This document, concerning room air-conditioners is an action issued by the Department of Energy. Though it is not intended or expected, should any discrepancy occur between the document posted here and the document published in the Federal Register, the Federal Register publication controls. This document is being made available through the Internet solely as a means to facilitate the public's access to this document.

[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

EERE-2017-BT-TP-0012

RIN 1904-AD47

Energy Conservation Program: Test Procedure for Room Air Conditioners

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

ACTION: Final rule.

SUMMARY: On June 11, 2020, the U.S. Department of Energy ("DOE") issued a notice of proposed rulemaking ("NOPR") to amend the test procedure for room air conditioners ("room ACs"). That proposed rulemaking serves as the basis for the final rule. Specifically, this final rule adopts the following updates to the test procedure for room ACs at appendix F: incorporate by reference current versions of applicable industry standards; establish test provisions to measure energy use of variable-speed room ACs during a representative average use cycle; update definitions to define key terms and support provisions for testing variable-speed room ACs; and incorporate specifications and minor corrections to improve the test procedure repeatability, reproducibility, and overall readability. This final rule does not modify the test procedures for single-speed room ACs and does not affect the measured energy use for these models. The provisions

established to measure energy use of variable-speed room ACs will improve the representativeness of the measured energy use of these models.

DATES: The effective date of this rule is **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER*]**. The final rule changes will be mandatory for product testing starting [**INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***]. The incorporation by reference of certain publications listed in the rule is approved by the Director of the Federal Register on [**INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***]. The incorporation by reference of certain other publications listed in this rulemaking were approved by the Director of the Federal Register on March 7, 2012 and July 31, 2015.

ADDRESSES: The docket, which includes *Federal Register* notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials, is available for review at *http://www.regulations.gov*. All documents in the docket are listed in the *http://www.regulations.gov* index. However, some documents listed in the index, such as those containing information that is exempt from public disclosure, may not be publicly available.

A link to the docket web page can be found at *https://www.regulations.gov/docket?D=EERE-2017-BT-TP-0012*. The docket web page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket contact the Appliance and Equipment Standards Program staff at (202) 287-1445 or by e-mail: *ApplianceStandardsQuestions@ee.doe.gov*.

FOR FURTHER INFORMATION CONTACT:

Mr. Bryan Berringer, 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) 586-0371. E-mail: *ApplianceStandardsQuestions@ee.doe.gov.*

Ms. Sarah Butler, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC 20585-0121. Telephone: (202) 586-1777. E-mail: *Sarah.Butler@hq.doe.gov*.

SUPPLEMENTARY INFORMATION:

DOE maintains previously approved incorporation by references and incorporates by reference the following industry standards into Title 10 Code of Federal Regulations ("CFR") part 430:

Association of Home Appliance Manufacturers ("AHAM") RAC-1-2020, ("AHAM RAC-1-2020"), "Room Air Conditioners;"

American National Standards Institute ("ANSI")/ American Society of Heating, Refrigerating, and Air-Conditioning Engineers ("ASHRAE") Standard 16-2016, ("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 October 31, 2016.

ANSI/ASHRAE Standard 41.1-2013, ("ANSI/ASHRAE Standard 41.1"), "Standard Method for Temperature Measurement;" ANSI approved January 30, 2013.

ANSI/ASHRAE Standard 41.2-1987 (RA 1992), ("ANSI/ASHRAE Standard 41.2-1987 (RA 1992)"), "Standard Methods for Laboratory Airflow Measurement;" ANSI reaffirmed April 20, 1992.

ANSI/ASHRAE Standard 41.3-2014, ("ANSI/ASHRAE Standard 41.3-2014"), "Standard Methods for Pressure Measurement;" ANSI approved July 3, 2014.

ANSI/ASHRAE Standard 41.6-2014, ("ANSI/ASHRAE Standard 41.6-2014"), "Standard Method for Humidity Measurement;" ANSI approved July 3, 2014.

ANSI/ASHRAE Standard 41.11-2014, ("ANSI/ASHRAE Standard 41.11-2014"), "Standard Methods for Power Measurement;" ANSI approved July 3, 2014.

International Electrotechnical Commission ("IEC") Standard 62301, ("IEC Standard 62301 Second Edition"), "Household electrical appliances—Measurement of standby power, (Edition 2.0, 2011-01)".

Copies of AHAM RAC-1-2020 can be obtained from the Association of Home Appliance Manufacturers at *https://www.aham.org/ht/d/Store/*. Copies of ANSI/ASHRAE Standard 16-2016, ANSI/ASHRAE Standard 41.1-2013, ANSI/ASHRAE Standard 41.2-1987, ANSI/ASHRAE Standard 41.3-2014, ANSI/ASHRAE Standard 41.6-2014, and ANSI/ASHRAE Standard 41.11-2014 can be obtained from the American National Standards Institute at *https://webstore.ansi.org/*.

Copies of IEC Standard 62301 can be obtained from *http://webstore.iec.ch.*

See section IV.N of this document for additional information on these standards.

Table of Contents

I. Authority and Background

Room ACs are included in the list of "covered products" for which DOE is authorized to establish and amend energy conservation standards and test procedures. (42 U.S.C. 6292(a)(2)) DOE's energy conservation standards and test procedure for room ACs are currently prescribed at 10 CFR 430.32(b) and 10 CFR 430.23(f), respectively. The following sections discuss DOE's authority to establish test procedures for room ACs and relevant background information regarding DOE's consideration of test procedures for this product.

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 B[2] of EPCA established the Energy Conservation Program for Consumer Products Other Than Automobiles, which sets forth a variety of provisions designed to improve energy efficiency. These products include room ACs, the subject of this document. (42 U.S.C. 6292(a)(2))

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 specifically include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

The testing requirements consist of test procedures that manufacturers of covered products must use as the basis for (1) certifying to DOE that their products comply with the applicable energy conservation standards adopted under EPCA (42 U.S.C. 6295(s)), and (2) making representations about the efficiency of those products (42 U.S.C. 6293(c)). Similarly, DOE must use these test procedures to determine whether the products comply with any relevant standards promulgated under EPCA. (42 U.S.C. 6295(s))

[1] All references to EPCA in this document refer to the statute as amended through Energy Act of 2020, Public Law 116-260 (Dec. 27, 2020).
[2] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated Part A.

Federal energy efficiency requirements for covered products established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (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. 6297(d))

Under 42 U.S.C. 6293, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered products. EPCA provides that any test procedures prescribed or amended under this section shall be reasonably designed to produce test results which measure energy efficiency, energy use or estimated annual operating cost of a covered product during a representative average use cycle or period of use and shall not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3))

EPCA also requires that, at least once every 7 years, DOE evaluate test procedures for each type of covered product, including room ACs, to determine whether amended test procedures would more accurately or fully comply with the requirements of 42 U.S.C. 6293(b)(3). (42 U.S.C. 6293(b)(1)(A)) If the Secretary determines, on his own behalf or in response to a petition by any interested person, that a test procedure should be prescribed or amended, the Secretary shall promptly publish in the *Federal Register* proposed test procedures and afford interested persons an opportunity to present oral and written data, views, and arguments with respect to such procedures. The comment period on a proposed rule to amend a test procedure shall be at least 60 days and may not exceed 270 days. In prescribing or amending a test procedure, the Secretary shall take into account such information as the Secretary determines relevant to such procedure, including technological developments relating to energy use or energy efficiency of the type (or class) of covered products involved. (42 U.S.C. 6293(b)(2)) If DOE determines that test procedure revisions are not appropriate, DOE must publish its determination not to amend the test procedures. DOE is publishing this final rule in satisfaction of the 7-year review requirement specified in EPCA. (42 U.S.C. 6293(b)(1)(A))

In addition, EPCA requires that DOE amend its test procedures for all covered products to integrate measures of standby mode and off mode energy consumption into the overall energy efficiency, energy consumption, or other energy descriptor, unless the current test procedure already incorporates the standby mode and off mode energy consumption, or if such integration is technically infeasible. (42 U.S.C. 6295(gg)(2)(A)) If an integrated test procedure is technically infeasible, DOE must prescribe separate standby mode and off mode energy use test procedures for the covered product, if a separate test is technically feasible. (*Id.*) Any such amendment must consider the most current versions of the International Electrotechnical Commission ("IEC") Standard 62301[3] and IEC Standard 62087[4] as applicable. (42 U.S.C. 6295(gg)(2)(A))

B. Background

[3] IEC 62301, *Household electrical appliances—Measurement of standby power* (Edition 2.0, 2011-01).
[4] IEC 62087, *Methods of measurement for the power consumption of audio, video, and related equipment* (Edition 3.0, 2011-04).

DOE's existing test procedure for room ACs appears at Title 10 of the CFR part 430, subpart B, appendix F ("Uniform Test Method for Measuring the Energy Consumption of Room Air Conditioners" ("appendix F")), and the room AC performance metric calculations are codified at 10 CFR 430.23(f). DOE most recently amended the test procedure for room ACs in a final rule published on January 6, 2011, (hereafter the "January 2011 Final Rule"), which added a test procedure to measure standby mode and off mode power and to introduce a new combined efficiency metric, Combined Energy Efficiency Ratio ("CEER"), that accounts for energy consumption in active mode, standby mode, and off mode. 76 FR 971.

