at p. 2 ; NEEA, No. 17 at p. 3) NEEA stated that product literature indicated that at least some PTACs and PTHPs utilize continuous fan operation in their primary mode *i.e.,* these units operate the fan any time the unit is on, regardless of whether the compressor is running. (NEEA, No. 17 at p. 3) NEEA stated that the number of fan hours spent in this mode have the potential to be significant, and this energy use should be captured by the test procedure. NEEA recommended that DOE conduct further research to determine the number of hours spent in fan-only mode and to include this energy use in the test procedure. *Id.*

To investigate the energy used during 'fan-only' mode, DOE reviewed literature for several PTAC/HPs and performed investigative testing on 2 single-speed PTHPs, running full-load and part-load cooling tests to evaluate the differences between running a unit with the indoor fan running continuously (''constant fan'' test) and running the indoor fan cycling with the compressor (''cycling fan'' test). The two tests were run at the same conditions and loads to provide a comparison. DOE's literature review agrees with AHRI's provided information that most PTAC/HPs have two user-selectable speeds: high and low, and that the default settings for the indoor fan is usually to run continuously for cooling and to cycle for heating. However, while DOE agrees with AHRI that there is no change in power consumption of the fan itself when running continuously compared to cycling with the compressor, DOE's investigative testing, which incorporated part-load cyclic tests, was able to conclude that the average total power consumed over several cycles was higher for the indoor fan when running in ''constant fan'' mode, as compared to when it was running on ''cycling fan'' mode. Consequently, the cooling efficiency (EER) observed for the constant fan tests were lower.

These test results suggest that PTAC/HPs may consume more energy when they are operating with the fan in continuous operation. However, DOE does not have enough information regarding the prevalence of use when only the fan is in operation, *i.e.,* number of annual hours spent in fan-only mode, as this is highly dependent on user preference and other factors. Further, DOE did not receive any comments that provided this information. Therefore, DOE is not proposing to measure energy use during fan-only mode. However, the evaluation of cooling and heating default degradation coefficients in section III.F.3 of this document are evaluated based on the cyclic testing data associated with the constant fan mode, as this presents the worst case for cycling losses.

J. Use of Psychrometric Testing

The current DOE test procedure for PTAC/HPs allow for cooling mode testing to be performed either in a calorimeter room per ASHRAE 16–1983 or by employing the indoor air enthalpy method per ANSI/ASHRAE 37–2009. The heating mode testing must be performed using ASHRAE 58–1986, which utilizes a psychrometric measurement.

In response to the May 2021 RFI, the CA IOUs recommended that DOE require testing in a calorimeter room for both cooling and heating mode. (CA IOUs, No. 15 at p. 3–4) The CA IOUs cited DOE's conclusion in the RAC rulemaking that testing done using the ANSI/ASHRAE 37 procedure for RACs did not provide repeatable data when compared to the calorimeter method and that, unlike the calorimeter, the air-enthalpy method did not accurately account for heat transfer within and through the unit chassis. *Id.* (*See* 86 FR 16446, 16461) The CA IOUs recommended that DOE either perform similar testing for PTAC/HPs or use the results from the RAC testing to only allow testing under ANSI/ASHRAE 16. *Id.*

DOE has in the past considered requiring calorimetric testing for all PTAC/HPs. In the test procedure NOPR published on March 13, 2014 (''March 2014 NOPR''), DOE proposed requiring that tests be conducted using the calorimetric method of ASHRAE 16, based on testing conducted using both methods which showed better performance using ASHRAE 16 than when using ASHRAE 37. 79 FR 14186, 14190–14191. However, DOE did not finalize such a requirement in the June 2015 TP final rule. DOE based this decision on feedback from commenters suggested that there would be additional burden if DOE were to require all testing to be performed calorimetrically, and data received from a commenter based on a more extensive series of tests that showed that the calorimetric and psychrometric test methods were comparable, contrary to DOE's test results. 80 FR 37136, 37141. Consequently, DOE did not eliminate the optional use of ANSI/ASHRAE 37–2009 to determine cooling capacity. *Id.* DOE notes that ASHRAE 16–2016 now allows for both calorimetric and psychrometric testing, indicating consensus of participants in the development of the updated test standard that the calorimeter and the psychrometric chamber provide comparable results. DOE more recently performed testing of a PTHP unit in cooling mode in both a calorimeter using methods in ASHRAE 16–1983, and in a psychrometric chamber using ASHRAE 37–2009, and found the results to be comparable. Regarding DOE's determination in the RAC rulemaking, it is not clear that the potential test inconsistency in that case would necessarily be an issue for PTAC/HPs, as it was specific to RACs. DOE notes that there are geometric differences and size differences between RACs and PTACs which can make recirculation of air from air discharge outlets to air inlets more likely for RACs than PTACs. This recirculation can occur on both the room side and the outdoor side. Such recirculation, which generally reduces a unit's performance, is blocked on the indoor side by use of ASHRAE 37–2009, due to ducting of the discharge air, but not when using the calorimetric method. Thus, DOE provisionally concludes that this issue would have a larger impact in the psychrometric testing of RACs as compared PTAC/HPs.

DOE is proposing to incorporate by reference ASHRAE 16–2016, which allows calorimetric and psychrometric testing for both heating and cooling mode tests. However, DOE welcomes additional data regarding the consistency of psychrometric and calorimetric tests for PTAC/HPs.

Issue 21: DOE requests data regarding the agreement of test results when testing PTAC/HPs using psychrometric test methods as opposed to calorimetric test methods.

K. Test Procedure Costs and Impact

In this NOPR, DOE proposes to amend the existing test procedure for PTACs and PTHPs by incorporating seasonal cooling and heating performance and establishing new cooling and heating metrices, SCP and SHP. DOE also proposes to include provisions to measure dehumidification energy use of make-up air PTAC/HPs.

DOE has tentatively determined that the proposed amendments in this NOPR would improve the representativeness, accuracy, and reproducibility of the test results and would not be unduly burdensome for manufacturers to conduct. Because the current DOE test procedure for PTAC/HPs would be relocated to appendix H without change, the proposed test procedure in appendix H for measuring EER and COP would result in no change in testing practices and thus result in no new burden or costs.

Should DOE adopt standards in a future energy conservation standards rulemaking in terms of the new metrics (SCP and SHP), the proposed test procedure in appendix H1 would be required. DOE has tentatively concluded that the proposed test procedure in appendix H1 for measuring SCP and SHP, would increase third-party lab testing costs per unit relative to the current DOE test procedure. DOE estimates the expected cost increase for physical testing to range from $5,100 to $15,300 per unit for the complete test, depending on the system configuration of the PTAC/HP unit (single-speed, two-speed or variable-speed). In addition to the increased costs due to required testing to determine SCP and SHP, make-up air PTAC/HPs may incur an additional cost of $3,000 if manufacturers chose to make dehumidification representations.

However, in accordance with 10 CFR 429.70, PTAC/HP manufacturers may elect to use AEDMs to rate models, which significantly reduces costs to industry. DOE estimates the per-manufacturer cost to develop and validate an AEDM for PTAC/HPs to be $25,200. DOE estimates a cost of approximately $50 [26] per basic model for determining energy efficiency using the validated AEDM. Both of these estimates reflect the costs for AEDM development based on the proposed appendix H1 procedure. Because DOE is not proposing any changes to appendix H that would affect current testing practices, there are no incremental costs

[26] DOE estimated initial costs to validate an AEDM assuming 80 hours of general time to develop an AEDM based on existing simulation tools and 16 hours to validate two basic models within that AEDM at the cost of an engineering technician wage of $50 per hour plus the cost of third-party physical testing of two units per validation class (as required in 10 CFR 429.70(c)(2)(iv)). DOE estimated the additional per basic model cost to determine efficiency using an AEDM, assuming 1 hour per basic model at the cost of an engineering technician wage of $50 per hour.

expected due to the proposed amendments to appendix H.

Issue 22: DOE requests comment on its understanding of the impact of the test procedure proposals in this NOPR, specifically DOE's estimates of the costs associated with testing using appendix H1 of this document.

L. Compliance Date

EPCA prescribes that, if DOE amends a test procedure, all representations of energy efficiency and energy use, including those made on marketing materials and product labels, must be made in accordance with that amended test procedure, beginning 360 days after publication of such a test procedure final rule in the **Federal Register**. (42 U.S.C. 6314(d)(1)) Representations related to energy consumption of PTACs and PTHPs must be made in accordance with the appropriate appendix that applies (*i.e.,* appendix H or appendix H1) when determining compliance with the relevant standard. DOE would not require that PTAC/HPs be tested according to the test procedure in the proposed appendix H1 until the compliance date of any future amended energy conservation standard that relies on the SCP and SHP metrics, should DOE adopt such standards. However, beginning 360 days after publication of a test procedure final rule finalizing appendix H1, any representations of dehumidification capacity and efficiency of make-up air PTAC/HPs must be made using the dehumidification test procedures in appendix H1.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866, 13563, and 14094

Executive Order (''E.O.'')12866, ''Regulatory Planning and Review,'' as supplemented and reaffirmed by E.O. 13563, ''Improving Regulation and Regulatory Review,'' 76 FR 3821 (Jan. 21, 2011) and E.O. 14094, ''Modernizing Regulatory Review,'' 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, to (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs (''OIRA'') in the Office of Management and Budget (''OMB'') has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this proposed regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit ''significant regulatory actions'' to OIRA for review. OIRA has determined that this proposed regulatory action does not constitute a ''significant regulatory action'' under section 3(f) of E.O. 12866. Accordingly, this action was not submitted to OIRA for review under E.O. 12866.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq.*) requires preparation of an initial regulatory flexibility analysis (''IRFA'') for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, ''Proper Consideration of Small Entities in Agency Rulemaking,'' 67 FR 53461 (August 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the DOE rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website: *www.energy.gov/gc/office-general-counsel.*

1. Description of Why Action Is Being Considered

DOE is proposing to amend the existing DOE test procedures for PTACs and PTHPs in satisfaction of the 7-year review requirement specified in EPCA. (42 U.S.C. 6314(a)(1)(A)(i)).

2. Objective of, and Legal Basis for, Rule

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317) Title III, Part C of EPCA, added by Public Law 95–619, Title IV, § 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. (42 U.S.C. 6311–6317) This equipment includes PTACs and PTHPs, the subjects of this document. (42 U.S.C. 6311(1)(J))

Further, if such an industry test procedure is amended, DOE must amend its test procedure to be consistent with the amended industry test procedure, unless DOE determines, by rule published in the **Federal Register** and supported by clear and convincing evidence, that such amended test procedure would not meet the requirements in 42 U.S.C. 6314(a)(2) and (3) related to representative use and test burden. (42 U.S.C. 6314(a)(4)(B))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered equipment, including PTACs and PTHPs, to determine whether amended test procedures would more accurately or fully comply with the requirements for the test procedures to not be unduly burdensome to conduct and be reasonably designed to produce test results that reflect energy efficiency, energy use, and estimated operating costs during a representative average use cycle. (42 U.S.C. 6146314(a)(1)(A))

3. Description and Estimate of Small Entities Regulated

For manufacturers of PTACs and PTHPs, the Small Business Administration (''SBA'') has set a size threshold, which defines those entities classified as ''small businesses'' for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. *See* 13 CFR part 121. The equipment covered by this rule are classified under North American Industry Classification System (''NAICS'') code 333415, ''Air-Conditioning and Warm Air Heating Equipment and Commercial and

Industrial Refrigeration Equipment Manufacturing.'' In 13 CFR 121.201, the SBA sets a threshold of 1,250 employees or fewer for an entity to be considered as a small business for this category. DOE identified twelve original equipment manufacturers (''OEMs'') of equipment covered by this rulemaking. DOE screened out companies that do not meet the definition of a ''small business'' or are foreign-owned and operated. Of the twelve OEMs, DOE identified one small, domestic OEM for consideration. DOE used subscription-based business information tools to determine headcount and revenue of the small business.

DOE relied on the CCMS Compliance Certification Database[27] to create a list of companies that manufacture equipment covered by this proposal.

4. Description and Estimate of Compliance Requirements

In the test procedure notice, DOE proposes to relocate the current DOE test procedure for PTACs and PTHPs to appendix H without change. This reorganization to the test procedure for measuring EER and COP would result in no change in testing practices and no cost to manufacturers.

Additionally, DOE is proposing to establish a new appendix H1 to subpart F of part 431. Appendix H1 would establish a new seasonal cooling performance metric (SCP) and a new seasonal heating performance metric (SHP) and the test procedure requirements for SCP and SHP. DOE also proposes to include provisions to measure dehumidification energy use of make-up air PTAC and PTHPs. Use of the proposed appendix H1 is not required and would not be required until the compliance date of amended energy conservation standards based on SCP and SHP, should DOE adopt such standards.

Should DOE adopt standards in a future energy conservation standards rulemaking in terms of the new metrics (SCP and SHP), the proposed test procedure in appendix H1 would be required. DOE has tentatively concluded that the proposed test procedure in appendix H1 for measuring SCP and SHP, would increase third-party lab testing costs per unit relative to the current DOE test procedure. DOE estimates the expected cost increase for physical testing to range from $5,100 to $15,300, depending on the system configuration of the PTAC/HP unit (single-speed, two-speed or variable-speed). In addition to the increased costs due to required testing to determine SCP and SHP, make-up air PTAC/HPs may incur an additional cost of $3,000 if manufacturers chose to make representations for dehumidification in terms of the DE metric. However, in accordance with 10 CFR 429.70, PTAC/HP manufacturers may elect to use AEDMs to rate models, which significantly reduces costs to industry. DOE estimates the per-manufacturer cost to develop and validate an AEDM for PTAC/HPs to be $25,200. DOE estimates a cost of approximately $50 per basic model for determining energy efficiency using the validated AEDM.

DOE estimates that developing an AEDM and re-rating all 219 basic models to new metrics would cost the identified small manufacturer approximately $40,000. DOE has tentatively determined that this amount would not constitute a significant economic impact on this small manufacturer. However, because these costs would only be incurred if DOE were to adopt a future energy conservation based on SCP and SHP metrics, the small manufacturer would incur no additional compliance costs as a direct result of this test procedure rulemaking. On this basis, DOE tentatively concludes that the proposed rule would not have a significant impact on a substantial number of small entities.

DOE has tentatively determined that the proposed amendments in this NOPR would improve the representativeness, accuracy, and reproducibility of the test results and would not be unduly burdensome for manufacturers to conduct.

Issue 23: DOE requests comment on the number of small OEMs identified. DOE also seeks comment the estimated costs the small manufacturer may incur.

5. Duplication Overlap, and Conflict With Other Rules and Regulations

DOE is not aware of any rules or regulations that duplicate, overlap, or conflict with the rule being considered today.

6. Significant Alternatives to the Rule

DOE proposes to reduce burden on manufacturers, including small businesses, by allowing AEDMs in lieu of physically testing all basic models. The use of an AEDM is less costly than physical testing of PTAC and PTHP models. Without AEDMs, DOE estimates the cost to physically test all PTAC and PTHP basic models for the identified small manufacturer to be approximately $2 million.