The previous room AC test procedure incorporates by reference three industry test methods: (1) American National Standards Institute ("ANSI")/ Association of Home Appliance Manufacturers ("AHAM") RAC-1-2008, "Room Air Conditioners" ("ANSI/AHAM RAC-1-2008"),[5] (2) ANSI/ American Society of Heating, Refrigerating, and Air-Conditioning Engineers ("ASHRAE") Standard 16-1983 (RA 2009), "Method of Testing for Rating Room Air Conditioners and Packaged Terminal Air Conditioners" ("ANSI/ASHRAE Standard 16-2009"),[6] and (3) IEC Standard 62301, "Household electrical appliances – Measurement of standby power (first edition June 2005)" ("IEC Standard 62301 First Edition").[7]

[5] Copies can be purchased from *http://webstore.ansi.org*
[6] Copies can be purchased from *http://www.techstreet.com*
[7] Copies can be purchased from *http://webstore.iec.ch*.

On May 8, 2019, DOE published a Decision and Order, granting a waiver for certain room AC models with variable-speed capabilities in response to a petition from LG Electronic USA, Inc. (“LG”). 84 FR 20111 (“LG Waiver”). As required under the waiver, the specified LG variable-speed room ACs must be tested at four different outdoor temperatures instead of a single outdoor temperature, with the unit compressor speed fixed at each temperature. This approach for the alternate test procedure was derived from the current DOE test procedure for central air conditioners (10 CFR part 430, subpart B, appendix M (“appendix M”)). The LG Waiver provides definitions for each fixed compressor speed, adjusts the annual energy consumption and operating cost calculations that provide the basis for the information presented to consumers on the EnergyGuide Label, and requires that compressor speeds be set in accordance with instructions submitted to DOE by LG on April 2, 2019.[8] 84 FR 20111, 20118–20121.

On May 26, 2020, DOE published a Decision and Order, granting a waiver to GD Midea Air Conditioning Equipment Co. LTD. (“Midea”) for six variable-speed basic models with the condition that Midea must test and rate these models according to an alternate test procedure that is substantively consistent with that prescribed by in the LG Waiver, and report product-specific information that reflects the alternate test procedure. 85 FR 31481 (“Midea Waiver”).

On June 11, 2020, DOE published a notice of proposed rulemaking (“June 2020 NOPR”) proposing amendments to the test procedures for room ACs to: (1) update to the

[8] While the instructions provided by LG on April 2, 2019 are listed in the docket for this rulemaking, they were marked as confidential and were treated accordingly.

latest versions of industry test methods that are incorporated by reference; (2) adopt new testing provisions for variable-speed room ACs that reflect the relative efficiency gains at reduced cooling loads; (3) adopt new definitions consistent with these two proposed amendments; and (4) provide specifications and minor corrections to improve the test procedure repeatability, reproducibility, and overall readability. 85 FR 35700.

DOE received comments in response to the June 2020 NOPR from the interested parties listed in Table II.1.

Table II.1 June 2020 NOPR Written Comments

Commenter(s)	**Reference in this NOPR**	**Commenter Type**
Association of Home Appliance Manufacturers	AHAM	Trade Association
California Investor-Owned Utilities	California IOUs	Utility
Appliance Standards Awareness Project ("ASAP"), American Council for an Energy-Efficient Economy ("ACEEE"), Natural Resources Defense Council ("NRDC")	Joint Commenters	Efficiency Organizations
Northwest Energy Efficiency Alliance	NEAA	Efficiency Organization
Keith Rice	Rice	Consultant
GE Appliances, a Haier Company	GEA	Manufacturer

Subsequent to the publication of the June 2020 NOPR, on September 23, 2020, DOE granted GE Appliances, a Haier Company ("GEA)" an interim waiver from the room AC test procedure for the 18 basic models listed in GEA's petition, using an alternate test procedure consistent with that granted to Midea in the Midea Waiver. 85 FR 59770. ("GEA Interim Waiver")

Additionally, on February 14, 2020, DOE published its updated Process Rule to improve the internal framework for establishing new energy efficiency regulations, with the goal of increasing transparency, accountability, and certainty for stakeholders. 85 FR 8626. As required under the updated Process Rule, DOE will adopt industry test standards as DOE test procedures for covered products and equipment, unless such methodology would be unduly burdensome to conduct or would not produce test results that reflect the energy efficiency, energy use, water use (as specified in EPCA) or estimated operating costs of that equipment during a representative average use cycle. Section 8(c) of 10 CFR part 430 subpart C appendix A. *See also*, 85 FR 8626, 8708.

II. Synopsis of the Final Rule

In this final rule, DOE amends the existing test procedure for room ACs to: (1) incorporate by reference current versions of the applicable industry standards; (2) adopt test provisions for variable-speed room ACs that reflect energy efficiency during a representative average use cycle; (3) update definitions to define key terms and support the adopted provisions for testing variable-speed room ACs; and (4) update specifications and implement minor corrections to improve the test procedure repeatability, reproducibility, and overall readability.

DOE has determined that the amendments will both provide efficiency measurements more representative of the energy efficiency of variable-speed room ACs and will not alter the measured efficiency of single-speed room ACs, which constitute the large majority of units on the market. DOE has determined that the amended test procedure will not be unduly burdensome to conduct. DOE's actions are summarized in Table II.2 and addressed in detail in section III of this document.

Table II.2 Summary of Changes in the Amended Test Procedure

Previous DOE Test Procedure	Amended Test Procedure	Attribution
References industry standards- • ANSI/AHAM RAC-1-2008, • ANSI/ASHRAE Standard 16-2009, and • IEC Standard 62301 First Edition.	Updates references to applicable sections of: • AHAM RAC-1-2020, • ANSI/ASHRAE Standard 16-2016 (including relevant cross-referenced industry standards), and • IEC Standard 62301 Second Edition.	Industry test procedure updates.
Testing, calculation of CEER metric, and certification for all room ACs based on single temperature rating condition.	Relevant definitions, testing, calculation of CEER metric, and certification for variable-speed room ACs based on additional reduced outdoor temperature test conditions.	In response to test procedure waivers
Definitions – - Definition of "room air conditioner" does not explicitly include function of providing cool conditioned air to an enclosed space, and references "prime," an undefined term, to describe the source of refrigeration. - "Cooling mode," "cooling capacity," "combined energy efficiency ratio," are undefined terms.	- Adds the word "cooled" to describe the conditioned air a room AC provides and the phrase "notwithstanding ASHRAE 16 and RAC-1 (incorporated by reference; see § 430.3)" to reiterate that the DOE definition takes precedence over conflicting language in relevant industry standards, in the definition of "room air conditioner" and removes "prime" from the definition. - Adds definition for "cooling mode," "cooling capacity," and "combined energy efficiency ratio."	Added by DOE (clarification)
Appendix F does not explicitly identify the scope of the test procedure.	Creates new section indicating the appendix applies to the energy performance of room ACs.	Added by DOE (specifies the applicability of the test procedure)
Provides that test unit be installed in a manner similar to consumer installation.	-References ANSI/ASHRAE Standard 16-2016, specifying that the perimeter of louvered room ACs be sealed to the separating partition, consistent with common testing practice. -Specifies that non-louvered room ACs be installed inside a compatible wall sleeve, with the manufacturer-provided installation materials.	Industry test procedure update and added by DOE (additional installation specifications)
Calculations for average annual energy consumption, combined annual energy consumption, energy efficiency ratio ("EER"), and CEER are located in 10 CFR 430.23(f)	-Moves calculations for CEER and annual energy consumption for each operating mode into appendix F. -Removes EER calculation and references entirely, as it is obsolete.	Added by DOE (improve readability)

The effective date for the amended test procedure adopted in this final rule is 30 days after publication of this document in the *Federal Register*. Representations of energy use or energy efficiency must be based on testing in accordance with the amended test procedure beginning 180 days after the publication of this final rule.

III. Discussion

A. Room Air Conditioner Definition

DOE defines a "room air conditioner" as a consumer product, other than a packaged terminal air conditioner, which is powered by a single-phase electric current and which is an encased assembly designed as a unit for mounting in a window or through the wall for the purpose of providing delivery of conditioned air to an enclosed space. It includes a prime source of refrigeration and may include a means for ventilating and heating. 10 CFR 430.2.

In the June 2020 NOPR, DOE proposed adding the term "cooled" to the room AC definition, so that it refers to a system that "…delivers *cooled*, conditioned air to an enclosed space…" (emphasis added). 85 FR 35700, 35705 (Jun. 11, 2020). DOE believed that this revised wording would better represent the key function of a room AC, and would avoid any potential for the room AC definition to cover other indoor air quality systems that could be described as "conditioning" the air, but that would not be appropriately included within the scope of coverage of a room AC. *Id.*

Additionally, as described previously, the previous definition of room AC specified that it includes a prime source of refrigeration. *Id.* DOE contended that using the word "prime" to describe the source of refrigeration in the previous definition was extraneous and could be construed as referring to a "primary" refrigeration system, a distinction that could inadvertently exclude future products that implement a different technology as the primary source of air conditioning, while implementing a refrigeration loop as the "secondary" means of cooling or heating. *Id.* Primary and secondary means of conditioning air are not uncommon in certain refrigeration products and chiller systems; in fact, some room ACs with heating functionality implement a resistance heater as a supplemental form of heating to the primary heat pump, for use under extreme temperature conditions. DOE also noted that the recently codified portable AC definition was not limited to products with a prime source of refrigeration. *Id.* For these reasons, DOE proposed to remove the word "prime" from the room AC definition.

DOE also proposed to add to the phrase "notwithstanding ASHRAE 16 and RAC-1 (incorporated by reference; see § 430.3)," to the room air conditioner definition to reiterate that the DOE definition takes precedence over conflicting language in relevant industry standards. *Id.* Additionally, DOE proposed to reorganize the room AC definition to improve its readability. *Id.* The minor editorial revisions and specifications discussed in this section do not modify the scope of the room AC definition.

In summary, DOE proposed to modify the room AC definition in 10 CFR 430.2 to read as follows:

"*Room air conditioner* means a window-mounted or through-the-wall-mounted encased assembly, other than a 'packaged terminal air conditioner,' that delivers cooled, conditioned air to an enclosed space, and is powered by single-phase electric current. It includes a source of refrigeration and may include additional means for ventilating and heating, notwithstanding ASHRAE 16 and RAC-1 (incorporated by reference; see § 430. 3)."

AHAM supported DOE's proposed amendments to the definition of room air conditioner which are consistent, though not verbatim, with the definitions in AHAM RAC-1-2020. (AHAM, No. 13 at p. 6)[9] DOE did not receive any comment in opposition to the proposed definition. For the reasons provided in the June 2020 NOPR, DOE adopts the definition of "room air conditioner" as proposed.

In the June 2020 NOPR, DOE also proposed to further specify the scope of coverage of appendix F by adding a new "Scope" section stating that appendix F contains the test requirements used to measure the energy performance of room ACs. In doing so, DOE would explicitly limit the scope of products tested in accordance with appendix F, and appendix F would be consistent with test procedures for other similar covered products in that it would include an introductory statement of scope.

[9] A notation in the form "AHAM, No. 13 at p. 6" identifies a written comment: (1) made by the Association of Home Appliance Manufacturers; (2) recorded in document number 13 that is filed in the docket of this test procedure rulemaking (Docket No. EERE-2017-BT-TP-0012-0008) and available for review at *http:// www.regulations.gov*; and (3) which appears on page 6 of document number 13.

There were no comments pertaining to this addition. DOE adds this new provision to appendix F as proposed.

B. Industry Test Standards

The DOE room AC test procedure in appendix F references the following two industry standards as the basis of the cooling mode test: ANSI/AHAM RAC-1-2008 and ANSI/ASHRAE Standard 16-2009. ANSI/AHAM RAC-1-2008 provides the specific test conditions and associated tolerances, while ANSI/ASHRAE Standard 16-2009 describes the test setup, instrumentation and procedures used in the DOE test procedure. The cooling capacity, efficiency metric, and other indicators are calculated based on the results obtained through the application of these test methods, as described in appendix F and 10 CFR 430.23(f).

Updated versions of AHAM RAC-1 and ANSI/ASHRAE Standard 16 have been released since the publication of the previous DOE test procedure. DOE assessed the updated versions of these standards to determine whether a DOE test procedure that adopted the updated industry standards would produce test results which measure energy efficiency of room ACs during a representative average use cycle without being unduly burdensome to conduct.

1. AHAM RAC-1

The cooling mode test in appendix F is conducted in accordance with the testing conditions, methods, and calculations in Sections 4, 5, 6.1, and 6.5 of ANSI/AHAM RAC-1-2008, as summarized in Table III-1.

Table III-1: Summary of ANSI/AHAM RAC-1-2008 Sections Referenced in Appendix F

Section	Description
4	General test requirements, including power supply and test tolerances
5	Test conditions and requirements for a standard measurement test
6.1	Determination of cooling capacity in British thermal units per hour ("Btu/h")
6.5	Determination of electrical input in watts ("W")

In the June 2020 NOPR, DOE proposed to incorporate by reference ANSI/AHAM RAC-1-2015 but limit the section references in appendix F to cooling mode-specific sections of ANSI/AHAM RAC-1-2015 (by excluding standby mode, off mode, and heating mode sections), and to update the section reference for measuring electrical power input. 85 FR 35700, 35706 (Jun. 11, 2020). ANSI/AHAM RAC-1-2015 introduced new provisions for the measurement of standby mode and off mode power in Section 6.3, as well as the calculations for annual energy consumption and CEER in Sections 6.4 through 6.8. Because those updates do not impact the sections relevant to appendix F, DOE noted in the June 2020 NOPR that it expects that updating the references to ANSI/AHAM RAC-1-2015 in appendix F would not substantively affect test results or test burden. *Id.* ANSI/AHAM RAC-1-2015 added test requirements and conditions for standby mode and off mode, and heating mode in Sections 4 and 5, respectively. Because the DOE test procedure already addresses standby mode and off mode testing but not heating mode, which is now included in ANSI/AHAM RAC-1-2015, and to avoid confusion regarding the appropriate applicability of ANSI/AHAM RAC-1-2015, DOE proposed in the June 2020 NOPR to update the existing references to Sections 4 and 5 of ANSI/AHAM RAC-1-2008 in appendix F with references to only the cooling mode-specific subsections of ANSI/AHAM RAC-1-2015: Sections 4.1, 4.2, 5.2.1.1, and 5.2.4. *Id.*

DOE also noted in the June 2020 NOPR that the provisions in ANSI/AHAM RAC-1-2015 for measuring electrical power input appear in Section 6.2, rather than Section 6.5 of ANSI/AHAM RAC-1-2008. To reflect this change in section numbers, DOE proposed to update appendix F to reference Section 6.2 of ANSI/AHAM RAC-1-2015 to determine the electrical power input in cooling mode. *Id.*

Since the June 2020 NOPR, AHAM RAC-1 has been updated and the current standard was released in September 2020 as AHAM RAC-1-2020, "Room Air Conditioners" (AHAM RAC-1-2020). Unlike ANSI/AHAM RAC-1-2015, AHAM RAC-1-2020 includes a test method for products with variable-speed compressor units; allows for voluntary testing inside a psychometric chamber; removes the tests for uncommon water-cooled units as well as the sweat, drip, and heating tests; and updates references to the most recent versions of other industry standards—AHAM RAC-1-2020 references ANSI/ASHRAE Standard 16-2016, for reasons outlined below, and IEC Standard 62301 Second Edition for standby power measurement.[10]

AHAM and GEA urged DOE to adopt AHAM RAC-1-2020. AHAM commented that this test procedure is identical to the existing test procedure waivers and the test procedure proposed in the June 2020 NOPR. AHAM further commented that uncommon

[10] Copies of AHAM RAC-1-2020 can be purchased from the Association of Home Appliance Manufacturers at 1111 19th Street NW, Suite 402, Washington, DC 20036, 202-872-5955, or by going to *http://www.aham.org*.

practices such as water-cooled unit testing have been eliminated and tests irrelevant to energy and capacity measurement such as the sweat, drip, and heating tests have been removed from AHAM RAC-1-2015 such that the AHAM RAC-1-2020 procedure is now consistent with the scope of the DOE test procedure. AHAM stated that AHAM RAC-1-2020 does allow for voluntary testing in a psychrometric (air-enthalpy) chamber, which DOE declined to propose for adoption in the June 2020 NOPR. AHAM and GEA further stated that adopting AHAM RAC-1-2020 as the DOE test procedure would not change the substance of DOE's proposed rule unless DOE were to consider allowing voluntary testing in a psychrometric chamber. AHAM asserted that AHAM RAC-1-2020 is not unduly burdensome to conduct and produces results that reflect the energy efficiency of room ACs during a representative average use cycle. (AHAM, Public Meeting Transcript, No. 12 at pp. 9−10, 21; AHAM, No. 13 at p. 2; GEA, No. 18 at p. 1)[11] AHAM further noted that, at the time of the June 2020 NOPR comment period, AHAM RAC-1-2020 had not yet been published. However, in an additional comment submitted on December 18, 2020, AHAM confirmed publication of AHAM RAC-1-2020 and that it is consistent with what AHAM stated it would be in their previous comment. (AHAM, No. 20 at pp. 1−2)

Consistent with the comments received, DOE has determined that AHAM RAC-1-2020 generally provides results that are representative of an average use cycle of room

[11] A notation in the form "AHAM, Public Meeting Transcript, No. 12 at pp. 9-10, 21" identifies an oral comment that DOE received on August 6, 2020 during the public meeting, and was recorded in the public meeting transcript in the docket for this test procedure rulemaking (Docket No. EERE-2017-BT-TP-0012-0012). This particular notation refers to a comment (1) made by AHAM during the public meeting; (2) recorded in document number 12, which is the public meeting transcript that is filed in the docket of this test procedure rulemaking; and (3) which appears on pages 9 through 10 and 21 of document number 12.

ACs, including room ACs that are variable-speed, and is not unduly burdensome to conduct. Therefore, DOE is adopting AHAM RAC-1-2020 as a referenced standard for the DOE room AC test procedure in appendix F, with modifications that DOE has determined are necessary to improve the representativeness and repeatability of the test procedure. The modifications are discussed in further detail in the sections that follow.

2. *ANSI/ASHRAE Standard 16*

Appendix F previously referenced the 1983 version of ANSI/ASHRAE Standard 16, which was reaffirmed in 2009, for cooling mode temperature conditions, methods, and calculations.

In the June 2020 NOPR, DOE proposed to reference sections of ANSI/ASHRAE Standard 16-2016 in appendix F. 85 FR 35700, 35707 (Jun. 11, 2020). In the June 2020 NOPR, DOE stated that ANSI/ASHRAE Standard 16-2016 made a number of updates to the industry standard, including an air-enthalpy test approach as an alternative to the calorimeter approach, heating mode testing, additional clarification on placement of air samplers and thermocouples, stability requirement definitions, and new figures for additional tests and to also improve previous figures. 85 FR 35700, 35706 (Jun. 11, 2020). DOE initially determined, however, that the general cooling mode methodology remains unchanged. *Id.* The addition of the air-enthalpy approach provides more flexibility in conducting the tests, and the heating mode test is based on the tests previously included in ANSI/ASHRAE Standard 58–1986 “Method of Testing for Rating Room Air Conditioner and Packaged Terminal Air Conditioner Heating Capacity.”