Additional compliance flexibilities may be available through other means. EPCA provides that a manufacturer whose annual gross revenue from all of its operations does not exceed $8 million may apply for an exemption from all or part of an energy conservation standard for a period not longer than 24 months after the effective date of a final rule establishing the standard. (42 U.S.C. 6295(t)) Additionally, manufacturers subject to DOE's energy efficiency standards may apply to DOE's Office of Hearings and Appeals for exception relief under certain circumstances. Manufacturers should refer to 10 CFR part 430, subpart E, and 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of PTAC/HPs must certify to DOE that their products comply with any applicable energy conservation standards. To certify compliance, manufacturers must first obtain test data for their products according to the DOE test procedures, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including PTAC/HPs. (*See generally* 10 CFR part 429.) The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act (''PRA''). This requirement has been approved by OMB under OMB control number 1910–1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

DOE is not proposing to amend the certification or reporting requirements for PTAC/HPs in this NOPR. Instead, DOE may consider proposals to amend the certification requirements and reporting for PTAC/HPs under a separate rulemaking regarding appliance and equipment certification. DOE will address changes to OMB Control Number 1910–1400 at that time, as necessary.

[27] U.S. Department of Energy Compliance Certification Database, available at: *www.regulations.doe.gov/certification-data/products.html.*

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

In this NOPR, DOE proposes test procedure amendments that it expects will be used to develop and implement future energy conservation standards for PTAC/HPs. DOE has determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 *et seq.*) and DOE's implementing regulations at 10 CFR part 1021. Specifically, DOE has determined that adopting test procedures for measuring energy efficiency of consumer products and industrial equipment is consistent with activities identified in 10 CFR part 1021, appendix A to subpart D, A5 and A6. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

E. Review Under Executive Order 13132

Executive Order 13132, ''Federalism,'' 64 FR 43255 (Aug. 4, 1999) imposes certain requirements on agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this proposed rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the products that are the subject of this proposed rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6297(d)) No further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

Regarding the review of existing regulations and the promulgation of new regulations, section 3(a) of Executive Order 12988, ''Civil Justice Reform,'' 61 FR 4729 (Feb. 7, 1996), imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. Section 3(b) of Executive Order 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation (1) clearly specifies the preemptive effect, if any, (2) clearly specifies any effect on existing Federal law or regulation, (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction, (4) specifies the retroactive effect, if any, (5) adequately defines key terms, and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of Executive Order 12988 requires Executive agencies to review regulations in light of applicable standards in sections 3(a) and 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, the proposed rule meets the relevant standards of Executive Order 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 (''UMRA'') requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Public Law 104–4, sec. 201 (codified at 2 U.S.C. 1531). For a proposed regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) The UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a proposed ''significant intergovernmental mandate,'' and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect small governments. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820; also available at *www.energy.gov/gc/office-general-counsel.* DOE examined this proposed rule according to UMRA and its statement of policy and determined that the rule contains neither an intergovernmental mandate, nor a mandate that may result in the expenditure of $100 million or more in any year, so these requirements do not apply.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105–277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This proposed rule would not have any impact on the autonomy or integrity of the family as an institution. Accordingly, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment.

I. Review Under Executive Order 12630

DOE has determined, under Executive Order 12630, ''Governmental Actions and Interference with Constitutionally Protected Property Rights'' 53 FR 8859 (March 18, 1988), that this proposed regulation would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516 note) provides for agencies to review most disseminations of information to the public under guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (Feb. 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M–19–15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf.* DOE has reviewed this proposed rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

Executive Order 13211, ''Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use,'' 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OMB, a Statement of Energy Effects for any proposed significant energy action. A ''significant energy action'' is defined as any action by an agency that promulgated or is expected to lead to promulgation of a final rule, and that (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

The proposed regulatory action to amend the test procedure for measuring the energy efficiency of PTAC/HPs is not a significant regulatory action under Executive Order 12866. Moreover, it would not have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as a significant energy action by the Administrator of OIRA. Therefore, it is not a significant energy action, and, accordingly, DOE has not prepared a Statement of Energy Effects.

L. Review Under Section 32 of the Federal Energy Administration Act of 1974

Under section 301 of the Department of Energy Organization Act (Pub. L. 95–91; 42 U.S.C. 7101), DOE must comply with section 32 of the Federal Energy Administration Act of 1974, as amended by the Federal Energy Administration Authorization Act of 1977. (15 U.S.C. 788; ''FEAA'') Section 32 essentially provides in relevant part that, where a proposed rule authorizes or requires use of commercial standards, the notice of proposed rulemaking must inform the public of the use and background of such standards. In addition, section 32(c) requires DOE to consult with the Attorney General and the Chairman of the Federal Trade Commission (''FTC'') concerning the impact of the commercial or industry standards on competition.

The proposed modifications to the test procedure for PTAC/HPs would incorporate testing methods contained in certain sections of the following commercial standards: AHRI 310/380–2017 and ASHRAE 16–2016. DOE has evaluated these standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the FEAA (*i.e.,* whether it was developed in a manner that fully provides for public participation, comment, and review.) DOE will consult with both the Attorney General and the Chairman of the FTC concerning the impact of these test procedures on competition, prior to prescribing a final rule.

M. Description of Materials Incorporated by Reference

In this NOPR, DOE proposes to incorporate by reference the following test standards:

AHRI 310/380–2017 is an industry-accepted test standard for measuring the performance of PTAC/HPs, and is an update of AHRI 310/380–2014. AHRI 310/380–2017 is available from AHRI at *www.ahrinet.org/search-standards.aspx.*

ANSI/ASHRAE 16–2016 is an industry-accepted test procedure that provides a calorimetric method for rating the cooling and heating capacity of room air conditioners and PTAC/HPs, and is an update of ANSI/ASHRAE 16–1983. ANSI/ASHRAE 16–2016 is available on ANSI's website at *webstore.ansi.org/standards/ashrae/ansiashraestandard162016.*

DOE proposes to maintain and update the incorporation by reference previously approved for the following test standards:

AHRI 310/380–2014 is an industry-accepted test standard for measuring the performance of PTAC/HPs. AHRI 310/380–2014 is available from AHRI at *www.ahrinet.org/search-standards.aspx.*

ANSI/ASHRAE 16–1983 (RA 2014) is an industry-accepted test procedure that provides a calorimetric method for rating the cooling and heating capacity of room air conditioners and PTAC/HPs. ANSI/ASHRAE 16–1983 (RA 2014) is available on ANSI's website at *https://webstore.ansi.org/standards/ashrae/ansiashraestandard161983r2014.*

ANSI/ASHRAE 58–1986 (RA 2014) is an industry-accepted test procedure that provides a psychometric method for rating the cooling and heating capacity of air conditioning and heating equipment. ANSI/ASHRAE 58–1986 (RA 2014) is available on ANSI's website at *webstore.ansi.org/standards/ashrae/ansiashraestandard581986r2014.*

ANSI/ASHRAE 37–2009 is an industry-accepted test procedure that provides methods for determining cooling or heating capacities of several categories of air conditioning and heating equipment. ANSI/ASHRAE 37–2009 is available on ANSI's website at *webstore.ansi.org/standards/ashrae/ansiashrae372009r2019.*

The following standards included in the proposed regulatory text were previously approved for incorporation by reference for the locations in which they appear in this proposed rule: AHRI 210/240–2008, AHRI 340/360–2007, and ISO Standard 13256–1.

V. Public Participation

A. Attendance at the Public Meeting

The time, date, and location of the public meeting are listed in the **DATES** and **ADDRESSES** sections at the beginning of this document. If you plan to attend the public meeting, please notify the Appliance and Equipment Standards staff at (202) 287–1445 or *Appliance_Standards_Public_Meetings@ee.doe.gov.*

Please note that foreign nationals visiting DOE Headquarters are subject to advance security screening procedures which require advance notice prior to attendance at the public meeting. If a foreign national wishes to participate in the public meeting, please inform DOE of this fact as soon as possible by contacting Ms. Regina Washington at (202) 586–1214 or by email (*Regina.Washington@ee.doe.gov*) so that the necessary procedures can be completed.

DOE requires visitors to have laptops and other devices, such as tablets, checked upon entry into the Forrestal Building. Any person wishing to bring these devices into the building will be required to obtain a property pass. Visitors should avoid bringing these devices, or allow an extra 45 minutes to check in. Please report to the visitor's desk to have devices checked before proceeding through security.

Due to the REAL ID Act implemented by the Department of Homeland Security (''DHS''), there have been recent changes regarding ID requirements for individuals wishing to enter Federal buildings from specific States and U.S. territories. DHS maintains an updated website identifying the State and territory driver's licenses that currently are acceptable for entry into DOE facilities at *www.dhs.gov/real-id-enforcement-*

brief. A driver's licenses from a State or territory identified as not compliant by DHS will not be accepted for building entry and one of the alternate forms of ID listed below will be required. Acceptable alternate forms of Photo-ID include U.S. Passport or Passport Card; an Enhanced Driver's License or Enhanced ID-Card issued by States and territories as identified on the DHS website (Enhanced licenses issued by these States and territories are clearly marked Enhanced or Enhanced Driver's License); a military ID or other Federal government-issued Photo-ID card.

In addition, you can attend the public meeting via webinar. Webinar registration information, participant instructions, and information about the capabilities available to webinar participants will be published on DOE's website at *https://www.energy.gov/eere/buildings/public-meetings-and-comment-deadlines.* Participants are responsible for ensuring their systems are compatible with the webinar software.

B. Procedure for Submitting Prepared General Statements for Distribution

Any person who has plans to present a prepared general statement may request that copies of his or her statement be made available at the public meeting. Such persons may submit requests, along with an advance electronic copy of their statement in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format, to the appropriate address shown in the **ADDRESSES** section at the beginning of this document. The request and advance copy of statements must be received at least one week before the public meeting and are to be emailed. Please include a telephone number to enable DOE staff to make follow-up contact, if needed.

C. Conduct of the Public Meeting

DOE will designate a DOE official to preside at the public meeting and may also use a professional facilitator to aid discussion. The meeting will not be a judicial or evidentiary-type public hearing, but DOE will conduct it in accordance with section 336 of EPCA. (42 U.S.C. 6306) A court reporter will be present to record the proceedings and prepare a transcript. DOE reserves the right to schedule the order of presentations and to establish the procedures governing the conduct of the public meeting. There shall not be discussion of proprietary information, costs or prices, market share, or other commercial matters regulated by U.S. anti-trust laws. After the public meeting, interested parties may submit further comments on the proceedings, as well as on any aspect of the rulemaking, until the end of the comment period.

The public meeting will be conducted in an informal, conference style. DOE will present a general overview of the topics addressed in this rulemaking, allow time for prepared general statements by participants, and encourage all interested parties to share their views on issues affecting this rulemaking. Each participant will be allowed to make a general statement (within time limits determined by DOE), before the discussion of specific topics. DOE will allow, as time permits, other participants to comment briefly on any general statements.

At the end of all prepared statements on a topic, DOE will permit participants to clarify their statements briefly. Participants should be prepared to answer questions by DOE and by other participants concerning these issues. DOE representatives may also ask questions of participants concerning other matters relevant to this proposed rulemaking. The official conducting the public meeting will accept additional comments or questions from those attending, as time permits. The presiding official will announce any further procedural rules or modification of the previous procedures that may be needed for the proper conduct of the public meeting.

A transcript of the public meeting will be included in the docket, which can be viewed as described in the *Docket* section at the beginning of this document and will be accessible on the DOE website. In addition, any person may buy a copy of the transcript from the transcribing reporter.

D. Submission of Comments

DOE will accept comments, data, and information regarding this proposed rule no later than the date provided in the **DATES** section at the beginning of this proposed rule.[28] Interested parties may submit comments using any of the methods described in the **ADDRESSES** section at the beginning of this document.

Submitting comments via www.regulations.gov. The *www.regulations.gov* web page will require you to provide your name and contact information. Your contact information will be viewable to DOE Building Technologies staff only. Your contact information will not be publicly viewable except for your first and last names, organization name (if any), and submitter representative name (if any). If your comment is not processed properly because of technical difficulties, DOE will use this information to contact you. If DOE cannot read your comment due to technical difficulties and cannot contact you for clarification, DOE may not be able to consider your comment.

However, your contact information will be publicly viewable if you include it in the comment or in any documents attached to your comment. Any information that you do not want to be publicly viewable should not be included in your comment, nor in any document attached to your comment. Persons viewing comments will see only first and last names, organization names, correspondence containing comments, and any documents submitted with the comments.

Do not submit to *www.regulations.gov* information for which disclosure is restricted by statute, such as trade secrets and commercial or financial information (hereinafter referred to as Confidential Business Information (''CBI'')). Comments submitted through *www.regulations.gov* cannot be claimed as CBI. Comments received through the website will waive any CBI claims for the information submitted. For information on submitting CBI, see the Confidential Business Information section.

DOE processes submissions made through *www.regulations.gov* before posting. Normally, comments will be posted within a few days of being submitted. However, if large volumes of comments are being processed simultaneously, your comment may not be viewable for up to several weeks. Please keep the comment tracking number that *www.regulations.gov* provides after you have successfully uploaded your comment.

Submitting comments via email. Comments and documents submitted

[28] DOE has historically provided a 75-day comment period for test procedure NOPRs pursuant to the North American Free Trade Agreement, U.S.-Canada-Mexico (''NAFTA''), Dec. 17, 1992, 32 I.L.M. 289 (1993); the North American Free Trade Agreement Implementation Act, Public Law 103–182, 107 Stat. 2057 (1993) (codified as amended at 10 U.S.C.A. 2576) (1993) (''NAFTA Implementation Act''); and Executive Order 12889, ''Implementation of the North American Free Trade Agreement,'' 58 FR 69681 (Dec. 30, 1993). However, on July 1, 2020, the Agreement between the United States of America, the United Mexican States, and the United Canadian States (''USMCA''), Nov. 30, 2018, 134 Stat. 11 (*i.e.,* the successor to NAFTA), went into effect, and Congress's action in replacing NAFTA through the USMCA Implementation Act, 19 U.S.C. 4501 *et seq.* (2020), implies the repeal of E.O. 12889 and its 75-day comment period requirement for technical regulations. Thus, the controlling laws are EPCA and the USMCA Implementation Act. Consistent with EPCA's public comment period requirements for consumer products, the USMCA only requires a minimum comment period of 60 days. Consequently, DOE now provides a 60-day public comment period for test procedure NOPRs.

via email also will be posted to *www.regulations.gov.* If you do not want your personal contact information to be publicly viewable, do not include it in your comment or any accompanying documents. Instead, provide your contact information on a cover letter. Include your first and last names, email address, telephone number, and optional mailing address. The cover letter will not be publicly viewable as long as it does not include any comments.

Include contact information each time you submit comments, data, documents, and other information to DOE. No faxes will be accepted.

Comments, data, and other information submitted to DOE electronically should be provided in PDF (preferred), Microsoft Word or Excel, WordPerfect, or text (ASCII) file format. Provide documents that are not secured, written in English and free of any defects or viruses. Documents should not contain special characters or any form of encryption and, if possible, they should carry the electronic signature of the author.

Campaign form letters. Please submit campaign form letters by the originating organization in batches of between 50 to 500 form letters per PDF or as one form letter with a list of supporters' names compiled into one or more PDFs. This reduces comment processing and posting time.

Confidential Business Information. Pursuant to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email two well-marked copies: one copy of the document marked confidential including all the information believed to be confidential, and one copy of the document marked non-confidential with the information believed to be confidential deleted. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

It is DOE's policy that all comments may be included in the public docket, without change and as received, including any personal information provided in the comments (except information deemed to be exempt from public disclosure).

E. Issues on Which DOE Seeks Comment

Although DOE welcomes comments on any aspect of this proposal, DOE is particularly interested in receiving comments and views of interested parties concerning the following issues:

Issue 1: DOE requests comment on its proposed A (95 °F), B (82 °F) and C (75 °F) test conditions to represent reduced cooling conditions experienced by PTACs and PTHPs in the field.

Issue 2: DOE requests comment on whether setting the unit thermostat down to 75 °F (*i.e.,* a 5 °F differential to the indoor condition of 80 °F) is sufficient to ensure that the compressor runs at full speed. DOE requests comment on whether manufacturers will be able to provide override instructions to ensure operation at the low and intermediate compressor speeds.