In the June 2020 NOPR DOE stated that the general calorimeter test methodology is unchanged in ANSI/ASHRAE Standard 16–2016 and tentatively determined that the additional detail and clarifying updates would improve the repeatability and reproducibility of test results. *Id.* ANSI/ASHRAE Standard 16–2016 provides best practices for thermocouple and air sampler placement, recognizing that the unique characteristics of each test chamber will result in particular air flow and temperature gradients in the chamber, influenced by the interaction of the reconditioning equipment and the test unit. These practices address the distances for placing the air sampler from the unit discharge points and thermocouple spacing on the air sampling device. Figure 1 and Figure 2 of ANSI/ASHRAE Standard 16 are updated with additional details and references. Section 5 of ANSI/ASHRAE Standard 16-2016 includes additional provisions regarding instrument calibration and accuracy. ANSI/ASHRAE Standard 16-2016 requires measuring data at more frequent intervals to minimize the sensitivity of the final average value to variations in individual data points, resulting in a more repeatable and reproducible test procedure. Based on DOE's experience with testing at various test laboratories, requiring more frequent data measurements will have minimal impact on testing burden because most testing laboratories are already using a data acquisition system that has the capability to take more frequent measurements.

In urging DOE to incorporate AHAM RAC-1-2020, AHAM and GEA supported the incorporation of relevant sections of the 2016 version of ANSI/ASHRAE Standard 16, ANSI/ASHRAE Standard 16-2016. In AHAM RAC-1-2020, AHAM adopted the most current industry standards, including ANSI/ASHRAE Standard 16-2016. (AHAM, Public Meeting Transcript, No. 12 at pp. 9−10; AHAM, No. 13 at p. 2; GEA, No. 18 at p. 1)

For these reasons provided in the June 2020 NOPR and in this document, and in consideration of the comments received in support of ANSI/ASHRAE Standard 16-2016, DOE is updating appendix F to reference ANSI/ASHRAE Standard 16–2016.

ANSI/ASHRAE Standard 16-2016 also updates requirements for the accuracy of instruments. The 2009 reaffirmation of ANSI/ASHRAE Standard 16 requires, in Section 5.4.2, accuracy to ±0.5 percent of the quantity measured for instruments used for measuring all electrical inputs to the calorimeter compartments. ANSI/ASHRAE Standard 16-2016, in Section 5.6.2, no longer broadly includes any inputs and instead includes more specific language (*e.g.,* it explicitly mentions the power input to the test unit, heaters, and other cooling load contributors). To ensure that the electrical input for all key equipment is properly measured, in the June 2020 NOPR, DOE proposed to maintain the accuracy requirement of ±0.5 percent of the quantity measured for instruments used for measuring all electrical inputs, to the test unit, all reconditioning equipment, and any other equipment that operates within the calorimeter walls. 85 FR 35700, 35707 (Jun. 11, 2020).

No comments were received pertaining to this reference. While DOE is incorporating by reference ANSI/ASHRAE Standard 16-2016 generally, DOE maintains that the instrument accuracy of ±0.5 percent of the quantity measured is applicable to all devices measuring electrical input for the room AC test procedure, and not just those explicitly mentioned in ANSI/ASHRAE Standard 16-2016.

3. *ANSI/ASHRAE Standards 41.1, 41.2, 41.3, 41.6, and 41.11*

ANSI/ASHRAE Standard 16-2016 references industry standards in specifying certain test conditions and measurement procedures. In the June 2020 NOPR, DOE proposed to incorporate those industry standards specified in the relevant sections of ANSI/ASHRAE Standard 16-2016. Specifically, DOE proposed to incorporate by reference: ANSI/ASHRAE Standard 41.1-2013, "Standard Method for Temperature Measurement, as referenced in ANSI/ASHRAE Standard 16-2016 Section 5.1.1 for all temperature measurements except for dew-point temperature; ANSI/ASHRAE Standard 41.2-1987 (RA 1992), "Standard Methods for Laboratory Airflow Measurement," as referenced in Section 5.5.1 of ANSI/ASHRAE Standard 16-2016 for airflow measurements; ANSI/ASHRAE Standard 41.3-2014, "Standard Methods for Pressure Measurement," as referenced in Section 5.2.5 of ANSI/ASHRAE Standard 16-2016 for the prescribed use of pressure measurement instruments; ANSI/ASHRAE Standard 41.6-2014, "Standard Method for Humidity Measurement," as referenced in Section 5.1.2 of ANSI/ASHRAE Standard 16-2016 for measuring dew-point temperatures using hygrometers; and ANSI/ASHRAE Standard 41.11-2014, "Standard Methods for Power Measurement," as referenced in Section 5.6.4 of ANSI/ASHRAE Standard 16-2016 regarding the use and application of electrical instruments during tests. Incorporating these standards would clarify which versions of the standards are required to conduct tests according to the procedure in appendix F. 85 FR 35700, 35707 (Jun. 11, 2020).

DOE received no comments on the proposal to incorporate ANSI/ASHRAE Standard 41.1-2013, ANSI/ASHRAE Standard 41.2-1987 (RA 1992), ANSI/ASHRAE Standard 41.3-2014, ANSI/ASHRAE Standard 41.6-2014, and ANSI/ASHRAE Standard 41.11-2014 in appendix F. DOE is adopting its proposal to incorporate those industry standards appendix F.

C. Variable-Speed Room Air Conditioner Test Procedure

Historically, room ACs have been designed using a single-speed compressor, which operates at full cooling capacity while the compressor is on. To match the cooling load of the space, which in most cases is less than the full cooling capacity of the compressor, a single-speed compressor cycles on and off. This cycling behavior generally introduces inefficiencies in refrigeration system performance. Variable-speed room ACs became available on the U.S. market in 2018. These models employ an inverter compressor that can reduce its speed to provide continuous cooling that matches the observed cooling load. Accordingly, a variable-speed compressor runs continuously, adjusting its speed up or down as required. In addition to reducing or eliminating cycling inefficiencies, in a variable-speed unit operating at reduced capacity the evaporator and condenser heat exchange effectiveness are improved, since they are handling reduced loads, thereby improving compressor efficiency.

The previous DOE test procedure measured the performance of a room AC while operating under a full cooling load; *i.e.*, the compressor is operated continuously in its "on" state. As a result, the DOE test does not capture any inefficiencies due to compressor cycling. Consequently, the efficiency gains that can be achieved by variable-speed room ACs due to the avoidance of cycling losses were not measured by the previous test procedure.

In the June 2020 NOPR, DOE presented the results of its investigative testing to quantify the impacts of cycling losses and the relative efficiency benefits of a variable-speed compressor. 85 FR 35700, 35707-35708 (Jun. 11, 2020). DOE compared the performance of two variable-speed room ACs from two different manufacturers, with single-speed room AC of similar capacity from the same manufacturers, under reduced cooling load conditions.[12] DOE installed each room AC in a calorimeter test chamber, set the unit thermostat to 80 degrees Fahrenheit (°F), and applied a range of fixed cooling loads to the indoor chamber.[13,14] The calorimeter chamber conditioning system was configured to apply a fixed cooling load rather than maintaining constant indoor chamber temperature, 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.[15] Figures III-1 and III-2 show the efficiency gains and losses for the range of reduced cooling loads tested for each unit, relative to the performance of each unit as tested using appendix F.[16]

[12] The first room AC was tested under the 95 °F outdoor test condition (Figure III-1), the second under the 82 °F outdoor test condition (Figure III-2), and the change in EER and load from full-load used for each test was determined based on an appendix F test with the noted outdoor test condition.
[13] 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.
[14] 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).
[15] DOE notes that this test chamber configuration differs from the configuration used in appendix F. Appendix F uses a constant-temperature configuration, in which the indoor chamber temperature is held fixed (*i.e.*, the indoor temperature does not drop while the room AC is operational).
[16] For single-speed room ACs under appendix F, the thermostat is typically set as low as possible to ensure that the unit provides maximum cooling during the cooling mode test period.

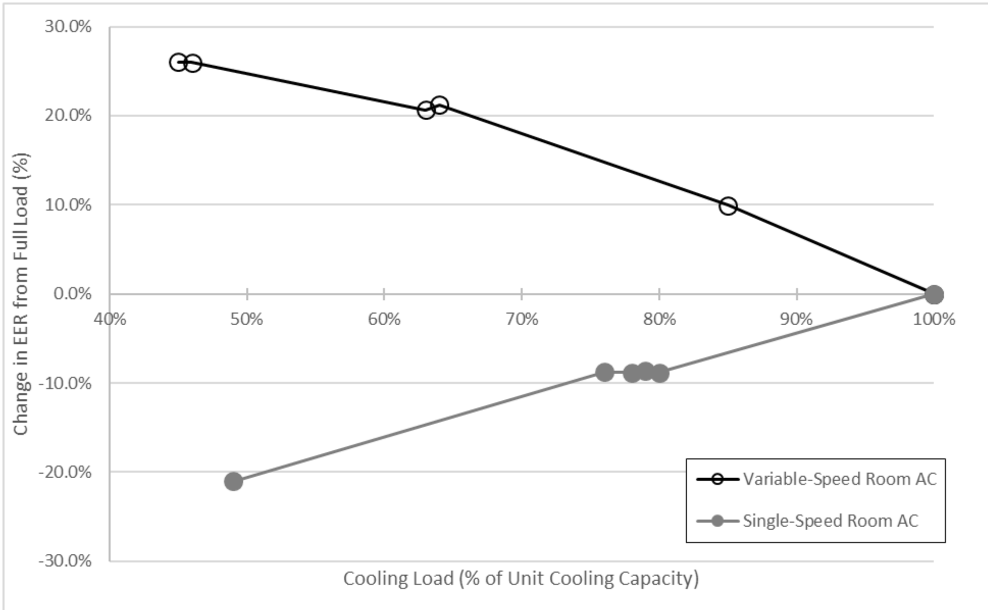

Figure III-1 Change in EER for Reduced Cooling Loads at 95 °F Outdoor Dry-Bulb Temperature, Unit 1

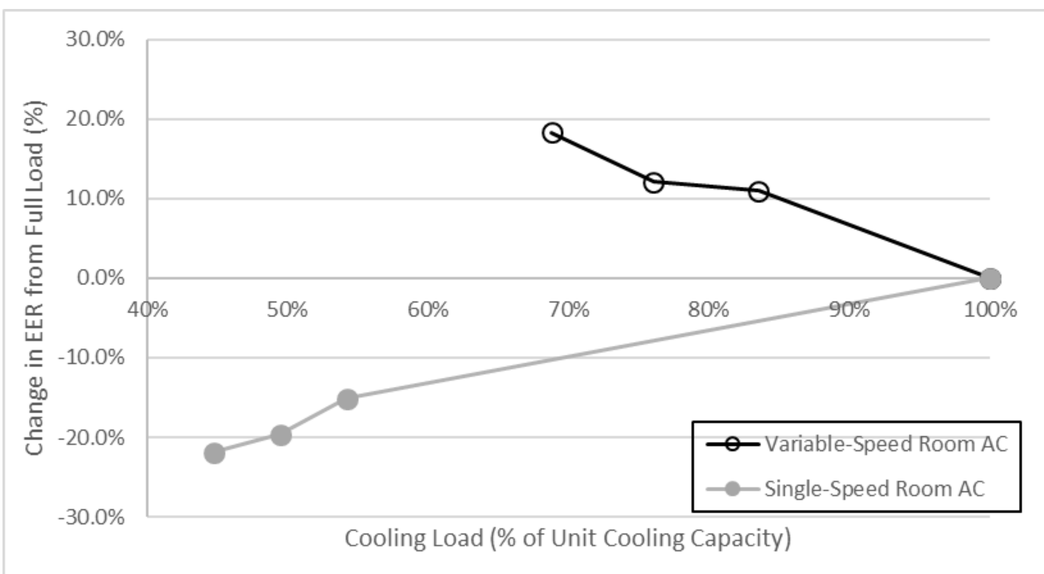

Figure III-2 Change in EER for Reduced Cooling Loads at 82 °F Outdoor Dry-Bulb Temperature, Unit 2

In Figures III-1 and III-2, 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 the outdoor test condition used.[12] The single-speed room AC 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 room AC increases as the cooling load decreases, reflecting the lack of cycling losses and inherent improvements in system efficiency associated with lower-capacity operation. As explained in the June 2020 NOPR, these results demonstrate that the previous test procedure does not account for significant efficiency gains that variable-speed room ACs can achieve under reduced temperature conditions. 85 FR 35700, 35708 (Jun. 11, 2020).

1. Methodology

In the June 2020 NOPR, DOE proposed a test method to measure the efficiency gains for variable-speed room ACs that are not captured by the previous DOE test procedure. 85 FR 35700, 35708–35709 (Jun. 11, 2020). DOE based the proposed method on the alternate test procedure required under the LG Waiver and the Midea Waiver, (collectively, “the waivers”) for specified basic models of variable-speed room ACs. 84 FR 20111 (May 8, 2019) and 85 FR 31481 (May 26, 2020). The alternate test procedure proposed in the NOPR, which is substantively consistent with the waivers, is generally consistent with the approach in AHAM RAC-1-2020, as discussed in section III.B.1 of this document. As discussed in this section below, DOE is adopting the AHAM RAC-1-2020 test procedure in this final rule, with some modifications for the purposes of improved representativeness and repeatability, which provides a methodology for obtaining a reported CEER value by adjusting the intermediate CEER value as tested at the 95 °F test condition according to appendix F using a "performance adjustment factor" ("PAF").

Conceptually, the approach for variable-speed room ACs adopted in this final rule involves measuring performance over a range of four test conditions, applying user settings to achieve the full compressor speed at two test conditions and manufacturer-provided instructions to achieve a reduced fixed compressor speed at the other two test conditions, which collectively comprise representative use. These temperature conditions were derived from the DOE test procedure for central air conditioners with variable-speed compressors and include three reduced-temperature test conditions—under which variable-speed room ACs perform more efficiently than single-speed room ACs—and the test condition specified in the previous test procedure.[17] The single-speed room AC test procedure, however, does not factor in the reduced-temperature test conditions under which single-speed units also will perform more efficiently (although not as well as variable-speed room ACs). As a result, comparing variable-speed performance at all test conditions against a single-speed unit at the highest-temperature test condition would not yield a fair comparison. The PAF represents the average relative benefit of variable-speed over single-speed across the whole range of test conditions. It is applied to the measured variable-speed room AC performance only at the high-temperature test

[17] The central air conditioner test procedure can be found at Title 10 of the CFR part 430, subpart B, appendix M, "Uniform Test Method for Measuring the Energy Consumption of Central Air Conditioners and Heat Pumps."

condition to provide a comparison to the single-speed CEER metric based on representative use.

The steps for determining a variable-speed room AC's PAF are summarized as follows:

- Measure the capacity and energy consumption of the sample unit at the single test condition used for single-speed room ACs (95 °F dry-bulb outdoor temperature), with the compressor speed at the maximum (full) speed, achieved using the user settings (*i.e.,* setpoint) selected in accordance with the appendix F test.

- Measure the capacity and energy consumption of the sample unit at three additional test conditions (92 °F, 87 °F, and 82 °F dry-bulb outdoor temperature),[18] with compressor speed at full using the user settings in accordance with appendix F, and fixed at intermediate and minimum (low) speed, respectively.[19] Using theoretically determined adjustment factors,[20] calculate the equivalent performance of a single-speed room AC with the same cooling capacity and electrical power input at the 95 °F dry-bulb outdoor temperature, with no cycling losses (*i.e.*, a "theoretical comparable single-speed" room AC) for each of the three test conditions.

[18] The additional reduced-temperature conditions are described further in section III.C.2 of this document.
[19] The fixed compressor speeds are described further in section III.C.3 of this document.
[20] These adjustment factors are described further in section III.C.4 of this document.

- Calculate the annual energy consumption in cooling mode at each of the four cooling mode test conditions for a variable-speed room AC, as well as for a theoretical comparable single-speed room AC with no cycling losses. This theoretical single-speed room AC would perform the same as the variable-speed test unit at the 95 °F test condition but perform differently at the other test conditions.

- Calculate an individual CEER value at each of the four cooling mode test conditions for the variable-speed room AC, as well as for a theoretical comparable single-speed room AC with no cycling losses.

- Using cycling loss factors derived from an industry test procedure and DOE test data,[21] calculate an adjusted CEER value at each of the four cooling mode test conditions for a theoretical comparable single-speed room AC, which includes cycling losses.

- Using weighting factors[22] representing the fraction of time spent and cooling load expected at each test condition in representative real-world operation, calculate a weighted-average CEER value (reflecting the weighted-average performance across the four test conditions) for the

[21] The derivation of these cycling loss factors is described in more detail in section III.C.5 of this document.
[22] These "fractional temperature bin" weighting factors are described in more detail in section III.C.6 of this document.

variable-speed room AC, as well as for a theoretical comparable single-speed room AC.

- Using these weighted-average CEER values for the variable-speed room AC and a theoretical comparable single-speed room AC, calculate the PAF as the percent improvement of the weighted-average CEER value of the variable-speed room AC compared to a theoretical comparable single-speed room AC.[23] This PAF represents the improvement resulting from the implementation of a variable-speed compressor.

DOE's approach to addressing the performance improvements associated with variable-speed room ACs is generally consistent with the alternate test procedures required in the waivers and with the test procedure updates proposed in the June 2020 NOPR.[24] The following sections of this document describe each aspect of the approach in greater detail.

2. Test Conditions

As discussed previously, variable-speed room ACs provide improved performance at reduced cooling loads by reducing the compressor speed to match the load, thereby improving system efficiency. DOE recognizes that throughout the cooling

[23] The performance adjustment factor is described in more detail in section III.C.7 of this document.
[24] DOE estimates that the CEER value for a variable-speed room AC determined in accordance with the amendments adopted in this final rule would be about 1.6 percent greater than the CEER value determined in accordance with the June 2020 NOPR proposed test approach, which was consistent with the alternate test procedure prescribed in a Decision and Order granting a waiver from the DOE test procedure for room air conditions to LG Electronics (84 FR 2011; May 8, 2019) and in an Interim Waiver granted to GD Midea Air Conditioning Equipment Co. LTD (84 FR 68159; Dec. 13, 2109). 85 FR 35700, 35709.

season, room ACs operate under various outdoor temperature conditions. DOE also asserts that these varying outdoor conditions present a range of reduced cooling loads in the conditioned space, under which a variable-speed room AC would perform more efficiently than a theoretical comparable single-speed room AC.

To measure this improved performance, in the June 2020 NOPR, DOE proposed a test procedure for variable-speed room ACs that adds three test conditions (92 °F, 87 °F, and 82 °F dry-bulb outdoor temperatures and 72.5 °F, 69 °F, and 65 °F wet-bulb outdoor temperatures, respectively) to the existing 95 °F test condition, consistent with the test conditions in the waivers. 85 FR 35700, 35709 (Jun. 11, 2020). These temperatures represent potential outdoor temperature conditions between the existing 95 °F test condition and the indoor setpoint of 80 °F. These additional test conditions are also consistent with the representative temperatures for bin numbers 6, 5, and 4 in Table 19 of DOE's test procedure for central air conditioners at appendix M. *See id*.