Issue 3: DOE requests comment on whether fan speed may vary with staging and whether it may have to be ''fixed'' at the right speed.

Issue 4: DOE requests comment on its proposed cooling tests for single-speed, two-speed and variable-speed compressor systems.

Issue 5: DOE requests comment on its proposed value of the cooling and heating degradation coefficients.

Issue 6: DOE requests comment on its proposed approach to calculate SCP using a similar binned analysis as that of SEER2. DOE also requests comment on the proposed cooling building load line; specifically, whether an equal weighting of the small hotel and midrise apartment use cases is appropriate.

Issue 7: DOE requests comment on its proposed temperature bins and associated fractional bin hours for cooling.

Issue 8: DOE requests comment on its proposed H1 (47 °F), H3 (17 °F) or HL and H4 (5 °F) test conditions to represent different heating outdoor conditions experienced by PTACs and PTHPs in the field.

Issue 9: DOE requests comment on whether setting the unit thermostat up to 75 °F (*i.e.,* a 5 °F differential to the indoor condition of 70 °F) is sufficient to ensure that the compressor runs at full speed for heating mode.

Issue 10: DOE requests comment on its proposed heating tests for single-speed, two-speed and variable-speed compressor systems.

Issue 11: DOE requests comment on its proposed method to evaluate cut-out and cut-in temperatures.

Issue 12: DOE requests comment on its proposed defrost adjustment coefficients; specifically, DOE requests feedback on its approach to use appendix M1 to inform the adjustment values for performance at 35 °F. DOE requests data on defrost degradation particular to PTHPs.

Issue 13: DOE requests comment on its proposed approach to calculate SHP using a similar binned analysis as that of HSPF2. DOE also requests comment on the proposed heating building load line; specifically, whether an equal weighting of the small hotel and midrise apartment use cases is appropriate.

Issue 14: DOE requests comment on its proposed temperature bins and associated fractional bin hours for heating.

Issue 15: DOE requests comment on its proposed definitions for make-up air PTAC, make-up air PTHP, add-on dehumidifier and integrated dehumidifier.

Issue 16: DOE requests comment on the required make-up airflow rate of 30 CFM and the proposed test setup to ensure this make-up airflow rate.

Issue 17: DOE requests comment on the proposed test conditions for the make-up air dehumidification test; specifically, whether the indoor air entering conditions, outdoor air entering conditions are appropriate.

Issue 18: DOE requests comment on its proposed test measurements and instructions for both make-up air system designs.

Issue 19: DOE requests comment on its proposed metric to evaluate dehumidification energy use.

Issue 20: DOE requests feedback on whether a separate metric is appropriate for evaluating dehumidification energy use, or whether dehumidification energy use be integrated into the cooling metric. If integrated into the cooling metric, DOE requests comment on the approach outlined above to represent the dehumidification energy use.

Issue 21: DOE requests data addressing potential inconsistency of test results when testing PTAC/HPs using psychrometric test methods as opposed to calorimetric test methods.

Issue 22: DOE requests comment on its understanding of the impact of the test procedure proposals in this NOPR, specifically DOE's estimates of the costs associated with testing using appendix H1 of this document.

Issue 23: DOE requests comment on the number of small OEMs identified. DOE also seeks comment on the estimated costs the small manufacturer may incur.

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this notice of proposed rulemaking and request for comment.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Intergovernmental relations, Reporting and recordkeeping requirements, Small businesses.

10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation test procedures, Incorporation by reference, Reporting and recordkeeping requirements.

Signing Authority

This document of the Department of Energy was signed on April 21, 2023, by Francisco Alejandro Moreno, Acting Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the **Federal Register**.

Signed in Washington, DC, on April 24, 2023.

Treena V. Garrett,

Federal Register Liaison Officer, U.S. Department of Energy.

For the reasons stated in the preamble, DOE is proposing to amend parts 429 and 431 of Chapter II of Title 10, Code of Federal Regulations as set forth below:

PART 429—CERTIFICATION, COMPLIANCE, AND ENFORCEMENT FOR CONSUMER PRODUCTS AND COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 1. The authority citation for part 429 continues to read as follows:

Authority: 42 U.S.C. 6291–6317; 28 U.S.C. 2461 note.

■ 2. Amend § 429.43 by revising paragraph (a)(1)(iii) to read as follows:

§ 429.43 Commercial heating, ventilating, air conditioning (HVAC) equipment (excluding air-cooled, three-phase, small commercial package air conditioning and heating equipment with a cooling capacity of less than 65,000 British thermal units per hour and air-cooled, three-phase, variable refrigerant flow multi-split air conditioners and heat pumps with less than 65,000 British thermal units per hour cooling capacity).

(a) * * *

(1) * * *

(iii) Packaged terminal air conditioners and packaged terminal heat pumps.

(A) The represented value of cooling capacity shall be the average of the capacities measured for the sample selected as described in paragraph (a)(1)(ii) of this section, rounded to the nearest 100 Btu/h.

(B) For make-up air PTACs and PTHPs, the represented value of dehumidification capacity will be the average of the capacities measured for the sample selected as described in paragraph (a)(1)(ii) of this section, rounded to the nearest 0.01 liters/hr.

(C) For make-up air PTACs and PTHPs, the represented value of dehumidification efficiency (DE) will be the average of the DE values measured for the sample selected as described in paragraph (a)(1)(ii) of this section, rounded to the nearest 0.01 liters/kWh.

* * * * *

■ 3. Amend § 429.70 by revising table 2 to paragraph (c)(5)(vi)(B) to read as follows:

§ 429.70 Alternative methods for determining energy efficiency and energy use.

* * * * *

(c) * * *

(5) * * *

(vi) * * *

(B) * * *

TABLE 2 TO PARAGRAPH (c)(5)(vi)(B)

Equipment	Metric	Applicable tolerance
Commercial Packaged Boilers	Combustion Efficiency	5% (0.05)
	Thermal Efficiency	5% (0.05)
Commercial Water Heaters or Hot Water Supply Boilers	Thermal Efficiency	5% (0.05)
	Standby Loss	10% (0.1)
Unfired Storage Tanks	R-Value	10% (0.1)
Air-Cooled, Split and Packaged ACs and HPs Greater than or Equal to 65,000 Btu/h Cooling Capacity and Less than 760,000 Btu/h Cooling Capacity.	Energy Efficiency Ratio	5% (0.05)
	Coefficient of Performance	5% (0.05)
	Integrated Energy Efficiency Ratio	10% (0.1)
Water-Cooled, Split and Packaged ACs and HPs, All Cooling Capacities.	Energy Efficiency Ratio	5% (0.05)
	Coefficient of Performance	5% (0.05)
	Integrated Energy Efficiency Ratio	10% (0.1)
Evaporatively-Cooled, Split and Packaged ACs and HPs, All Capacities	Energy Efficiency Ratio	5% (0.05)
	Coefficient of Performance	5% (0.05)
	Integrated Energy Efficiency Ratio	10% (0.1)
Water-Source HPs, All Capacities	Energy Efficiency Ratio	5% (0.05)
	Coefficient of Performance	5% (0.05)
	Integrated Energy Efficiency Ratio	10% (0.1)
Single Package Vertical ACs and HPs	Energy Efficiency Ratio	5% (0.05)
	Coefficient of Performance	5% (0.05)
Packaged Terminal ACs and HPs	Energy Efficiency Ratio	5% (0.05)
	Coefficient of Performance	5% (0.05)
	Seasonal Cooling Performance	10% (0.1)
	Seasonal Heating Performance	10% (0.1)
	Dehumidification Efficiency	10% (0.1)
Variable Refrigerant Flow ACs and HPs (Excluding Air-Cooled, Three-phase with Less than 65,000 Btu/h Cooling Capacity).	Energy Efficiency Ratio	5% (0.05)
	Coefficient of Performance	5% (0.05)
	Integrated Energy Efficiency Ratio	10% (0.1)
Computer Room Air Conditioners	Sensible Coefficient of Performance	5% (0.05)
Direct Expansion-Dedicated Outdoor Air Systems	Integrated Seasonal Coefficient of Performance 2	10% (0.1)
	Integrated Seasonal Moisture Removal Efficiency 2	10% (0.1)

TABLE 2 TO PARAGRAPH (c)(5)(vi)(B)—Continued

Equipment	Metric	Applicable tolerance
Commercial Warm-Air Furnaces	Thermal Efficiency	5% (0.05)
Commercial Refrigeration Equipment	Daily Energy Consumption	5% (0.05)

* * * * *

PART 431—ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

■ 4. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C 6291–6317; 28 U.S.C 2461 note.

■ 5. Amend § 431.92 by adding, in alphabetical order, definitions for ''Dehumidification efficiency'', ''Make-up air PTAC'', ''Make-up air PTHP'', ''Seasonal cooling performance'' and ''Seasonal heating performance'' to read as follows:

§ 431.92 Definitions concerning commercial air conditioners and heat pumps.

* * * * *

Dehumidification efficiency, or *DE,* means the ratio of water removed from the air by the energy consumed, measured in liters per kilowatt-hour (L/kWh).

* * * * *

Make-up air PTAC means a PTAC for which a portion of the total airflow is drawn in from the outside of the conditioned space and in which this outside air passes through a dehumidifying or cooling coil, either before or after mixing with the air drawn into the unit from inside the conditioned space, but before being discharged from the unit.

Make-up air PTHP means a PTHP for which a portion of the total airflow is drawn in from outside the conditioned space and in which this outside air passes through a dehumidifying or cooling coil, either before or after mixing with the air drawn into the unit from inside the conditioned space, but before being discharged from the unit.

* * * * *

Seasonal cooling performance or *SCP* means the total heat removed from the conditioned space during the cooling season, expressed in Btu's, divided by the total electrical energy consumed by the package terminal air conditioner or heat pump during the same season, expressed in watt-hours. SCP is determined in accordance with appendix H1.

* * * * *

Seasonal heating performance or *SHP* means the total heat added to the conditioned space during the heating season, expressed in Btu's, divided by the total electrical energy consumed by the package terminal air conditioner or heat pump during the same season, expressed in watt-hours. SHP is determined in accordance with appendix H1.

* * * * *

■ 6. Amend § 431.95 by:

■ a. Redesignating paragraphs (b)(4) through (9) as paragraphs (b)(5) through (10);

■ b. Adding paragraph (b)(4);

■ c. Revising paragraph (c)(1);

■ d. Redesignating paragraphs (c)(2) through (8) as paragraphs (c)(3) through (9);

■ e. Adding paragraph (c)(2);

■ f. In newly redesignated paragraph (c)(3), removing the words ''and G1'' and adding in its place, the words ''and G1, H and H1''; and

■ g. In newly redesignated paragraph (c)(7), removing the text ''§ 431.96'' and adding in its place, the text ''§ 431.96 and appendix H to this subpart''.

The additions and revision read as follows:

§ 431.95 Materials incorporated by reference.

* * * * *

(b) * * *

(4) AHRI Standard 310/380–2017 (''AHRI 310/380–2017''), ''Packaged Terminal Air-Conditioners and Heat Pumps,'' July 2017; IBR approved for appendices H and H1 to this subpart.

* * * * *

(c) * * *

(1) ANSI/ASHRAE Standard 16–1983 (RA 2014), (''ANSI/ASHRAE 16–1983''), ''Method of Testing for Rating Room Air Conditioners and Packaged Terminal Air Conditioners,'' ASHRAE reaffirmed July 3, 2014, IBR approved for appendix H to this subpart.

(2) ANSI/ASHRAE Standard 16–2016, (''ANSI/ASHRAE 16–2016''), ''Method of Testing for Rating Room Air Conditioners, Packaged Terminal Air Conditioners, and Packaged Terminal Heat Pumps for Cooling and Heating Capacity,'' November 2016, IBR approved for appendix H1 to this subpart.

* * * * *

■ 7. Amend § 431.96 by:

■ a. Removing paragraph (b)(2);

■ b. Revising table 1 to paragraph (b); and

■ c. Removing paragraph (g).

The revisions read as follows:

§ 431.96 Uniform test method for the measurement of energy efficiency of commercial air conditioners and heat pumps.

* * * * *

(b) * * *

TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
Small Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled, 3-Phase, AC and HP.	<65,000 Btu/h	SEER and HSPF	Appendix F to this subpart [3].	None.
			SEER2 and HSPF2.	Appendix F1 to this subpart [3].	None.
	Air-Cooled AC and HP	≥65,000 Btu/h and <135,000 Btu/h.	EER, IEER, and COP	Appendix A of this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	<65,000 Btu/h	EER	AHRI 210/240–2008 (omit section 6.5).	Paragraphs (c) and (e).
		≥65,000 Btu/h and <135,000 Btu/h.	EER	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
	Water-Source HP	<135,000 Btu/h	EER and COP	ISO Standard 13256–1	Paragraph (e).

TABLE 1 TO PARAGRAPH (b)—TEST PROCEDURES FOR COMMERCIAL AIR CONDITIONERS AND HEAT PUMPS—Continued

Equipment type	Category	Cooling capacity or moisture removal capacity [2]	Energy efficiency descriptor	Use tests, conditions, and procedures [1] in	Additional test procedure provisions as indicated in the listed paragraphs of this section
Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP	≥135,000 Btu/h and <240,000 Btu/h.	EER, IEER and COP	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	≥135,000 Btu/h and <240,000 Btu/h.	EER.	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
Very Large Commercial Package Air-Conditioning and Heating Equipment.	Air-Cooled AC and HP	≥240,000 Btu/h and <760,000 Btu/h.	EER, IEER and COP	Appendix A to this subpart.	None.
	Water-Cooled and Evaporatively-Cooled AC.	≥240,000 Btu/h and <760,000 Btu/h.	EER.	AHRI 340/360–2007 (omit section 6.3).	Paragraphs (c) and (e).
Packaged Terminal Air Conditioners and Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	Appendix H to this subpart [3].	None.
	AC and HP.	<760,000 Btu/h.	SCP and SHP.	Appendix H1 to this subpart [3].	None.
Computer Room Air Conditioners.	AC	<760,000 Btu/h	SCOP	Appendix E to this subpart [3].	None.
		<760,000 Btu/h	NSenCOP	Appendix E1 to this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems.	AC	<65,000 Btu/h (3-phase)	SEER	Appendix F to this subpart [3].	None.
			SEER2	Appendix F1 to this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	HP	<65,000 Btu/h (3-phase)	SEER and HSPF	Appendix F to this subpart [3].	None.
			SEER2 and HSPF2.	Appendix F1 to this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Air-cooled.	AC and HP	≥65,000 Btu/h and <760,000 Btu/h.	EER and COP	Appendix D of this subpart [3].	None.
		≥65,000 Btu/h and <760,000 Btu/h.	IEER and COP.	Appendix D1 of this subpart [3].	None.
Variable Refrigerant Flow Multi-split Systems, Water-source.	HP	<760,000 Btu/h	EER and COP	Appendix D of this subpart [3].	None.
		<760,000 Btu/h.	IEER and COP.	Appendix D1 of this subpart [3].	None.
Single Package Vertical Air Conditioners and Single Package Vertical Heat Pumps.	AC and HP	<760,000 Btu/h	EER and COP	Appendix G to this subpart [3].	None.
			EER, IEER, and COP.	Appendix G1 to this subpart [3].	None.
Direct Expansion-Dedicated Outdoor Air Systems.	All	<324 lbs. of moisture removal/hr.	ISMRE2 and ISCOP2	Appendix B of this subpart.	None.