Rice expressed concern that the temperature range of the proposed test points in the NOPR is too narrow, as they are based on only four of the eight cooling-mode outdoor-temperature bins of the 2017 version of Air-Conditioning, Heating and Refrigeration Institute ("AHRI") Standard 210/240, ("AHRI Standard 210/240"), "Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment," and a wider temperature range for testing is needed. Rice commented that the binned loads in AHRI Standard 210/240 were determined for more typical indoor dry-bulb settings, but the analysis in AHRI Standard 210/240 uses 80 °F dry-bulb and 67 °F wet-bulb indoor ratings data. Rice recommended that a more complete range of temperature bins and their associated cooling load hours from AHRI Standard 210/240 should be considered for the CEER analysis. (Rice, No. 17 at pp. 1−2; *see also* Rice, Preliminary Analysis,[25] No. 25 at p. 2) Rice recommended accounting for the fractional loads and hours of outdoor-temperature bins 67, 72, and 77 °F with a lower temperature test condition with an outdoor dry-bulb temperature of 75 °F be used in place of the 92 °F dry-bulb temperature test condition. Rice asserted that there was not sufficient justification to test at full speed test at 92 °F, as it is close to a full speed test at the 95 °F dry-bulb temperature test condition. Rice recommended that the fractional bin hours of the 92, 97, and 102 °F outdoor-temperature bins should be applied to the 95 °F dry-bulb temperature test condition, which is actually the midpoint temperature of the lower two bins. (Rice, No. 17 at pp. 1–2; *see also* Rice, Preliminary Analysis, No. 25 at p. 2)

DOE recognizes that the test conditions proposed in the June 2020 NOPR do not encompass the full range of bin temperature in Table 16 of ANSI/AHRI Standard 210/240. The temperature bins in Table 16 of ANSI/AHRI Standard 201/240 apply to central air conditioners, which are fixed appliances, installed year-round, built into homes, and operate based on a central thermostat to maintain a relatively constant temperature throughout the conditioned space. Room ACs are instead, often seasonally, installed in a single room; operate based on an internal thermostat when turned on, typically only during the cooling season; and may be readily turned off when the room is not occupied. Consumers are more acutely aware of a room AC's operation than that of a

[25] The notation "Preliminary Analysis" indicates that the comment is filed in the docket of the Energy Conservation Standards for Room Air Conditioners Preliminary Analysis rulemaking (EERE-2014-BT-STD-0059) and available for review at *http://www.regulations.gov*.

central air conditioner; as they are used to cool a single room, often only when that room is occupied; make more noise; and are visible in the room. For these reasons, consumers are more likely to rely on a room AC at the higher temperatures in the range of bin temperatures in Table 16 of ANSI/AHRI Standard 210/240, as compared to at the lower temperatures in the bin. At the lower temperatures, consumers using room ACs are more likely than consumers with central air conditioners to open a window or operate the unit with only the fan on to circulate indoor air when cooler outdoor air is available to draw in through a "fresh air" vent, making the lower temperature bins less representative of room AC operation in cooling mode. DOE also notes that the temperature conditions proposed in the June 2020 NOPR are consistent with the industry-accepted test procedure, AHAM RAC-1-2020.

For the reasons discussed in this section, DOE is adopting the four temperature conditions for variable-speed room ACs proposed in the June 2020 NOPR.

3. Variable-Speed Compressor Operation

The DOE test procedure maintains fixed temperature and humidity conditions in the indoor chamber and requires configuring the test unit settings (*i.e.,* setpoint and fan speed), to achieve maximum cooling capacity. See Section 3.1 of appendix F, as amended, and Section 6.1.1.4 of ANSI/ASHRAE Standard 16-2016. Under these conditions, units under test may operate continuously at their full cooling capacity, even at the reduced outdoor temperature test conditions described in section III.C.2 of this document, without the compressor cycling (for single-speed units) or compressor speed reduction (for variable-speed units) that would be expected under real-world operation.

Therefore, in this final rule, DOE establishes additional test procedure adjustments, beyond reduced outdoor temperature test conditions, to fully capture the energy efficiency of variable variable-speed room ACs at reduced cooling loads.

As described previously, in a typical consumer installation, reduced outdoor temperatures would result in reduced indoor cooling loads. A test that would provide constant reduced cooling loads could be considered, but as discussed below in section III.E.1.e of this document, DOE concludes such a test would not be feasible at this time. Instead, in the June 2020 NOPR, DOE proposed adopting a test that requires fixing the variable-speed room AC compressor at particular compressor speeds that would reflect the expected load under each of the four test conditions, as described further in the following sections. 85 FR 35700, 35709 (Jun. 11, 2020).

a. Compressor Speeds

In the June 2020 NOPR, to ensure the compressor speeds are representative of actual speeds at the expected cooling loads at each of the outdoor test conditions, DOE proposed requiring that the compressor speed of a variable-speed room AC be set to full speed at the two highest outdoor temperature test conditions (based on test A_{Full} at 95 °F and test B_{Full} at 92 °F from Table 8 of AHRI Standard 210/240), at intermediate compressor speed at the 87 °F test condition (based on test E_{Int}), and at low compressor speed at the 82 °F test condition (based on test D_{Low}), consistent with the tests and requirements in Table 8 of AHRI Standard 210/240, which specifies representative test conditions and the associated compressor speeds for variable-speed unitary air conditioners. 85 FR 35700, 35709 (Jun. 11, 2020).

The California IOUs questioned the representativeness of testing variable-speed room ACs using fixed-speed testing and referenced statements from the 2019 Appliance Standards and Rulemaking Federal Advisory Committee's Variable Refrigerant Flow Working Group that such testing was not representative of field performance, largely because the control settings used during testing did not match the operational behavior of units outside of their test mode.[26] The California IOUs also cited research conducted at the Bundesanstalt für Materialforschung und -prüfung ("BAM") Federal Institute for Material Research and Testing in Germany, in which all but one of the seven residential mini-split air conditioners with variable-speed equipment that were tested consumed significantly higher energy when consumer-adjustable, built-in controls were used relative to fixed controls (*i.e.*, controls that set the compressor speed using a manufacturer-provided remote or code).[27] The California IOUs stated that researchers reported many units reverted to on-off (cycling) operation when the outdoor temperatures were between 77 and 86 °F. The California IOUs encouraged DOE to amend the test procedure to improve representativeness and facilitate product comparison with air conditioners tested under appendix M1[28] to 10 CFR part 430. The California IOUs further encouraged DOE, in collaboration with industry and energy efficiency advocates, to update the test procedure for room ACs by requiring the measurement of units at the

[26] All published documents directly related to the 2019 Appliance Standards and Rulemaking Federal Advisory Committee's Variable Refrigerant Flow Working Group test data are available in docket EERE-2018-BT-STD-0003 (*https://regulations.gov/docket/EERE-2018-BT-STD-0003*).
[27] Palkowski, Carsten & Schwarzenberg, Stefan & Simo, Anne. (2019). "Seasonal cooling performance of air conditioners: The importance of independent test procedures used for MEPS and labels." International Journal of Refrigeration. 104. 10.1016/j.ijrefrig.2019.05.021.
[28] Appendix M is the currently applicable DOE test procedure for central air conditioners and heat pumps. Appendix M1 will become the test procedure mandatory for use for central air conditioners and heat pumps on or after January 1, 2023. Appendix M and appendix M1 contain similar test conditions, so DOE's evaluation of comments relative to appendix M applies equally to appendix M1.

95 °F test condition under their native controls to see the speeds at which the compressors operate to ensure accurate testing. (California IOUs, Public Meeting Transcript, No. 12 at pp. 30–33; California IOUs, No. 14 at p. 4)

DOE notes that the findings of the 2019 Appliance Standards and Rulemaking Federal Advisory Committee's Variable Refrigerant Flow Working Group applied to variable-refrigerant flow multi-split air conditioners and heat pumps, which have different applications and typical use cases from room ACs and which typically provide cooling to multiple locations within a home. Based on a review of the market, room ACs are typically marketed for temporary seasonal installation[29] for the purpose of cooling a single room,[30] whereas multi-split systems are permanent and may be used as part of a larger whole-home cooling system. For these reasons, the comparability of the room AC test procedure and the test procedure for multi-split air conditioners was not further considered in this final rule.

During investigative testing, two variable-speed room AC models from different manufacturers performed differently under fixed temperature conditions with the user settings (*e.g.,* fan speed, grille position) and thermostat setpoint selected in accordance with the appendix F test ("appendix F setpoint"), relative to the fixed controls, as specified in the waivers and proposed in the June 2020 NOPR. When operating under

[29] Only 14 room AC models on the market have reverse-cycle heating (a heating technology implemented in other electric cooling products intended for year-round operation), compared to the 1,825 total room AC models on the market according to DOE's CCMS database, as accessed February 10, 2021. This indicates that room AC are overwhelmingly used for seasonal cooling.
[30] Room air conditioners are typically purchased by selecting cooling capacity to match the size of a single room to be cooled. See, for example, the ENERGY STAR buying guidance at: *https://www.energystar.gov/products/heating_cooling/air_conditioning_room*

fixed temperature conditions and the appendix F setpoint (*i.e.,* the setpoint which resulted in the maximum cooling capacity, per the requirement in ASHRAE 16-2016), one unit was 10 percent more efficient than when using fixed controls at the 95 °F test condition as specified in the waivers. The second unit was 11 percent less efficient when operated under fixed temperature conditions and the appendix F setpoint than when using fixed controls. Based on the observed differences in the room AC performance when using the fixed full compressor speed as compared to the fixed temperature conditions and appendix F setpoint, DOE is requiring the use of fixed chamber temperature conditions with a unit setpoint of 75 °F for the "full speed" test, as use of this test setup improves representativeness and reproducibility of results. While AHAM RAC-1-2020 requires the use of a fixed full compressor speed set in accordance with manufacturer instructions, as described above, DOE is adopting a revised approach in this final rule to improve representativeness and repeatability. Using a constant temperature test with a thermostat setpoint of 75 °F, in place of the fixed "full" compressor speed, will ensure measured performance reflects the expected performance of the unit when using a common setpoint selected in the field at 95 °F and 92 °F outdoor temperatures, where DOE expects these units to be operating at full speed.

However, DOE is not requiring the use of fixed temperature conditions, user settings, and thermostat set at 75 °F for the 87 °F and 82 °F outdoor test condition tests, because those tests represent lower cooling load conditions and would require a load-based test to represent expected unit performance at the associated reduced loads without fixing the compressor speed. As discussed in section III.E.1.d of this document, a load-based test is not feasible at this time. Therefore, the reduced outdoor conditions tests are conducted with fixed compressors speeds that are representative of performance at the expected loads at those reduced conditions. The fixed compressor speeds are defined based on the resulting cooling capacity using fixed temperature condition tests and a unit thermostat setpoint at 75 °F, as discussed in section III.D of this document.

Therefore, in this final rule, DOE is requiring fixed temperature conditions with a unit thermostat setpoint of 75 °F, rather than using manufacturer instructions to fix the compressor speed for variable-speed room ACs at the 95 °F and 92 °F test conditions, while requiring that the compressor speed be fixed to intermediate speed at the 87 °F test condition and low speed at the 82 °F test condition, as discussed and defined in section III.D.1.b of this document and in Sections 2.15 and 2.16 in appendix F, respectively.

b. Instructions for Fixing Compressor Speeds

Setting and maintaining a specific compressor speed for a variable-speed room AC is not typically possible without special control instructions from manufacturers.

In the June 2020 NOPR, DOE proposed to require that manufacturers provide in their certification reports the control settings for each variable-speed room AC basic model required to achieve the fixed compressor speed for each test condition, consistent with the approach in the waivers. 85 FR 35700, 35709 (Jun. 11, 2020). These include the compressor frequency setpoints at each test condition, instructions necessary to maintain the compressor speeds required for each test condition, and the control settings used for the variable components. *Id.* DOE received no comments on the proposal.

Due to the change to require that user settings be implemented to achieve maximum cooling capacity when testing at the 95 °F and 92 °F test conditions, as discussed in section III.C.3.a of this document, DOE is requiring that the manufacturer provide in the certification reports the control settings to achieve the fixed compressor speed at only the 87 °F and 82 °F test conditions, thus minimizing certification burden on manufacturers.

c. Boost Compressor Speed

DOE is aware that a variable-speed room AC's full compressor speed may not be its fastest speed. In particular, the fastest compressor speed may be one that is automatically initiated and used for a brief period of time to rapidly reduce the indoor temperature to within typical range of the setpoint. This compressor speed is referred to as "Boost Compressor Speed" in AHRI Standard 210/240 and is defined as a speed faster than full compressor speed, at which the unit will operate to achieve increased capacity.

Manufacturers have described boost compressor speed as used for limited periods of time on occasions where the indoor room temperature is far out of normal operating range of the setpoint. Once the indoor room temperature is within the typical operating range of the setpoint, the room AC returns to the "Full Compressor Speed," as defined in AHRI Standard 210/240. Because of the typical limited duration of boost compressor speed, it would not significantly contribute to annual energy consumption. AHRI Standard 210/240 does not measure boost compressor speed energy use, and in a final rule published on June 8, 2016, DOE declined to include provisions for measuring boost compressor speed energy use in the central air conditioner test procedure. 81 FR 36992, 37029. DOE stated that accurately accounting for boost compressor speed requires more careful consideration of test procedure changes beyond simply allowing the compressor speed to vary for the test conditions required by the previous procedure, and that DOE would consider such revisions in a future rulemaking. *Id.*

Accordingly, DOE did not propose to measure boost compressor speed performance and energy consumption in appendix F in the June 2020 NOPR, because of the minimal expected operating hours in boost compressor mode and the subsequent insignificant impact on annual energy consumption and performance, to harmonize with AHRI Standard 210/240, the industry approach for variable-speed compressor testing, and because DOE has previously opted to forgo including it for other air conditioning products. 85 FR 35700, 35710 (Jun. 11, 2020).

AHAM supported DOE's proposal to forgo measuring boost compressor speed for variable-speed room ACs. AHAM commented that boost compressor speed is used for limited periods of time on occasions where the indoor room temperature is far out of normal operating range of the setpoint. AHAM stated that once the indoor temperature is within the typical operating range of the setpoint, the room AC will return to full compressor speed. AHAM asserted that accounting for boost compressor speed would likely not impact annual energy consumption and performance and, thus, additional test burden would not have a corresponding energy savings or consumer benefit. According to AHAM, EPCA does not require testing of every available mode; EPCA only requires testing of the average consumer use cycle, which boost mode is not according to data available. (AHAM, Public Meeting Transcript, No. 12 at p. 53; AHAM, No. 13 at p. 5)

The Joint Commenters, the California IOUs, NEAA, and Rice commented in favor of capturing boost compressor speed operation in the test procedure. (ASAP, Public Meeting Transcript, No. 12 at p. 12; Joint Commenters, No. 15 at pp. 2−3; California IOUs, Public Meeting Transcript, No. 12 at pp. 23−24; NEAA, Public Meeting Transcript, No. 12 at pp. 42−48, 56; Rice, No. 17 at p. 3) The California IOUs commented that boost mode operation may be a significant portion of how consumers actually use the product. (California IOUs, Public Meeting Transcript, No. 12 at pp. 23−24)

Rice commented that boost compressor capability requires the inverter/motor drives to be oversized to handle the increased torque and power draw, resulting in more performance drop off at lighter loads. Rice stated that this performance drop-off supports why limiting variable-speed rating tests to no lower than 82 °F may preclude future introduction of more efficient variable-speed drive/motor combinations in compressors that have larger performance advantages below 50-percent capacity reduction. Rice commented that boost compressor speed capability not only can result in unnecessary energy use and increased power demand during rapid cooldown but can also penalize unit performance at lower outdoor temperatures where significant amounts of cooling are delivered. Rice further commented that there is no incentive for manufacturers to limit or drop boost compressor speed features from their designs without some performance penalty applied to units with boost operation, especially if the lowest test point remains at the 82 °F test condition with 50 percent of rated capacity loading. Rice suggested provisions might also be included for suitable performance credits for variable-speed units that allow boost mode to be turned off by the homeowner or utility to reduce unnecessary energy use and/or peak demand. (Rice, No. 17 at pp. 2−3)

ASAP, NEAA, the Joint Commenters, and Rice encouraged DOE to further investigate the use and timing of boost compressor speed, expressing concern that not testing it may result in excluding a significant component of the energy use of these units. (ASAP, Public Meeting Transcript, No. 12 at p. 12; NEAA, Public Meeting Transcript, No. 12 at pp. 42−48; Joint Commenters, No. 15 at pp. 2−3; Rice, No. 17 at p. 3) Specifically, NEAA recommended that DOE conduct tests to determine the setpoint differential that would cause boost mode to kick in and the difficulty at which that is under normal or extreme operating conditions. (NEAA, Public Meeting Transcript, No. 12 at pp. 42−48) Rice recommended that DOE conduct additional load-based testing to estimate the added energy use and peak demand from boost compressor speed operation from a typical daytime setback, evening setup schedule.[31] (Rice, No. 17 at p. 3)

As discussed, boost compressor speed is a temporary period of elevated compressor speed that occurs to quickly reduce the indoor temperature of a room, typically upon startup or after a service interruption. DOE is not aware of any publicly available data on the frequency or duration of boost compressor speed operation in the

[31] "Setback" typically refers to when the temperature setting on a thermostat is adjusted to a higher temperature for a period of time when the space will not be occupied or won't require as much cooling, and "setup" refers to when the thermostat setpoint is adjusted back to its original setting, at which the desired level of comfort is provided when the conditioned space is occupied.

field. As such, DOE is unable to ensure the representativeness of a test procedure that addresses boost compressor speed operation.

Further, in limited investigative testing of boost compressor speeds for two variable-speed room ACs, DOE was not able to induce a compressor speed higher than the full compressor speed, either by increasing the cooling load to greater than 100 percent or by adjusting the temperature setpoint during cooling mode operation. As such, it is unclear what test procedure provisions would be necessary to test boost compressor speed operation, or if there exists a compressor speed greater than that already activated by the settings in appendix F, without being unduly burdensome. Therefore, DOE is not adopting boost compressor speed provisions in appendix F.

4. Capacity and Electrical Power Adjustment Factors

In the waivers and proposed June 2020 NOPR approach, a capacity adjustment factor is used to estimate the increased cooling capacity and reduced electrical power draw of a single-speed room AC at lower outdoor temperature conditions, using a linear extrapolation based on the measured capacity and power draw at the 95 °F test condition, respectively. 85 FR 35700, 35711 (Jun. 11, 2020). To determine these two adjustment factors, DOE used the MarkN model[32] to model room AC performance at reduced outdoor temperature conditions. *Id.* These modeling results suggested linear capacity

[32] MarkN is an energy modeling program developed in an ECS direct final rule for room ACs that DOE published on April 21, 2011. 76 FR 22454. The MarkN program is an update of an adaptation to the Oak Ridge National Laboratory Mark III Heat Pump program for modeling room AC cooling performance.

and electrical power adjustment factors of 0.0099 per °F and 0.0076 per °F, respectively. *Id*.