[1] Incorporated by reference; see § 431.95.
[2] Moisture removal capacity applies only to direct expansion-dedicated outdoor air systems.
[3] For equipment with multiple appendices listed in table 1, consult the notes at the beginning of those appendices to determine the applicable appendix to use for testing.

* * * * *

■ 8. Add appendix H to subpart F of part 431 to read as follows:

Appendix H to Subpart F of Part 431—Uniform Test Method for Measuring the Energy Consumption of Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps

Note: Manufacturers must use the results of testing under this appendix to determine compliance with the relevant standard from § 431.97 as that standard appeared in the January 1, 2022 edition of 10 CFR parts 200–499. Specifically, representations must be based upon results generated either under this appendix H or under 10 CFR 431.96 as it appeared in the 10 CFR parts 200–499 edition revised as of January 1, 2022.

For any amended standards for packaged terminal air conditioners and packaged terminal heat pumps that rely on seasonal cooling performance (SCP) and seasonal heating performance (SHP) published after January 1, 2022, manufacturers must use the results of testing under appendix H1 of this subpart to determine compliance. Representations related to energy consumption must be made in accordance with the appropriate appendix that applies (*i.e.,* appendix H or appendix H1) when determining compliance with the relevant standard.

1. Incorporation by Reference

DOE incorporated by reference in § 431.95, the entire standard for AHRI 310/380–2017, ANSI/ASHRAE 16–1983, ANSI/ASHRAE 37–2009, and ANSI/ASHRAE 58–1986. However, only enumerated provisions of AHRI 310/380–2017, ANSI/ASHRAE 16–1983, ANSI/ASHRAE 37–2009, and ANSI/ASHRAE 58–1986, as listed in this section 1.1 are required. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

1.1 AHRI 310/380–2017

(a) Section 3—Definitions and Table 1—Operating Conditions for Standard Rating and Performance Tests, as referenced in sections 2.1 and 2.2 of this appendix;

(b) Section 4—Test Requirements, as referenced in sections 2.1, 2.1.2 and 2.2 of this appendix;

(c) Section 5—Rating Requirements, as referenced in section 2.2 of this appendix.

1.2 ANSI/ASHRAE 16–1983

(a) Section 2—Definitions, as referenced in section 2.1.1 of this appendix;

(b) Section 4—Calorimeters, as referenced in section 2.1.1 of this appendix;

(c) Section 5—Instruments, as referenced in section 2.1.1 of this appendix;

(d) Section 6—Cooling Capacity Test, as referenced in section 2.1.1 of this appendix;

(e) Section 7.2—Nozzles, as referenced in section 2.1.1 of this appendix;

(f) Section 7.3—Apparatus, as referenced in section 2.1.1 of this appendix;

(g) Section 7.5—Ventilation, Exhaust, and Leakage Airflow Measurement, as referenced in section 2.1.1 of this appendix;

1.3 ANSI/ASHRAE 58–1986

(a) Section 3—Definitions, as referenced in section 2.2 of this appendix;

(b) Section 5—Instruments, as referenced in section 2.2 of this appendix;

(c) Section 6—Apparatus, as referenced in section 2.2 of this appendix;

(d) Section 7—Test Procedures, as referenced in section 2.2 of this appendix;

(e) Section 8—Data to be Recorded, as referenced in section 2.2 of this appendix;

(f) Section 9—Calculation of Test Results, as referenced in section 2.2 of this appendix;

1.4 ANSI/ASHRAE 37–2009

(a) Section 3—Definitions, as referenced in section 2.1.2 of this appendix;
(b) Section 5—Instruments, as referenced in section 2.1.2 of this appendix;
(c) Section 6—Airflow and Air Differential Pressure Measurement Apparatus, as referenced in section 2.1.2 of this appendix;
(d) Section 7—Methods of Testing and Calculation, as referenced in section 2.1.2 of this appendix;
(e) Section 8—Test Procedures, as referenced in section 2.1.2 of this appendix;
(f) Section 9—Data to be Recorded, as referenced in section 2.1.2 of this appendix; and
(g) Section 11—Symbols Used in Equations, as referenced in section 2.1.2 of this appendix.

2. Test Method

2.1 Cooling Mode Testing

The test method for testing packaged terminal air conditioners and packaged terminal heat pumps in cooling mode shall consist of application of the methods and conditions in AHRI 310/380–2017 sections 3, 4, and, and in the enumerated sections of the following test standards, depending on the cooling mode test standard utilized.

2.1.1 Calorimetric Test Method

The calorimetric test method shall consist of application of the methods and conditions in ANSI/ASHRAE 16–1983, sections 2, 4, 5, 6, 7.2, 7.3, and 7.5.

2.1.2 Psychrometric Test Method

The psychrometric test method shall consist of application of the methods and conditions in ANSI/ASHRAE 37–2009, sections 3, 5, 6, 7, 8, 9, and 11, subject to the requirement of AHRI 310/380–2017, section 4.2.1.1(b) indicating that no secondary capacity check is required and no ductwork shall be attached to the condenser.

2.2 Heating Mode Testing

The test method for testing packaged terminal heat pumps in heating mode shall consist of application of the methods and conditions in AHRI 310/380–2017 sections 3, 4, and 5, and in ANSI/ASHRAE 58–1986, sections 3, 5, 6, 7, 8 and 9.

2.3 Precedence

Where definitions provided in AHRI 310/380–2017, ANSI/ASHRAE 16–1983, ANSI/ASHRAE 37–2009 and/or ANSI/ASHRAE 58–1986 conflict with the definitions provided in 10 CFR 431.92, the 10 CFR 431.92 definitions shall be used.

■ 9. Add appendix H1 to subpart F of part 431 to read as follows:

Appendix H1 to Subpart F of Part 431—Uniform Test Method for Measuring the Energy Consumption of Packaged Terminal Air Conditioners and Packaged Terminal Heat Pumps

Note: Manufacturers must use the results of testing under this appendix to determine compliance with any amended standards for packaged terminal air conditioners and packaged terminal heat pumps provided in § 431.97 that are published after January 1, 2022, and that rely on seasonal cooling performance (SCP) and seasonal heating performance (SHP). Representations related to energy consumption, must be made in accordance with the appropriate appendix that applies (*i.e.,* appendix H or appendix H1) when determining compliance with the relevant standard. Manufacturers may make representations of dehumidification capacity and efficiency only if measured in accordance with this appendix.

1. Incorporation by Reference

DOE incorporated by reference in § 431.95, the entire standard for AHRI 310/380–2017, ANSI/ASHRAE 16–2016, and ANSI/ASHRAE 37–2009. However, enumerated provisions of AHRI 310/380–2017 and ANSI/ASHRAE 16–2016, as listed in this section 1 are required. To the extent there is a conflict between the terms or provisions of a referenced industry standard and the CFR, the CFR provisions control.

1.1 AHRI 310/380–2017

(a) Section 3—Definitions, as referenced in section 2 of this appendix;
(b) Section 4—Test Requirements, as referenced in section 3.1 of this appendix;
(c) Section 5—Rating Requirements, as referenced in section 3.1 of this appendix.

1.2 ASHRAE 16–2016

(a) Section 3—Definitions, as referenced in section 2 of this appendix,
(b) Section 5—Instruments, as referenced in section 3.1 of this appendix,
(c) Section 6—Apparatus, as referenced in section 4.1 of this appendix,
(d) Section 7—Methods of Testing, as referenced in sections 4.4.2.1.2 and 4.4.2.2.2 of this appendix,
(e) Section 8—Test Procedures, as referenced in sections 3.1, 4.4.2.1.2, and 4.4.2.2.2 of this appendix;
(e) Section 9—Data to be recorded, as referenced in section 3.1 of this appendix,
(f) Section 10—Measurement Uncertainty and Table 5—Uncertainties of Measurement for the Indicated Values, as referenced in section 3.1 of this appendix,
(g) Section 11—Test Results, as referenced in section 3.1 of this appendix,
(h) Normative Appendix A—Cooling Capacity Calculations—Calorimeter Test Indoor and Calorimeter Test Outdoor, as referenced in section 3.1 of this appendix,
(i) Normative Appendix B—Cooling Capacity Calculations—Calorimeter Test Indoor and Psychrometric Test Indoor, as referenced in section 3.1 of this appendix,
(j) Normative Appendix C—Cooling Capacity Calculations—Psychrometric Test Indoor and Calorimeter Test Outdoor, as referenced in section 3.1 of this appendix,
(k) Normative Appendix E—Heating Capacity Calculations—Calorimeter Test Indoor and Calorimeter Test Outdoor, as referenced in section 3.1 of this appendix,
(l) Normative Appendix F—Heating Capacity Calculations—Calorimeter Test Indoor and Psychrometric Test Indoor, as referenced in section 3.1 of this appendix,
(m) Normative Appendix G—Heating Capacity Calculations—Psychrometric Test Indoor and Calorimeter Test Outdoor, as referenced in section 3.1 of this appendix,

1.2 ASHRAE 37–2009

(a) Section 6.2—Nozzle Airflow Measuring Apparatus, as referenced in section 4.1.1 of this appendix;
(b) Section 6.5—Recommended Practices for Static Pressure Measurements, as referenced in section 4.2.1 of this appendix;
(c) Section 7.3.3—Cooling Calculations, as referenced in section 3.1 of this appendix;
(d) Section 7.3.4—Heating Calculations When Using the ''S'' Test Method of section 8.8.2, as referenced in section 3.1 of this appendix;
(e) Section 7.8.2.1—Latent Cooling Capacity Calculation, as referenced in section 4.4.2.1.2 of this appendix.

2. *Definitions.* In addition to the definitions in section 3 of AHRI 310/380–2017 and section 3 of ANSI/ASHRAE 16–2016, the following definitions apply.

Add-on dehumidifier means a dehumidification system of a make-up air PTAC or PTHP that has its own complete dehumidification system and does not use the main PTAC/HP system indoor coil for any portion of the outdoor air dehumidification.

Degradation coefficient (C_D) means a parameter used in calculating the part load factor. The degradation coefficient for cooling is denoted by $C_D{}^c$. The degradation coefficient for heating is denoted by $C_D{}^h$.

Dehumidification efficiency, or *DE,* means the quantity of water removed from the air divided by the energy consumed, measured in liters per kilowatt-hour (L/kWh).

Integrated dehumidifier means a dehumidification system of a make-up air PTAC or PTHP for which some of the dehumidification of the outdoor air is provided by the main PTAC/HP system indoor coil.

Part-load factor (PLF) means the ratio of the cyclic EER (or COP for heating) to the steady-state EER (or COP), where both EERs (or COPs) are determined based on operation at the same ambient conditions.

Make-up air PTAC means a PTAC for which a portion of the total airflow is drawn in from outside the conditioned space and in which this outside air passes through a dehumidifying or cooling coil, either before or after mixing with the air drawn into the unit from the conditioned space, but before being discharged from the unit.

Make-up air PTHP means a PTHP for which a portion of the total airflow is drawn in from outside the conditioned space and in which this outside air passes through a dehumidifying or cooling coil, either before or after mixing with the air drawn into the unit from inside the conditioned space, but before being discharged from the unit.

Seasonal cooling performance or *SCP* means the total heat removed from the conditioned space during the cooling season, expressed in Btu's, divided by the total electrical energy consumed by the package terminal air conditioner or heat pump during the same season, expressed in watt-hours. SCP is determined in accordance with appendix H1.

Seasonal heating performance or *SHP* means the total heat added to the conditioned space during the heating season, expressed in Btu's, divided by the total electrical energy consumed by the package terminal heat pump during the same season, expressed in watt-hours. SHP is determined in accordance with appendix H1.

Variable speed PTAC/HP means a packaged terminal air-conditioner or heat pump with a compressor that uses a variable-speed drive to vary the compressor speed to achieve variable capacities or three or more capacities for any operating condition for which the compressor would be running.

3. Heating and Cooling Test Procedures

3.1 *General.* Evaluate SCP and SHP using instructions in sections 3.1 to 3.8 to this appendix. For the cooling tests required to evaluate SCP, use the cooling test conditions in section 3.5 of this appendix. For the heating tests required to evaluate SHP, use the heating test conditions in section 3.7 of this appendix. The capacity and power input measurements for the cooling tests shall be determined using section 4 and section 5 of AHRI 310/380–2017; section 8, section 11, appendix A, appendix B and appendix C of ANSI/ASHRAE 16–2016 and section 7 of ANSI/ASHRAE 37–2009. The capacity and power input measurements for the heating tests shall be determined using section 4 and section 5 of AHRI 310/380–2017; section 8, section 11, appendix E, appendix F and appendix G of ANSI/ASHRAE 16–2016 and section 7 of ANSI/ASHRAE 37–2009. Test measurements shall be made in accordance with section 5, section 9 and section 10 of ANSI/ASHRAE 16–2016.

3.2 *Additional setup instructions.* If applicable, unit dehumidification mode will be turned off. Any controls setting for dehumidification (*e.g.,* for lower fan speed) shall not to be activated. Any make-up air opening or opening in the unit bulkhead shall be sealed shut for the cooling and heating tests.

3.3 *Compressor speeds.* Use compressor speeds as required by the cooling and heating tests in section 3.5 and 3.7 respectively, of this appendix. To operate the unit at full compressor speed, set the room thermostat at 75 °F for both heating and cooling tests, representing a 5 °F differential above the heating test condition and 5 °F below the cooling test condition. Use the certified values for the low and intermediate compressor speeds.

3.4 *Indoor Fan Settings.* Conduct all tests with the fan control selections that set the fan speed to high and the indoor fan to cycle with the compressor. If the fan control selections do not allow for indoor fan to cycle with the compressor, use the alternate selection that runs the fan continuously. If needed, the manufacturer supplemental test instructions must provide a means for overriding the controls to achieve this high airflow.

3.5 *Cooling Mode Tests*

3.5.1 *Tests for a System with a Single-Speed Compressor.* Conduct two steady-state full-load tests, at the A and C conditions. Table 1 specifies test conditions for the two tests.

TABLE 1—COOLING MODE TEST CONDITIONS FOR UNITS HAVING A SINGLE-SPEED COMPRESSOR

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
A_{full} Test—required	80	67	95	75	Full.
C_{full} Test—required	80	67	75	60	Full.

3.5.2 *Tests for a System with a Two-Speed Compressor.* Conduct two full-load tests, at the A and B conditions. Conduct two low-load tests, at the B and C conditions. Table 2 specifies test conditions for the four tests.

TABLE 2—COOLING MODE TEST CONDITIONS FOR UNITS HAVING A TWO-CAPACITY COMPRESSOR[1]

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
A_{full} Test—required	80	67	95	75	Full.
B_{full} Test—required	80	67	82	65	Full.
B_{low} Test—required	80	67	82	65	Low.
C_{low} Test—required	80	67	75	60	Low.

[1] This includes units with compressors that achieve no more than two capacity levels using variable speed technology for any one of the test conditions used for the tests.

3.5.3 *Tests for a System with a Variable-Speed Compressor.* Conduct two full-load tests, at the A and B conditions. Conduct two low-load tests, at the B and C conditions. Conduct an optional intermediate test at the B condition. Table 3 specifies test conditions for the four tests.

TABLE 3—COOLING MODE TEST CONDITIONS FOR VARIABLE-SPEED PTAC/HPS

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
A_{full} Test—required	80	67	95	75	Full.
B_{full} Test—required	80	67	82	65	Full.
B_{low} Test—required	80	67	82	65	Low.
B_{int} Test—optional	80	67	82	65	Intermediate.
C_{low} Test—required	80	67	75	60	Low.

3.6 *Evaluation of Cut-out and Cut-in Temperatures in Heating Mode*

3.6.1 Setup. Set the unit to operate in heating mode with the thermostat set at 75 °F and the conditioned space at a lower temperature of 70 °F.

3.6.2 Cut-out Temperature. Reduce outdoor chamber temperature in steps or continuously at an average rate of 1 °F every 5 minutes. The average outdoor coil air inlet temperature when the PTHP operation stops is noted as the cut-out temperature.

3.6.3 Cut-in Temperature. Hold outdoor temperature constant for 5 minutes where the cut-out occurred—then increase outdoor chamber temperature by 1 °F every 5 minutes. Continue temperature ramp until 5 minutes after the HP operation restarts. The average outdoor coil air inlet temperature when the HP operation restarts is noted as the cut-in temperature.

3.7 *Heating Mode Tests*

3.7.1 *Tests for a System with a Single-Speed Compressor.* Conduct two steady-state full-load tests, at the H_1 and H_3 (or H_L) conditions. Table 4 specifies test conditions for the two tests.

TABLE 4—HEATING MODE TEST CONDITIONS FOR UNITS HAVING A SINGLE-SPEED COMPRESSOR

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
$H_{1,full}$ Test—required	70	60 max	47	43	Full.
$H_{3,full}$ Test—required	70	60 max	17	15	Full.
$H_{L,full}$ Test [1]	70	60 max	See note 2	See note 3	Full.

[1] To be conducted only if the unit is unable to test at H_3 conditions.
[2] Use the average of the cut-in and cut-out temperatures.
[3] Use a wet-bulb temperature corresponding to a maximum 60% RH level.

3.7.2 *Tests for a System with a Two-Speed Compressor.* Conduct two full-load tests, at the H_1 and H_3 (or H_L) conditions. Conduct two low-load tests, at the H_1 and H_3 (or H_L). Conduct an optional full-load test at the H_4 condition. Table 5 specifies test conditions for the four tests.

TABLE 5—HEATING MODE TEST CONDITIONS FOR UNITS HAVING A TWO-CAPACITY COMPRESSOR *

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
$H_{1,full}$ Test—required	70	60 max	47	43	Full.
$H_{3,full}$ Test—required	70	60 max	17	15	Full.
$H_{L,full}$ Test [1]	70	60 max	See note 2	See note 3	Full.
$H_{4,full}$ Test—optional	70	60 max	5	4	Full.
$H_{1,low}$ Test—required	70	60 max	47	43	Low.
$H_{3,low}$ Test—required	70	60 max	17	15	Low.
$H_{L,low}$ Test [1]	70	60 max	See note 2	See note 3	Low.

* This includes units with compressors that achieve no more than two capacity levels using variable speed technology for any one of the test conditions used for the tests.
[1] To be conducted only if the unit is unable to test at H_3 conditions.
[2] Use the average of the cut-in and cut-out temperatures.
[3] Use a wet-bulb temperature corresponding to a maximum 60% RH level.

3.7.3 *Tests for a System with a Variable-Speed Compressor.* Conduct tests as indicated in section 3.7.2 of this appendix. Conduct an additional optional intermediate low load test at the H_3 (or H_L) condition.

TABLE 6—HEATING MODE TEST CONDITIONS FOR UNITS HAVING A VARIABLE-SPEED COMPRESSOR WITH THREE OR MORE SPEED LEVELS AT ANY GIVEN OUTDOOR TEMPERATURE

Test description	Air entering indoor unit temperature (°F)		Air entering outdoor unit temperature (°F)		Compressor speed
	Dry bulb	Wet bulb	Dry bulb	Wet bulb	
$H_{1,full}$ Test—required	70	60 max	47	43	Full.
$H_{3,full}$ Test—required	70	60 max	17	15	Full.
$H_{L,full}$ Test [1]	70	60 max	See note 2	See note 3	Full.
$H_{4,full}$ Test—optional	70	60 max	5	4	Full.
$H_{1,low}$ Test—required	70	60 max	47	43	Low.
$H_{3,low}$ Test—required	70	60 max	17	15	Low.
$H_{L,low}$ Test [1]	70	60 max	See note 2	See note 3	Low.
$H_{3,int}$ Test—optional	70	60 max	17	15	Intermediate.
$H_{L,int}$ Test—optional [1]	70	60 max	See note 2	See note 3	Intermediate.

[1] To be conducted only if the unit is unable to test at H_3 conditions.
[2] Use the average of the cut-in and cut-out temperatures.
[3] Use a wet-bulb temperature corresponding to a maximum 60% RH level.

3.8 *Calculation of seasonal performance descriptors*

3.8.1 *SCP Calculation*

The SCP is calculated per equation 3.8.1–1:

Equation 3.8.1–1:

$$SCP = \frac{\sum_{j=1}^{8} q_c(T_j)}{\sum_{j=1}^{8} e_c(T_j)} = \frac{\sum_{j=1}^{8} \frac{q_c(T_j)}{N}}{\sum_{j=1}^{8} \frac{e_c(T_j)}{N}}$$

Where:

$\frac{q_c(T_j)}{N}$ = the ratio of the total space cooling provided during periods of the space cooling season when the outdoor temperature fell within the range represented by the bin temperature T_j to the total number of hours in the cooling season (N), Btu/h.

$\frac{e_c(T_j)}{N}$ = the electrical energy consumed by the test unit during periods of the space cooling season when the outdoor temperature fell within the range represented by the bin temperature T_j to the total number of hours in the cooling season (N), Btu/h.

T_j = the outdoor bin temperature, °F, which are binned in bins of 5°F with the 8 cooling season bin temperatures being 67,72,77,82,87,92,97 and 102°F.

j = the bin number, For cooling season calculations, j ranges from 1 to 8.

Evaluate the building cooling load, $BL(T_j)$ using equation 3.8.1–2:

Equation 3.8.1–2:

$$BL(T_j) = \frac{(T_j - 37)}{95 - 37} * \frac{Q_{A,full}}{1.1}$$

Where:

$Q_{A,full}$ is the space cooling capacity measured in the A_{full} test

Use the fractional cooling hours for each temperature bin, j as defined in Table 7

TABLE 7—DISTRIBUTION OF FRACTIONAL HOURS WITHIN COOLING SEASON TEMPERATURE BINS

Bin number, j	Bin temperature range °F	Representative temperature for bin °F	Fraction of total temperature bin hours, n_j/N
1	65–69	67	0.229
2	70–74	72	0.238
3	75–79	77	0.220
4	80–84	82	0.150
5	85–89	87	0.094
6	90–94	92	0.047
7	95–99	97	0.014
8	100–104	102	0.007

3.8.1.1 *Single-speed system*

Evaluate $\frac{q_c(T_j)}{N}$ and $\frac{e_c(T_j)}{N}$ using equations below:

Equation 3.8.1.1–1:

$$\frac{q_c(T_j)}{N} = X\left(T_j\right) * \dot{Q}_c\left(T_j\right) * \frac{n_j}{N}$$

Equation 3.8.1.1–2:

$$\frac{e_c(T_j)}{N} = \frac{X\left(T_j\right) * \dot{E}_c\left(T_j\right)}{PLF_j} * \frac{n_j}{N}$$

Where:

$X\left(T_j\right) = \left\{\frac{BL(T_j)}{\dot{Q}_c(T_j)} or\ 1\right\}$ whichever is less ; the cooling load factor for temperature bin j, dimensionless;

$\dot{Q}_c(T_j)$ = the space cooling capacity of the unit when operating at outdoor temperature, Tj, Btu/h;

$\dot{E}_c(T_j)$ = the electrical power consumption of the test unit when operating at outdoor temperature Tj, W;

$PLF = 1 - C_D{}^C \cdot [1 - X(T_j)]$, the part load factor, dimensionless;

$C_D{}^C$ = 0.3, the cooling degradation coefficient, dimensionless; and

$\frac{n_j}{N}$ = fractional bin hours for the cooling season; the ratio of the number of hours during the cooling season when the outdoor temperature fell within the range represented by bin temperature T_j to the total number of hours in the cooling season, dimensionless.

Evaluate the terms $\dot{Q}_c(T_j)$ and $\dot{E}_c(T_j)$ using equations 3.8.1.1–3 and 3.8.1.1–4:

Equation 3.8.1.1–3:

$$\dot{Q}_c\left(T_j\right) = \dot{Q}_{C,full} + \frac{\dot{Q}_{A,full} - \dot{Q}_{C,full}}{95 - 75} * (T_j - 75)$$

Equation 3.8.1.1–4:

$$\dot{E}_c\left(T_j\right) = \dot{E}_{C,full} + \frac{\dot{E}_{A,full} - \dot{E}_{C,full}}{95 - 75} * (T_j - 75)$$

Where $\dot{Q}_{C,full}$ and $\dot{E}_{C,full}$ are determined from the C_{full} test, $\dot{Q}_{A,full}$ and $\dot{E}_{A,full}$ are determined from the A_{full} test, and all four quantities are measured as specified in section 3.5.1 of this appendix.

3.8.1.2 *Two-speed systems*

Calculate SCP using Equation 3.8.1–1. Evaluate the space cooling capacity $\dot{Q}_{c,low}(T_j)$, and electrical power consumption, $\dot{E}_{c,low}(T_j)$, of the test unit when operating at low compressor capacity and outdoor temperature Tj using:

Equation 3.8.1.2–1:

$$\dot{Q}_{c,low}\left(T_j\right) = \dot{Q}_{C,low} + \left\{\frac{\dot{Q}_{B,low} - \dot{Q}_{C,low}}{82 - 75}\right\} * \left(t_j - 75\right)$$

Equation 3.8.1.2–2:

$$\dot{E}_{c,low}(T_j) = \dot{E}_{C,low} + \left\{\frac{\dot{E}_{B,low} - \dot{E}_{C,low}}{82 - 75}\right\} * (t_j - 75)$$

Where $\dot{Q}_{C,low}$ and $\dot{E}_{C,low}$ are determined from the C_{low} test, $\dot{Q}_{B,low}$ and $\dot{E}_{B,low}$ are determined from the B_{low} test, and all four quantities are measured as specified in section 3.5.2 of this appendix.

Evaluate the space cooling capacity $\dot{Q}_{c,full}(T_j)$, and electrical power consumption, $\dot{E}_{c,full}(T_j)$, of the test unit when operating at full compressor capacity and outdoor temperature Tj using:

Equation 3.8.1.2–3:

$$\dot{Q}_{full}(T_j) = \dot{Q}_{B,full} + \left\{\frac{\dot{Q}_{A,full} - \dot{Q}_{B,full}}{95 - 82}\right\} * (t_j - 82)$$

Equation 3.8.1.2–4:

$$\dot{E}_{full}(T_j) = \dot{E}_{B,full} + \left\{\frac{\dot{E}_{A,full} - \dot{E}_{B,full}}{95 - 82}\right\} * (t_j - 82)$$

Where $\dot{Q}_{B,full}$ and $\dot{E}_{B,full}$ are determined from the B_{full} test, and $\dot{Q}_{A,full}$ and $\dot{E}_{A,full}$ are determined from the A_{full} test, and all four quantities are measured as specified in section 3.5.2 of this appendix.

The calculation of equation 3.8.1–1 quantities differs depending on whether the test unit would operate at low capacity (section 3.8.1.2.1 of this appendix), cycle between low and high capacity (section 3.8.1.2.2 of this appendix), or operate at high capacity (section 3.8.1.2.3) in responding to the building load. Use Equation 3.8.1–2 to calculate the building load, BL(Tj), for each temperature bin.

3.8.1.2.1 *Building load is less than low-stage cooling capacity* ($BL(T_j) < \dot{Q}_{c,low}$)

Evaluate $\frac{q_c(T_j)}{N}$ and $\frac{e_c(T_j)}{N}$ using equations below:

Equation 3.8.1.2.1–1:

$$\frac{q_c(T_j)}{N} = X_{low}(T_j) * \dot{Q}_{c,low}(T_j) * \frac{n_j}{N}$$

Equation 3.8.1.2.1–2:

$$\frac{e_c(T_j)}{N} = \frac{X_{low}(T_j) * \dot{E}_{c,low}(T_j)}{PLF_{low}} * \frac{n_j}{N}$$

$$PLF = 1 - C_D^C . [1 - X_{low}(T_j)]$$

Where:

$X_{low}(T_j) = \frac{BL(T_j)}{\dot{Q}_{c,low}(T_j)}$; the cooling load low capacity factor for temperature bin j, dimensionless;

$PLF = 1 - C_D^C. [1 - X_{low}(T_j)]$, the part load factor, dimensionless;

$C_D^C = 0.3$, the cooling degradation coefficient, dimensionless; and

$\frac{n_j}{N}$ = fractional bin hours for the cooling season; the ratio of the number of hours during the cooling season when the outdoor temperature fell within the range represented by bin temperature T_j to the total number of hours in the cooling season, dimensionless.

3.8.1.2.2 *Building load is higher than the low-stage capacity and less than the full-stage capacity* ($\dot{Q}_{c,low} < BL(T_j) < \dot{Q}_{c,full}$)

Evaluate $\frac{q_c(T_j)}{N}$ and $\frac{e_c(T_j)}{N}$ using equations below:

Equation 3.8.1.2.2–1:

$$\frac{q_c(T_j)}{N} = \left[X_{low}\left(T_j\right) * \dot{Q}_{c,low}\left(T_j\right) + X_{full}\left(T_j\right) * \dot{Q}_{c,full}\left(T_j\right)\right] * \frac{n_j}{N}$$

Equation 3.8.1.2.2–2:

$$\frac{e_c(T_j)}{N} = \left[X_{low}\left(T_j\right) * \dot{E}_{c,low}\left(T_j\right) + X_{full}\left(T_j\right) * \dot{E}_{c,full}\left(T_j\right)\right] * \frac{n_j}{N}$$

Where:

$X_{low}\left(T_j\right) = \frac{\dot{Q}_{c,full}(T_j) - BL(T_j)}{\dot{Q}_{c,full}(T_j) - \dot{Q}_{c,low}(T_j)}$ is the cooling mode, low capacity load factor for temperature bin j, dimensionless; and

$X_{full}(T_j) = 1 - X_{low}(T_j)$ is the cooling mode, full capacity load factor for temperature bin j, dimensionless.

3.8.1.2.3 *Building load is higher than the full-stage capacity* ($BL(T_j) > \dot{Q}_{c,full}$)

Evaluate $\frac{q_c(T_j)}{N}$ and $\frac{e_c(T_j)}{N}$ using equations below:

$$\frac{q_c(T_j)}{N} = \dot{Q}_{c,full}\left(T_j\right) * \frac{n_j}{N}$$

$$\frac{e_c(T_j)}{N} = \dot{E}_{c,full}\left(T_j\right) * \frac{n_j}{N}$$

Evaluate $\dot{Q}_{c,full}(T_j)$ and $\dot{E}_{c,full}(T_j)$ using equations 3.8.1.2–3 and 3.8.1.2–4.

3.8.1.3 *Variable-speed system*

Calculate SCP using Equation 3.8.1–1. Evaluate the space cooling capacity $\dot{Q}_{c,low}(T_j)$, and electrical power consumption, $\dot{E}_{c,low}(T_j)$, of the test unit when operating at low compressor capacity and outdoor temperature Tj using equations 3.8.1.2–1 and 3.8.1.2–2.

Calculate the space cooling capacity, $\dot{Q}_{c,int}(T_j)$, and electrical power consumption, $\dot{E}_{c,int}(T_j)$, of the test unit when operating at outdoor temperature Tj and the intermediate compressor speed used during using the following:

Equation 3.8.1.3–1:

$\dot{Q}_{c,int}(T_j) = \dot{Q}_{B,int} + M_Q * (T_j - 82)$

Equation 3.8.1.3–2:

$\dot{E}_{c,int}(T_j) = \dot{E}_{B,int} + M_E * (T_j - 82)$

Where $\dot{Q}_{B,int}$ and $\dot{E}_{B,int}$ are determined from the optional B_{int} test or interpolated from the B_{low} and B_{full} tests.

Approximate the slopes of the intermediate speed cooling capacity and electrical power input curves, M_Q and M_E, as follows:

$$M_Q = \left[\frac{\dot{Q}_{B,low} - \dot{Q}_{C,low}}{82-75} * (1 - N_Q)\right] + \left[N_Q * \frac{\dot{Q}_{A,full} - \dot{Q}_{B,full}}{95-82}\right]$$

$$M_E = \left[\frac{\dot{E}_{B,low} - \dot{E}_{C,low}}{82-75} * (1 - N_E)\right] + \left[N_E * \frac{\dot{E}_{A,full} - \dot{E}_{B,full}}{95-82}\right]$$

Where:

$$N_Q = \frac{\dot{Q}_{c,int}(87) - \dot{Q}_{c,low}(87)}{\dot{Q}_{c,full}(87) - \dot{Q}_{c,low}(87)}$$

$$N_E = \frac{\dot{E}_{c,int}(87) - \dot{E}_{c,low}(87)}{\dot{E}_{c,full}(87) - \dot{E}_{c,low}(87)}$$

Use Equations 3.8.1.2–1, 3.8.1.2–2, 3.8.1.2–3 and 3.8.1.2–4, respectively, to calculate $\dot{Q}_{c,low}(87)$, $\dot{E}_{c,low}(87)$, $\dot{Q}_{c,full}(87)$ and $\dot{E}_{c,full}(87)$.

3.8.1.3.1 *Building load is less than low-stage capacity* $(BL(T_j) < \dot{Q}_{c,low})$

$$\frac{q_c(T_j)}{N} = X_{low}(T_j) * \dot{Q}_{c,low}(T_j) * \frac{n_j}{N}$$

$$\frac{e_c(T_j)}{N} = \frac{X_{low}(T_j) * \dot{E}_{c,low}(T_j)}{PLF_{low}} * \frac{n_j}{N}$$

Where:

$X_{low}(T_j) = \frac{BL(T_j)}{\dot{Q}_{c,low}(T_j)}$; the cooling load low capacity factor for temperature bin j, dimensionless

$PLF = 1 - C_D^C . [1 - X_{low}(T_j)]$, the part load factor, dimensionless.

C_D^C = Cooling degradation coefficient, 0.3

$\frac{n_j}{N}$ = fractional bin hours for the cooling season; the ratio of the number of hours during the cooling season when the outdoor temperature fell within the range represented by bin temperature T_j to the total number of hours in the cooling season, dimensionless.

Obtain the fractional bin hours for the cooling season,

$$\frac{n_j}{N},$$

from Table 7. Use Equations 3.8.1.2–1 and 3.8.1.2–2, respectively, to evaluate $\dot{Q}_{c,low}(T_j)$ and $\dot{E}_{c,low}(T_j)$.

3.8.1.3.2 *Building load is higher than the low-stage capacity and lesser than the full-stage capacity and the unit operates at an intermediate speed to match capacity to load* ($\dot{Q}_{c,low} < BL(T_j) < \dot{Q}_{c,full}$)

$$\frac{q_C(T_j)}{N} = \dot{Q}_{c,int-bin}(T_j) * \frac{n_j}{N}$$

$$\frac{e_C(T_j)}{N} = \dot{E}_{c,int-bin}(T_j) * \frac{n_j}{N}$$

Where:

$\dot{Q}_{c,int-bin}(T_j) = BL(T_j)$, the space cooling capacity delivered by the unit in matching the building load at temperature T_j, Btu/h.

$\dot{E}_{c,int-bin}(T_j) = \frac{\dot{Q}_{c,int-bin}(T_j)}{EER_{int-bin}(T_j)}$, the electrical power input required by the test unit

$EER_{int-bin}(T_j)$ = the steady-state energy efficiency ratio of the test unit when operating at an intermediate compressor speed and temperature T_j, Btu/h per W.

Obtain the fractional bin hours for the cooling season,

$$\frac{n_j}{N},$$

from Table 7 of this appendix. For each temperature bin where the unit operates at an intermediate compressor speed, determine the energy efficiency ratio $EER_{int-bin}(T_j)$ using the following equations:

For each temperature bin where $\dot{Q}_{c,low}(T_j) < BL(T_j) < \dot{Q}_{c,int}(T_j)$,

$$EER_{int-bin}(T_j) = EER_{low}(T_j) + \frac{EER_{int}(T_j) - EER_{low}(T_j)}{\dot{Q}_{c,int}(T_j) - \dot{Q}_{c,low}(T_j)} * (BL(T_j) - \dot{Q}_{c,low}(T_j))$$

For each temperature bin where $\dot{Q}_{c,int}(T_j) \leq BL(T_j) < \dot{Q}_{c,full}(T_j)$,

$$EER_{int-bin}(T_j) = EER_{int}(T_j) + \frac{EER_{full}(T_j) - EER_{int}(T_j)}{\dot{Q}_{c,full}(T_j) - \dot{Q}_{c,int}(T_j)} * (BL(T_j) - \dot{Q}_{c,int}(T_j))$$

Where:

$EER_{low}(T_j)$ is the steady-state energy efficiency ratio of the test unit when operating at minimum compressor speed and temperature T_j, Btu/h per W, calculated using capacity $\dot{Q}_{c,low}(T_j)$ calculated using Equation 3.8.1.2–1 and electrical power consumption $\dot{E}_{c,low}(T_j)$ calculated using Equation 3.8.1.2–2;

$EER_{int}(T_j)$ is the steady-state energy efficiency ratio of the test unit when operating at intermediate compressor speed and temperature T_j, Btu/h per W, calculated using capacity $\dot{Q}_{c,int}(T_j)$ calculated using Equation 3.8.1.3–1 and electrical power consumption $\dot{E}_{c,int}(T_j)$ calculated using Equation 3.8.1.3–2;

$EER_{full}(T_j)$ is the steady-state energy efficiency ratio of the test unit when operating at full compressor speed and temperature T_j, Btu/h per W, calculated using capacity $\dot{Q}_{c,full}(T_j)$ calculated Equation 3.8.1.2–3 and electrical power consumption $\dot{E}_{c,full}(T_j)$, calculated using Equation 3.8.1.2–4.

$BL(T_j)$ is the building cooling load at temperature T_j, Btu/h.

3.8.1.3.3 *Building load is higher than the full-stage capacity a* ($BL(T_j) > \dot{Q}_{c,full}(T_j)$)

Evaluate $\frac{q_c(T_j)}{N}$ and $\frac{e_c(T_j)}{N}$ using instructions in section 3.8.1.2.3.

3.8.2 *SHP Calculation*

The SHP is calculated using equation 3.8.2–1:

Equation 3.8.2–1

$$SHP = \frac{\sum_{j=1}^{7} n_j * BL(T_j)}{\sum_{j=1}^{7} e_h(T_j) + \sum_{j=1}^{8} RH(T_j)} = \frac{\sum_{j=1}^{7} \frac{n_j}{N} * BL(T_j)}{\sum_{j=1}^{7} \frac{e_h(T_j)}{N} + \sum_{j=1}^{7} \frac{RH(T_j)}{N}}$$

Where:

$BL(T_j)$ = the value of the heating building load evaluated at the outdoor bin temperature, btu/hr.

$\frac{e_h(T_j)}{N}$ = the ratio of the electrical energy consumed by the test unit during periods of the space heating season when the outdoor temperature fell within the range represented by the bin temperature T_j to the total number of hours in the heating season (N), W.

$\frac{RH(T_j)}{N}$ = the ratio of the electrical energy used for resistive space heating during periods when the outdoor temperature fell within the range represented by the bin temperature T_j to the total number of hours in the heating season (N), W. Resistive space heating is modeled as being used to meet that portion of the building load that the heat pump does not meet because of insufficient capacity or because the heat pump automatically turns off at the lowest outdoor temperatures.

$\frac{n_j}{N}$ = fractional bin hours for the heating season; the ratio of the number of hours during the heating season when the outdoor temperature fell within the range represented by bin temperature T_j to the total number of hours in the heating season, dimensionless.

T_j = the outdoor bin temperature, °F, which are binned in bins of 5°F with the 7 heating season bin temperatures being 7, 12, 17, 22, 27, 32, 37.

j = the bin number, For heating season calculations, j ranges from 1 to 7.

Evaluate the building heating load, $BL(T_j)$ using equation 3.8.2–2:

Equation 3.8.2–2:

$$BL(T_j) = \frac{(T_{zl} - T_j)}{T_{zl} + 15} * Q_{A,full}$$

Where:

$Q_{A,full}$ = is the space cooling capacity from the A_{full} test

T_{zl} the zero-load temperature, °F, is equal to 40 °F

T_j the outdoor bin temperature, °F

Use the fractional heating hours for each temperature bin, j as defined in table 8.

TABLE 8—DISTRIBUTION OF FRACTIONAL HOURS WITHIN HEATING SEASON TEMPERATURE BINS

Bin number, j	Bin temperature range °F	Representative temperature for bin °F	Fraction of total temperature bin hours, n_j/N
1	39–35	37	0.337
2	34–30	32	0.298
3	29–25	27	0.192
4	24–20	22	0.108
5	19–15	17	0.051
6	14–10	12	0.008
7	9–5	7	0.006

3.8.2.1 *Single-speed system*

Evaluate $\frac{e_h(T_j)}{N}$ and $\frac{RH(T_j)}{N}$ using the following equations:

Equation 3.8.2.1–1:

$$\frac{e_h(T_j)}{N} = \frac{X(T_j) * \dot{E}_h(T_j) * \delta(T_j)}{PLF_j} * \frac{n_j}{N}$$

Equation 3.8.2.1–2:

$$\frac{RH(T_j)}{N} = \frac{BL(T_j) - [X(T_j) * \dot{Q}_h(T_j) * \delta(T_j)]}{3.413\frac{Btu/h}{W}} * \frac{n_j}{N}$$

Where:

$$X(T_j) = \begin{cases} \frac{BL(T_j)}{\dot{Q}_h(T_j)} \\ or \\ 1 \end{cases}, \text{ whichever is less; the heating mode load factor for temperature}$$

$\dot{Q}_h(T_j)$ = the space heating capacity of the heat pump when operating at outdoor temperature T_j, Btu/h.

$\dot{E}_h(T_j)$ = the electrical power consumption of the heat pump when operating at outdoor temperature T_j, W.

$\delta(T_j)$ = the heat pump low temperature cut-out factor, dimensionless.

$PLF_j = \dot{C}_D^h * [1 - XT_j]$ (the part load factor, dimensionless.

$\dot{C}_D^h$ = Heating degradation coefficient = 0.3

Use Equation 3.8.2–2 to determine $BL(T_j)$. Obtain fractional bin hours for the heating season,

$$\frac{n_j}{N},$$

from Table 8.

Determine the low temperature cut-out factor, $\delta(T_j)$, using the equation below:

Equation 3.8.2.1–3:

$$\delta(T_j) = \begin{cases} 0, & if\ T_j \le T_{off}\ or\ \frac{\dot{Q}_h(T_j)}{3.413 * \dot{E}_h(T_j)} < 1 \\ \frac{1}{2}, & if\ T_{off} < T_j \le T_{on}\ and\ \frac{\dot{Q}_h(T_j)}{3.413 * \dot{E}_h(T_j)} \ge 1 \\ 1, & if\ T_j > T_{on}\ and\ \frac{\dot{Q}_h(T_j)}{3.413 * \dot{E}_h(T_j)} \ge 1 \end{cases}$$

Where:

T_{off} = the outdoor temperature when the compressor is automatically shut off, °F. (If no such temperature exists, T_j is always greater than T_{off} and T_{on}).

T_{on} = the outdoor temperature when the compressor is automatically turned back on, if applicable, following an automatic shut-off, °F.

If the H_4 test is not conducted, calculate $\dot{Q}_h(T_j)$ and $\dot{E}_h(T_j)$ using Equations 3.8.2.1–4 and 3.8.2.1–5 if the H_3 is conducted, or equations 3.8.2.1–6 and 3.8.2.1–7 if the H_L test is conducted.

Equation 3.8.2.1–4:

$$\dot{Q}_{h.full}(T_j) = \begin{cases} \dot{Q}_{H3,full} + \frac{[\dot{Q}_{H1,full} - \dot{Q}_{H3,full}] * (T_j - 17)}{47 - 17}, & if\ T_j \le 17°F \\ \dot{Q}_{H3,full} + \frac{[\dot{Q}_{h,full}(35) - \dot{Q}_{H3,full}] * (T_j - 17)}{35 - 17}, & if\ 17°F < T_j \le 42°F \end{cases}$$

Where:

$\dot{Q}_{h,full}(35) = 0.9 * \{\dot{Q}_{H3,full} + 0.6 * [\dot{Q}_{H1,full} - \dot{Q}_{H3,full}]\}$

Equation 3.8.2.1–5:

$$\dot{E}_{h,full}(T_j) = \begin{cases} \dot{E}_{H3,full} + \frac{[\dot{E}_{H1,full} - \dot{E}_{H3,full}] * (T_j - 17)}{47 - 17}, & if\ T_j \le 17°F \\ \dot{E}_{H3,full} + \frac{[\dot{E}_{h,full}(35) - \dot{E}_{H3,full}] * (T_j - 17)}{35 - 17}, & if\ 17°F < T_j \le 42°F \end{cases}$$

Where:

$\dot{E}_{h,full}(35) = 0.985 * \{\dot{E}_{H3,full} + 0.6 * [\dot{E}_{H1,full} - \dot{E}_{H3,full}]\}$

Equation 3.8.2.1–6:

$$\dot{Q}_{h.full}(T_j) = \begin{cases} \dot{Q}_{HL,full} + \frac{[\dot{Q}_{H1,full} - \dot{Q}_{HL,full}] * (T_j - H_L)}{47 - H_L}, & if\ T_j \le H_L \\ \dot{Q}_{HL,full} + \frac{[\dot{Q}_{h,full}(35) - \dot{Q}_{HL,full}] * (T_j - H_L)}{35 - H_L}, & if\ H_L < T_j \le 42°F \end{cases}$$

Where:

$$\dot{Q}_{h,full}(35) = 0.9 * \{ \dot{Q}_{HL,full} + \frac{35 - H_L}{47 - H_L} * [\dot{Q}_{H1,full} - \dot{Q}_{HL,full}]\}$$

Equation 3.8.2.1–7:

$$\dot{E}_{h,full}(T_j) = \begin{cases} \dot{E}_{HL,full} + \frac{[\dot{E}_{H1,full} - \dot{E}_{HL,full}] * (T_j - H_L)}{47 - H_L}, & if\ T_j \le H_L \\ \dot{E}_{HL,full} + \frac{[\dot{E}_{h,full}(35) - \dot{E}_{HL,full}] * (T_j - H_L)}{35 - H_L}, & if\ 17°F < T_j \le 42°F \end{cases}$$

Where:

$$\dot{E}_{h,full}(35) = 0.985 * \{ \dot{E}_{HL,full} + \frac{35-H_L}{47-H_L} * [\dot{E}_{H1,full} - \dot{E}_{HL,full}]\}$$

If the H_4 test is conducted, calculate $\dot{Q}_h(T_j)$ and $\dot{E}_h(T_j)$ using equations 3.8.2.1–8 and 3.8.2.1–9:

Equation 3.8.2.1–8:

$$\dot{Q}_{h.full}(T_j) = \begin{cases} \dot{Q}_{H3,full} + \dfrac{[\dot{Q}_{H3,full} - \dot{Q}_{H4,full}] * (T_j - 5)}{17-5}, & if\ T_j < 17°F \\ \dot{Q}_{H3,full} + \dfrac{[\dot{Q}_{h,full}(35) - \dot{Q}_{H3,full}] * (T_j - 17)}{35-17}, & if\ 17°F \le T_j \le 42°F \end{cases}$$

Where:

$\dot{Q}_{h,full}(35) = 0.9 * \{\dot{Q}_{H3,full} + 0.6 * [\dot{Q}_{H1,full} - \dot{Q}_{H3,full}]\}$

Equation 3.8.2.1–9:

$$\dot{E}_h(T_j) = \begin{cases} \dot{E}_{H3,full} + \dfrac{[\dot{E}_{H3,full} - \dot{E}_{H4,full}] * (T_j - 5)}{17-5}, & if\ T_j < 17°F \\ \dot{E}_{H3,full} + \dfrac{[\dot{E}_{h,full}(35) - \dot{E}_{H3,full}] * (T_j - 17)}{35-17}, & if\ 17°F \le T_j \le 42°F \end{cases}$$

Where:

$\dot{E}_{h,full}(35) = 0.985 * \{\dot{E}_{H3,full} + 0.6 * [\dot{E}_{H1,full} - \dot{E}_{H3,full}\}$

3.8.2.2 *Two-speed system*

The calculation of Equation 3.8.2–1 quantities differs depending upon whether the heat pump would operate at low capacity (section 3.8.2.2.1 of this appendix), cycle between low and high capacity (section 3.8.2.2.2 of this appendix), or operate at high capacity (section 3.8.2.2.3 of this appendix) in responding to the building load.

Evaluate the space heating capacity and electrical power consumption of the heat pump when operating at low compressor capacity and outdoor temperature T_j using equations 3.8.2.2–1 and 3.8.2.2–2 if the H_3 is conducted, or equations 3.8.2.2–3 and 3.8.2.2–4 if the H_L is conducted:

Equation 3.8.2.2–1:

$$\dot{Q}_{h.low}(T_j) = \begin{cases} \dot{Q}_{H3,low} + \dfrac{[\dot{Q}_{H1,low} - \dot{Q}_{H3,low}] * (T_j - 17)}{47-17}, & if\ T_j \le 17°F \\ \dot{Q}_{H3,low} + \dfrac{[\dot{Q}_{h,low}(35) - \dot{Q}_{H3,low}] * (T_j - 17)}{35-17}, & if\ 17°F < T_j \le 42°F \end{cases}$$

Where:

$\dot{Q}_{h,low}(35) = 0.9 * \{\dot{Q}_{H3,low} + 0.6 * [\dot{Q}_{H1,low} - \dot{Q}_{H3,low}]\}$

Equation 3.8.2.2–2:

$$\dot{E}_{h,low}(T_j) = \begin{cases} \dot{E}_{H3,low} + \dfrac{[\dot{E}_{H1,low} - \dot{E}_{H3,low}] * (T_j - 17)}{47-17}, & if\ T_j \le 17°F \\ \dot{E}_{H3,low} + \dfrac{[\dot{E}_{h,low}(35) - \dot{E}_{H3,low}] * (T_j - 17)}{35-17}, & if\ 17°F < T_j \le 42°F \end{cases}$$

Where:

$\dot{E}_{h,low}(35) = 0.985 * \{\dot{E}_{H3,low} + 0.6 * [\dot{E}_{H1,low} - \dot{H}_{H3,low}]\}$

Equation 3.8.2.2–3:

$$\dot{Q}_{h.low}(T_j) = \begin{cases} \dot{Q}_{HL,low} + \dfrac{[\dot{Q}_{H1,low} - \dot{Q}_{HL,low}] * (T_j - H_L)}{47-H_L}, & if\ T_j \le H_L \\ \dot{Q}_{HL,low} + \dfrac{[\dot{Q}_{h,low}(35) - \dot{Q}_{HL,low}] * (T_j - H_L)}{35-H_L}, & if\ H_L < T_j \le 42°F \end{cases}$$

Where:

$$\dot{Q}_{h,low}(35) = 0.9 * \{ \dot{Q}_{HL,low} + \frac{35-H_L}{47-H_L} * [\dot{Q}_{H1,low} - \dot{Q}_{HL,low}]\}$$

Equation 3.8.2.2–4:

$$\dot{E}_{h,low}(T_j) = \begin{cases} \dot{E}_{HL,low} + \frac{[\dot{E}_{H1,low} - \dot{E}_{HL,low}] * (T_j - H_L)}{47 - H_L}, & if\ H_L \leq 17°F \\ \dot{E}_{HL,low} + \frac{[\dot{E}_h(35) - \dot{E}_{HL,low}] * (T_j - H_L)}{35 - H_L}, & if\ H_L < T_j \leq 42°F \end{cases}$$

Where:

$$\dot{E}_{h,low}(35) = 0.985 * \{ \dot{E}_{HL,low} + \frac{35-H_L}{47-H_L} * [\dot{E}_{H1,low} - \dot{E}_{HL,low}]\}$$

If the H_4 test is not conducted, evaluate the space heating capacity and electrical power consumption ($\dot{Q}_{h,full}(T_j)$ and $\dot{E}_{h,full}(T_j)$ of the heat pump when operating at high compressor capacity and outdoor temperature T_j by solving Equations 3.8.2.1–4 and 3.8.2.1–5, or Equations 3.8.2.1–6 and 3.8.2.1–7 as appropriate . If the H_4 test is conducted, evaluate the space heating capacity and electrical power consumption ($\dot{Q}_{h,full}(T_j)$ and $\dot{E}_{h,full}(T_j)$ of the heat pump when operating at high compressor capacity and outdoor temperature T_j using Equations 3.8.2.1–8 and 3.8.2.1–9, respectively.

3.8.2.2.1 *Building load is less than low-stage capacity* ($BL(T_j) < \dot{Q}_{h,low}$)

Evaluate $\frac{e_h(T_j)}{N}$ and $\frac{RH(T_j)}{N}$ using the following equations:

Equation 3.8.2.2.1–1:

$$\frac{e_h(T_j)}{N} = \frac{X_{low}(T_j) * \dot{E}_{h,low}(T_j) * \delta(T_j)}{PLF_j} * \frac{n_j}{N}$$

Equation 3.8.2.2.1–2:

$$\frac{RH(T_j)}{N} = \frac{BL(T_j) * [1 - \delta(T_j)]}{3.413 \frac{Btu/h}{W}} * \frac{n_j}{N}$$

Where:

$X_{low}(T_j) = \frac{BL(T_j)}{\dot{Q}_{h.low}(T_j)}$, the heating mode low capacity load factor for temperature

$PLF_j = 1 - \dot{C}_D^h * [1 - X_{low} \leq (T_j)]$, the part load factor, dimensionless.

$\delta(T_j)$ the low temperature cutoff factor, dimensionless.

$\dot{C}_D^h$ = Heating degradation coefficient = 0.3

Determine the low temperature cut-out factor using Equation 3.8.2.2.1–3:

Equation 3.8.2.2.1–3:

$$\delta(T_j) = \begin{cases} 0, & if\ T_j \leq T_{off} \\ \frac{1}{2}, & if\ T_{off} < T_j \leq T_{on} \\ 1, & if\ T_j > T_{on} \end{cases}$$

Where:

T_{off} = the outdoor temperature when the compressor is automatically shut off, °F. (If no such temperature exists, T_j is always greater than T_{off} and T_{on}).

T_{on} = the outdoor temperature when the compressor is automatically turned back on, if applicable, following an automatic shut-off, °F.

3.8.2.2.2 *Building load is higher than the low-stage capacity and lesser than the full-stage capacity* ($\dot{Q}_{h,low} < BL(T_j) < \dot{Q}_{h,full}$)

Calculate $\frac{RH(T_j)}{N}$ and $\frac{e_h(T_j)}{N}$ using the following equations:

Equation 3.8.2.2.2–1:

$$\frac{RH(T_j)}{N} = \frac{BL(T_j) * [1 - \delta(T_j)]}{3.413 \frac{Btu/h}{W}} * \frac{n_j}{N}$$

Equation 3.8.2.2.2–2:

$$\frac{e_h(T_j)}{N} = \left[X_{low}(T_j) * \dot{E}_{h,low}(T_j) + X_{full}(T_j) * \dot{E}_{h,low}(T_j)\right] * \delta(T_j) * \frac{n_j}{N}$$

Where:

$$X_{low}(T_j) = \frac{\dot{Q}_{h,full}(T_j) - BL(T_j)}{\dot{Q}_{h,full}(T_j) - \dot{Q}_{h,low}(T_j)}$$

$X_{full}(T_j) = 1 - X_{low}(T_j)$ the heating mode, high capacity load factor for temperature bin j, dimensionless.

Determine the low temperature cut-out factor, $\delta(T_j)$, using equation 3.8.2.2.1–3.

3.8.2.2.3 *Building load is higher than the full-stage capacity a* ($BL(T_j) > \dot{Q}_{h,full}$)

Calculate $\frac{RH(T_j)}{N}$ and $\frac{e_h(T_j)}{N}$ using the following equations:

Equation 3.8.2.2.3–1:

$$\frac{e_h(T_j)}{N} = \dot{E}_{h,full}(T_j) * \delta'(T_j) * \frac{n_j}{N}$$

Equation 3.8.2.2.3–2:

$$\frac{RH(T_j)}{N} = \frac{BL(T_j) * [\dot{Q}_{h,full}(T_j) * \delta'(T_j)]}{3.413 \frac{Btu/h}{W}} * \frac{n_j}{N}$$

Where:

$$\delta'(T_j) = \begin{cases} 0, & if\ T_j \le T_{off}\ or\ \frac{\dot{Q}_{h,full}(T_j)}{3.413 * \dot{E}_{h,full}(T_j)} < 1 \\ \frac{1}{2}, & if\ T_{off} < T_j \le T_{on}\ and\ \frac{\dot{Q}_{h,full}(T_j)}{3.413 * \dot{E}_{h,full}(T_j)} \ge 1 \\ 1, & if\ T_j > T_{on}\ and\ \frac{\dot{Q}_{h,full}(T_j)}{3.413 * \dot{E}_{h,full}(T_j)} \ge 1 \end{cases}$$

3.8.2.3 *Variable-speed system*

The calculation of the Equation 3.8.2–1 quantities differs depending upon whether the heat pump would operate at low capacity (section 3.8.2.3.1 of this appendix), cycle between low and high capacity (section 3.8.2.3.2 of this appendix), or operate at high capacity (section 3.8.2.3.3 of this appendix) in responding to the building load.

Calculate the space heating capacity, $\dot{Q}_{h,int}(T_j)$, and electrical power consumption, $\dot{E}_{h,int}(T_j)$, of the test unit when operating at outdoor temperature Tj and the intermediate compressor speed used during using the following equations:

Equation 3.8.2.3–1:

$\dot{Q}_{h,int}(T_j) = \dot{Q}_{h,int}(35) + M_Q * (T_j - 35)$

Equation 3.8.2.3–2:

$\dot{E}_{h,int}(T_j) = \dot{E}_{h,int}(35) + M_E * (T_j - 35)$

Where:

$\dot{Q}_{h,int}(35) = 0.9 * \{\dot{Q}_{H3,int} + 0.6 * [\dot{Q}_{H1,full} - \dot{Q}_{H3,int}]$

$\dot{E}_{h,int}(35) = 0.985 * \{\dot{E}_{H3,int} + 0.6 * [\dot{E}_{H1,full} - \dot{E}_{H3,int}]$

Where $\dot{Q}_{H3,int}$ and $\dot{E}_{H3,int}$ are determined from the optional $H_{3,int}$ test or interpolated from the $H_{3,low}$ and $H_{3,full}$ tests.

Approximate the slopes of the intermediate speed heating capacity and electrical power input curves, M_Q and M_E, as follows:

$$M_Q = \left[\frac{\dot{Q}_{H1,low} - \dot{Q}_{H3,low}}{47-17} * (1 - N_Q)\right] + \left[N_Q * \frac{\dot{Q}_{h,full}(35) - \dot{Q}_{H3,low}}{35-17}\right]$$

$$M_E = \left[\frac{\dot{E}_{H1,low} - \dot{E}_{H3,low}}{47-17} * (1 - N_E)\right] + \left[N_E * \frac{\dot{E}_{h,full}(35) - \dot{E}_{H3,low}}{35-17}\right]$$

Where:

$$N_Q = \frac{\dot{Q}_{h,int}(35) - \dot{Q}_{h,low}(35)}{\dot{Q}_{h,full}(35) - \dot{Q}_{h,low}(35)}$$

$$N_E = \frac{\dot{E}_{h,int}(35) - \dot{E}_{h,low}(35)}{\dot{E}_{h,full}(35) - \dot{E}_{h,low}(35)}$$

3.8.2.3.1 *Building load is less than low-stage capacity* $(BL(T_j) < \dot{Q}_{h,low})$

Calculate $\frac{RH(T_j)}{N}$ and $\frac{e_h(T_j)}{N}$ using instruction in section 3.8.2.2.1

3.8.2.3.2 *Building load is higher than the low-stage capacity and lesser than the full-stage capacity* $(\dot{Q}_{h,low} < BL(T_j) < \dot{Q}_{h,full})$ *and the compressor operates at an intermediate speed) in order to match the building heating load at a temperature Tj*

Evaluate $\frac{RH(T_j)}{N}$ using equation 3.8.2.2.1-2. Evaluate $\frac{e_h(T_j)}{N}$ as follows:

$$\frac{e_h(T_j)}{N} = \dot{E}_{h,int-bin}(T_j) * \delta(T_j) * \frac{n_j}{N}$$

Where:

$$\dot{E}_{h,int-bin}(T_j) = \frac{\dot{Q}_{h,int-bin}(T_j)}{3.413 \frac{Btu/h}{W} * COP_{int-bin}(T_j)}$$

and $\delta(T_j)$ is evaluated using Equation 3.8.2.2.1–3 while, $\dot{Q}_{h,int-bin}(T_j) = (BL(T_j)$, the space heating capacity delivered by the unit in matching the building load at temperature (T_j), Btu/h. The matching occurs with the heat pump operating at an intermediate compressor speed.

$COP_{int-bin}(T_j)$ = the steady-state coefficient of performance of the heat pump when operating at an intermediate compressor speed and temperature (T_j), dimensionless.

For each temperature bin where the heat pump operates at an intermediate compressor speed, determine $COP_{int-bin}(T_j)$ using the following equations,

For each temperature bin where $\dot{Q}_{h,low}(T_j) < BL(T_j) < \dot{Q}_{h,int}(T_j)$ –

$$COP_{int-bin}(T_j) = COP_{low}(T_j) + \frac{COP_{int}(T_j) - COP_{low}(T_j)}{\dot{Q}_{h,int}(T_j) - \dot{Q}_{h,low}(T_j)} * (BL(T_j) - \dot{Q}_{h,low}(T_j))$$

For each temperature bin where $\dot{Q}_{h,int}(T_j \leq BL(T_j) < \dot{Q}_{h,full}(T_j)$ –

$$COP_{int-bin}(T_j) = COP_{int}(T_j) + \frac{COP_{full}(T_j) - COP_{int}(T_j)}{\dot{Q}_{h,full}(T_j) - \dot{Q}_{h,int}(T_j)} * (BL(T_j) - \dot{Q}_{h,int}(T_j))$$

Where:

$COP_{low}(T_j)$ is the steady-state coefficient of performance of the heat pump when operating at minimum compressor speed and temperature T_j, dimensionless, calculated using capacity $\dot{Q}_{h,low}(T_j)$ calculated using Equation 3.8.2.2.1 and electrical power consumption $\dot{E}_{h,low}(T_j)$ calculated using Equation 3.8.2.2.2;

$COP_{int}(T_j)$ is the steady-state coefficient of performance of the heat pump when operating at intermediate compressor speed and temperature T_j, dimensionless, calculated using capacity $\dot{Q}_{h,int}(T_j)$ calculated using Equation 3.8.2.3–1 and electrical power consumption $\dot{E}_{h,int}(T_j)$ calculated using Equation 3.8.2.3–2;

$COP_{full}(T_j)$ is the steady-state coefficient of performance of the heat pump when operating at full compressor speed and temperature T_j, dimensionless, calculated using capacity $\dot{Q}_{h,full}(T_j)$ and electrical power consumption $\dot{E}_{h,full}(T_j)$, both calculated as described in section 3.8.2.1; and

$BL(T_j)$ is the building heating load at temperature T_j, Btu/h.

3.8.2.3.3 *Building load is higher than the full-stage capacity a* ($BL(T_j) > \dot{Q}_{h,full}$)

Calculate $\frac{RH(T_j)}{N}$ and $\frac{e_h(T_j)}{N}$ using instruction in section 3.8.2.2.3

4. Dehumidification Test Procedures

4.1 *Test Setup for Dehumidification Tests.* Install the unit according to section 6 of ANSI/ASHRAE 16–2016, subject to the following additional requirements:

4.1.1 *Makeup Air Inlet Duct Assembly.*

(1) Connect a makeup air inlet duct assembly as shown in Figure 1. The inlet duct assembly will include a nozzle airflow measuring apparatus and an inlet plenum, with interconnecting duct sections. The inlet plenum shall be insulated to a level of R–19. The interconnecting duct between the inlet plenum and the unit's makeup air inlet shall be insulated to a level or R–19 up to the inlet grill.

(2) The connecting duct between the code tester and the inlet plenum shall have cross-sectional dimensions such that the air velocity within it is no more than 200 fpm.

(3) The connecting duct between the inlet plenum and the makeup air inlet of the unit under test shall have dimensions equal to those of the dehumidification air inlet. If this is not possible due to interference of components within the unit under test, the dimensions of the duct may be different, but the cross-sectional area of the connecting duct shall be equal to that of the inlet. A hole shall be cut in the air inlet grill to make room for the duct. External to the inlet grill, the duct shall have an area-reducing section with reducing angle no greater than 45 degrees. At the connection to the inlet plenum, the connecting duct cross section shall be at least twice the cross section of the connection to the dehumidification air inlet. The duct shall extend beyond the grill such that the inlet plenum wall insulation is at least 3 inches distant from the grill.

(4) When testing a PTAC/HP with an integrated dehumidification system, the inlet plenum shall be located offset to the side, away from the center of the unit under test to impose minimal air flow restriction on outdoor coil air inlet and discharge.

(5) The inlet plenum shall have interior dimensions of at least 12 inches high and at least 12 inches wide in the plane perpendicular to air flow, and an interior dimension of at least 24 inches between the edges of the inlet and outlet ducts that are closest to each other.

(6) Install a thermocouple grid consisting of nine thermocouples in a three-by-three arrangement in the inlet air plenum upstream of the plane of the pressure taps

(7) Seal all duct connections between the code tester inlet and the connection to the unit's dehumidification air inlet.

(8) Use a nozzle airflow measuring apparatus as described in section 6.2 of ASHRAE 37–2009 with an adjustable fan to allow adjustment of the inlet plenum pressure. Set up the nozzle airflow measuring apparatus to take in outdoor room air and move it into the unit under test in a blow-through arrangement.

(9) If testing a makeup air PTAC/HP with an integrated dehumidification system, provide means to heat or cool the inlet air as needed to achieve the target makeup air dry bulb temperature at a location between the measurement of conditions at the nozzle airflow measuring apparatus inlet and the apparatus fan. The applied heating or cooling shall not affect the makeup air dew point temperature.

4.1.2 *Indoor air duct connection.* When testing a makeup air PTAC/HP with an add-on dehumidification system, test the system without connection of an indoor air duct. When testing a makeup air PTAC/HP with an integrated dehumidification system, if the cooling performance of the unit was tested using the psychrometric method, keep the indoor air duct assembly connected.

4.1.3 *Transfer Fan.* Install an adjustable transfer fan to transfer makeup air from the indoor room back to the outdoor room. The fan shall be adjustable to allow setting of the needed pressure differential when the target makeup air is passing through the test unit.

4.1.4 *Thermostatic plug.* Remove the thermostatic plug that prevents condensate drainage from the unit in cooling mode. Attach an adapter if needed, and a tube to transfer collected condensate to a measurement location in the outdoor room. Collect condensate in a bucket placed on a scale with mass measurement resolution of 1 gram. Provide a cover for the bucket to limit re-evaporation.

4.2 *Measurements*

4.2.1 *Pressure Measurement.* Consistent with section 6.5 of ASHRAE 37–2009, static pressure taps shall be placed at four locations around the inlet air plenum as shown in Figure 1, halfway between the nearest edges of the connecting ducts to the nozzle airflow measuring apparatus and the PTAC/HP makeup air inlet. The pressure taps shall be manifolded together as indicated section 6.5.3 of ASHRAE 37–2009. Measure pressure differential between the outdoor room and the inlet air plenum.

4.2.2 *Temperature Measurements.* Outdoor inlet dry bulb and wet bulb temperature shall be measured at the inlet of the nozzle airflow measurement apparatus, as described in ASHRAE 16–2016.

4.2.3 *Outdoor Coil Temperature Measurement for PTAC/HPs with Integrated Dehumidification Systems.* For PTAC/HPs with integrated dehumidification systems, measure outdoor coil temperature using provisions as described in this section, for both the cooling A_{full} test and all of the dehumidification tests. Attach a thermocouple with +/− 0.5 ºF measurement accuracy to a return bend at approximately the midpoint of the outdoor coil circuit.

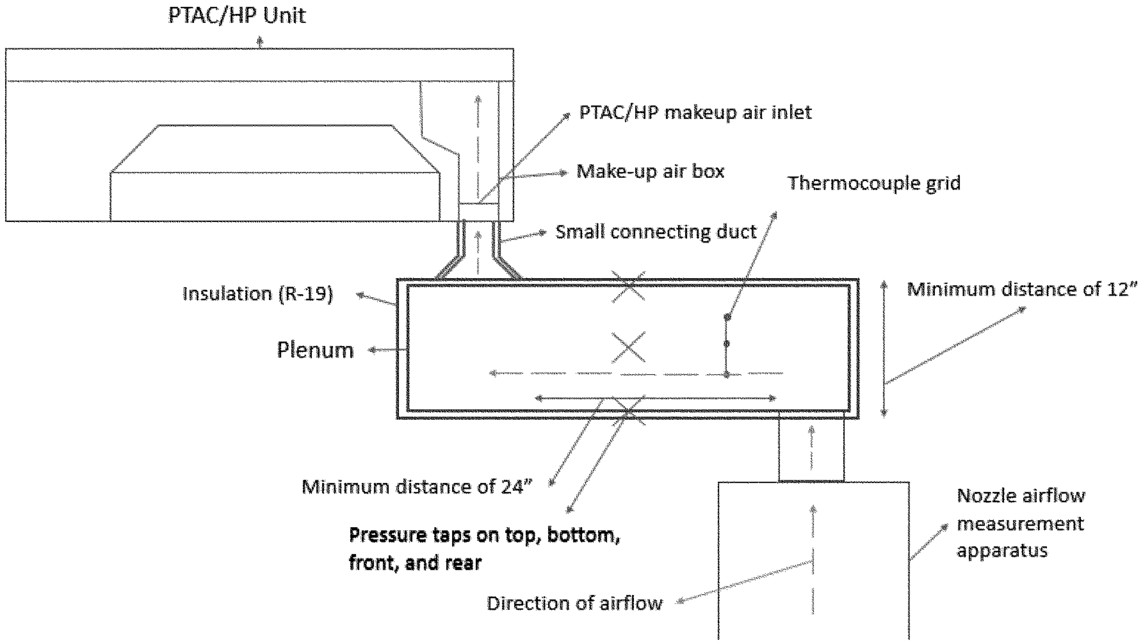

Figure 1 – Makeup Air Inlet Duct Assembly

Figure 1—Makeup Air Inlet Duct Assembly

4.4 Tests to be Conducted

4.4.1 *Units with Add-on dehumidification system*

4.4.1.1 *Preliminary Power Measurement.* Operate the PTAC/HP in fan-only mode or with the thermostat and fan controls set such that the indoor fan is energized, but the compressor and outdoor fan are not. Establish operating conditions as specified in Table 10, keeping indoor air dry bulb and wet bulb within 3 °F of specified values, and preliminarily setting dry bulb and dew point of air at the nozzle airflow measuring apparatus inlet within 3 °F of specified values. Make a preliminary measurement of PTAC/HP power input for a duration of 5 minutes when operating in this mode without the dehumidification system activated.

4.4.1.2 *Establishing Test Conditions.* Set up the makeup air flow by starting operation of the transfer fan and the nozzle airflow measuring apparatus fan. Activate the dehumidification system. Adjust the transfer fan and the nozzle airflow measuring apparatus fan so that the pressure differential from the inlet plenum to outdoor room is 0 +/−0.005 inches of W.C. and the certified airflow is flowing as measured by the nozzle airflow measuring apparatus. Adjust outdoor room conditions such that the dew point of air entering the nozzle airflow measuring apparatus matches the specified outdoor air dew point and the dry bulb temperature measured by the thermocouple grid in the inlet plenum matches the specified outdoor air dry bulb temperature, both within required tolerances as specified in Table 10 of this appendix.

4.4.1.3 *Equilibrium and Test Periods.* Equilibrium test conditions shall be maintained within tolerances shown in Table 10 for not less than one hour before recording data for the capacity test. The dehumidification test shall then be conducted over a 1-hour period, confirming that at no time any measured parameter exceeds the allowable tolerances specified in Table 10. Measurements of test conditions, input power and energy, and airflow shall be taken at least every 60 seconds and logged. Measurements of condensate mass shall be made every 10 minutes.

4.4.2 *Units with Integrated dehumidification*

4.4.2.1 *Preliminary Test*

4.4.2.1.1 Calculate the average coil temperature measured during the A_{full} cooling test using the temperature measurement described in section 4.2.3 of this section.

4.4.2.1.2 With the make-up airflow passage blocked as for the A_{full} test, but with the makeup air inlet duct assembly installed as described in section 4.1.1 of this appendix and with the condensate plug removed to allow collection of condensate as described in section 4.1.4 of this appendix, conduct a repeat of the A_{full} test. For this preliminary test, reduce outdoor room dry bulb temperature to a level for which the outdoor coil return bend temperature is within 0.5 °F of the temperature measured during the official A_{full} test. Measure capacity and latent capacity as described in ASHRAE 16–2016. Measure condensate every 10 minutes. Calculate latent capacity based on the condensate measurement as described in section 7.8.2.1 of ASHRAE 37–2009. When conditions have been stable for 60 minutes, as described in section 8.5.3 of ASHRAE 16–2016, measure performance for a 60 minute test period. The test is valid when energy balance requirements described in section 7 of ASHRAE 16–2016 have been met and the latent capacity calculated based on the condensate measurement is within 6 percent of the latent capacity measurement based on the psychrometric or calorimetric test method, whichever is used.

4.4.2.2 *Makeup air test*

4.4.2.2.1 Remove the blockage of the makeup air passage. Restart cooling operation as conducted for the preliminary test and set up the makeup air flow and conditions as described in section 4.4.1.2 of this appendix. However, maintain outdoor room dry bulb temperature within 0.3 °F of the average measured during the preliminary test, and set dry bulb temperature of the makeup air by adjusting the heating or cooling thereof using provisions set up in the nozzle airflow measuring apparatus as described in section 4.1.1(9) of this appendix.

4.4.2.2.2 When conditions have been stable for 60 minutes, as described in section 8.5.3 of ASHRAE 16–2016, measure performance for a 60 minute test period. The test is valid when energy balance requirements described in section 7 of ASHRAE 16–2016 have been met and the latent capacity calculated based on the condensate measurement is within 6 percent of the latent capacity measurement based on the psychrometric or calorimetric test method, whichever is used.

TABLE 9—DEHUMIDIFICATION TEST CONDITIONS

Air entering makeup air inlet temperatures (°F)		Air entering indoor side of unit temperature (°F)		Make-up air flow (scfm)
Dry bulb	Dew point	Dry bulb	Wet bulb	
95	67	80	67	30

TABLE 10—DEHUMIDIFICATION TEST TOLERANCES

Reading	Variation of arithmetic average from specified conditions (test condition tolerance)	Maximum observed range of readings (test operating tolerance)
Air entering makeup air inlet dry bulb (°F)	0.3	1.2
Dew point (°F)	0.5	1.5
Add-on dehumidification system test:		
Air entering indoor side dry bulb (°F)	3	5
Wet bulb (°F)	3	5
Integrated dehumidification system test:		
Air entering indoor side dry bulb (°F)	0.3	1.5
Wet bulb (°F)	0.3	1.0
Makeup airflow (scfm)	1	
Makeup airflow Nozzle pressure drop (%)		5

4.3 *Calculations*

4.3.1 *Dehumidifier capacity for PTAC/HP with add-on dehumidification system.* Calculate the capacity of an add-on dehumidification system using the data obtained and the formula:

$$C_d = 24 \times \frac{w_{d,add}}{\tau_{test}}$$

Where:

$w_{d,add}$ is the mass of collected condensate during the test period in pounds;
τ is the test period duration in hours; and
24 is a conversion from hours to 24-hour period.

4.3.2 *Dehumidifier capacity for PTAC/HP with integrated dehumidification system.* Calculate the capacity of an integrated dehumidification system using the data obtained and the formula:

$$C_d = 24 \times \left[\frac{w_{d,int}}{\tau_{test}} - \frac{w_{d,pre}}{\tau_{pre}}\right]$$

Where:

$w_{d,int}$ and $w_{d,pre}$ are the masses of collected condensate during the tests with the dehumidification system operative and non-operative, respectively, in pounds;
τ_{test} and τ_{pre} are the test period durations in hours for the test with the dehumidification system operative and the preliminary test with the system non-operative, respectively; and
24 is a conversion from hours to 24-hour period.

4.3.3 *Dehumidifier Capacity in Pints per 24 hours.* Calculate capacity in pints per 24 hours by dividing the capacity in pounds per 24 hours by 1.04.

4.3.4 *Dehumidification Energy Use.* Calculate the 24-hour energy use associated with system dehumidification as follows.

$$E_d = 24 \times \left[\frac{E_{test}}{\tau_{test}} - \frac{E_{pre}}{\tau_{pre}}\right]$$

Where:

E_{test} and E_{pre} are the energy use measured during the dehumidification test and the preliminary test, respectively, both in watt-hours (kWh);
τ_{test} and τ_{pre} are the durations of the dehumidification test and the preliminary test, respectively, both in hours; and
24 is a conversion from hours to 24-hour period.

4.3.5 *Dehumidification Efficiency.* Calculate the dehumidification efficiency DE as follows:

$$DE = \frac{C_d}{E_d} \times 0.454$$

Where:

C_d is dehumidification capacity in pounds per 24 hour period;
E_d is the energy use in kWh per 24 hour period; and
0.454 is a conversion factor from pounds to liters of water.
Values of DE shall be rounded to the nearest 0.01 L/kWh.

[FR Doc. 2023–08897 Filed 5–11–23; 8:45 am]

BILLING CODE 6450–01–P