To confirm the validity of these modeled adjustment factors, DOE tested a sample of 14 single-speed room ACs at a range of reduced outdoor temperature test conditions (92 °F, 87 °F, and 82 °F) and compared the predicted values of cooling capacity and electrical power with the measured values at each test condition. The results generally indicated close agreement (*i.e.,* less than 5 percent difference on average) between the modeled cooling capacity (based on an adjustment factor of 0.0099 per °F) and the measured capacity at each test condition, and between the modeled electrical power draw (based on an adjustment factor of 0.0076 per °F) and the measured electrical power draw at each test condition. DOE tentatively determined that the average difference of less than 5 percent between the modeled values and the experimental values confirmed the validity of these modeled adjustment factors. Therefore, in the June 2020 NOPR, DOE proposed to use the modeled adjustment factors of 0.0099 per °F and 0.0076 per °F for capacity and electrical power, respectively, to calculate the theoretical comparable single-speed room AC performance at reduced outdoor temperature test conditions. 85 FR 35700, 35711 (Jun. 11, 2020).

NEAA expressed concern about DOE's proposal to use linear capacity and electrical power adjustment factors to predict the capacity of fixed speed equipment at lower outdoor temperatures. NEAA commented that, while the order of magnitude of the error is small, the factors chosen consistently overpredict capacity and underpredict energy use for single-speed equipment. NEAA further commented that this will reduce the CEER ratings of variable-speed room ACs. NEAA recommended modifying the capacity and electrical power adjustment factors so that they do not overpredict capacity and underpredict energy use consistently. (NEAA, No. 16 at p. 5)

DOE disagrees with NEAA's assessment that the modeling factors consistently overpredict capacity and underpredict energy use. DOE observed that the modeling factors were able to predict capacity and energy use in the test sample within four percent on average, and often more accurately. Additionally, there was no consistent trend in the variation in capacity or energy use predictions (*i.e.*, some predictions were higher than the actual, some were lower). Therefore, DOE is adopting as proposed the capacity and electrical power adjustment factors of 0.0099 per °F and 0.0076 per °F, respectively.

5. Cycling Loss Factors

In the June 2020 NOPR, to represent the cycling losses of a theoretical comparable single-speed room AC at reduced outdoor temperature test conditions and expected reduced cooling loads, DOE identified cycling loss factors ("CLFs") to apply to the interim CEER values at each of the four cooling mode test conditions for a theoretical comparable single-speed room AC. 85 FR 35700, 35711 (Jun. 11, 2020). Table III-4 shows the CLFs for each of the four test conditions.

Table III-4: June 2020 NOPR Proposed Cycling Loss Factors

Test Condition	Evaporator Inlet Air, °F		Condenser Inlet Air, °F		Cycling Loss Factor
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb	
Test Condition 1	80	67	95	75	1.0
Test Condition 2	80	67	92	72.5	0.971
Test Condition 3	80	67	87	69	0.923
Test Condition 4	80	67	82	65	0.875

These CLFs were based on the default cooling degradation coefficient ("Cd") in Section 11.2 of AHRI Standard 210/240. The CLF at the 82 °F test condition for a theoretical comparable single-speed room AC is consistent with the default Cd of 0.25, which corresponds to a part-load (cycling loss) factor of 0.875, as determined in Section 11.2 of AHRI Standard 210/240. The remaining CLFs for the other test conditions are consistent with linear interpolation between the CLF of 0.875 at the 82 °F test condition and the CLF of 1.0 at the 95 °F test condition, at which no cycling is expected.

Thus, DOE proposed to implement CLFs consistent with the default Cd in AHRI Standard 210/240, to represent the expected performance of a theoretical comparable single-speed room AC at reduced outdoor temperature test conditions. *Id.*

AHAM commented that while DOE cited Section 11.2 of AHRI Standard 210/240 and a Cd of 0.25, AHRI Standard 210/240 includes a Cd of 0.20 for Single Stage Systems in Section 6.1.3.1.1. AHAM recommended that DOE ensure it uses the most recent version of the standard and the correct Cd. (AHAM, No. 13 at p. 5)

The California IOUs, NEAA, and Rice expressed concern about the proposed default Cd of 0.25. (California IOUs, Public Meeting Transcript, No. 12 at p. 30; NEAA, No. 16 at p. 5; Rice, No. 17 at pp. 3−4) NEAA commented that room ACs may cycle more than central air conditioners due to improper sizing, further pointing to a need for additional testing. (NEAA, No. 16 at p. 5) Rice commented that Figure III.1 in the June 2020 NOPR suggested that the Cd for the load-tested room AC unit could be as high as 0.42, based on the 21-percent performance loss observed at 50-percent load; this compared with the 12.5-percent loss assumed at 50-percent load with the default Cd assumption. (Rice, No. 17 at pp. 3−4) The California IOUs and Rice recommended DOE conduct additional investigative load-based testing on single-speed room ACs to better estimate the Cd at the 82 °F test condition. (California IOUs, Public Meeting Transcript, No. 12 at p. 30; Rice, No. 17 at pp. 3−4)

Rice also commented that a room AC unit is unlikely to be sized exactly to match the room load at 95 °F outdoor ambient conditions. Rice further commented that a minimal 10-percent oversizing, equivalent to that assumed in AHRI Standard 210/240 for unitary ACs, would be more appropriate and would also provide a common basis with current AC ratings practice. Rice stated that use of 110-percent sizing would also provide an appropriate performance benefit, estimated to be approximately 3 percent, to variable-speed room ACs relative to single-speed units. Accordingly, Rice recommended that the assumption of exact sizing be modified to at least be consistent with 110-percent sizing as assumed in AHRI Standard 210/240 for unitary air conditioners. With 110-percent sizing, Rice noted that the default CLFs at 95, 87, and 82 °F would need to be adjusted to 0.977, 0904, and 0.864, respectively, for a Cd of 0.25. Rice also noted that they would need further adjustment if a different default Cd were selected or if the slope of the default single-speed capacity curve was changed. As for the proposed 75 °F test point, Rice commented that the CLFs with a 0.25 Cd are 0.820 at 100-percent sizing and 0.813 at 110-percent sizing. (Rice, No. 19 at p. 6; *see also* Rice, Preliminary Analysis, No. 25 at pp. 1–2)

DOE disagrees with Rice's claim that it is unlikely that room ACs are sized to match room cooling load at a 95 °F outdoor temperature test condition. Room ACs are intended to cool a single room, where the cooling load is more likely to remain steady or within a smaller range. DOE is not aware of any data showing that room ACs are typically oversized. Given the application of room ACs to a more limited space, DOE has determined that it is reasonable to assume that room ACs are sized to match room cooling loads at a 95 °F outdoor temperature test condition.

DOE acknowledges the concerns regarding the Cd as proposed in the June 2020 NOPR. In response, DOE conducted additional testing in support of this final rule to determine whether the AHRI Standard 210/240 single-stage Cd of 0.2 suggested by AHAM or a higher value such as 0.42 as suggested by the California IOUs, NEAA, and Rice would be more appropriate. DOE conducted load-based testing on two single-speed room ACs with cooling capacities comparable to variable-speed room ACs of the same brand / manufacturer currently on the market using an outdoor temperature of 82 °F and cooling loads between 47 and 57 percent of the full load, with a target of 52 percent (*i.e.*, the center of the acceptable range specified in the low compressor speed definition). DOE did not consider cycling losses at an outdoor temperature of 75 °F, based on the decision to not include testing at that temperature condition, as discussed in section III.C.2 of this document. The results of this testing are summarized in Table III-5.

Table III-5: Cycling Loss Factors

Unit	Load %	Cd
Unit 1	52	0.42
Unit 2	49	0.39
	54	0.30
	52[*]	*0.34*

[*] Due to difficulties in achieving the target load percentage of 52% for Unit 2, data for the nearest higher and lower data points were interpolated to estimate the expected Cd at a 52% load.

On average, the two single-speed room ACs had a Cd of 0.38 at the 82 °F test condition and 52 percent cooling load, which is relatively close to the maximum Cd value of 0.42 suggested by Rice. Based on DOE's test data, use of a Cd of 0.38 would increase a variable-speed room AC's measured CEER by approximately 5.5 percent. Based on this testing, DOE is adopting a Cd of 0.38, resulting in a CLF at the 82 °F test condition of 0.81. Interpolating between the 82 °F test condition and CLF of 0.81 and 95 °F test condition and CLF of 1, results in a CLF of 0.883 for the 87 °F test condition and a CLF of 0.956 for the 92 °F test condition.

6. Test Condition Weighting Factors

In the approach proposed in the June 2020 NOPR, the four interim CEER values representing each of the four cooling mode test conditions were combined, using four weighting factors, into a single weighted-average CEER value. 85 FR 35700, 35711–35712 (Jun. 11, 2020). The resulting weighted-average CEER value represented the weighted-average performance across the range of outdoor test conditions. *Id.* DOE calculated weighting factors based on the fractional temperature bin hours in Table 19 of DOE's test procedure for central air conditioners at appendix M. DOE identified the fractional temperature bin hours representing the four test conditions in the proposed approach and normalized these four values from appendix M so that they sum to 1.00.

Table III-6 shows the June 2020 NOPR weighting factors for each of the four test conditions.

Table III-6: June 2020 NOPR Proposed Temperature Condition Weighting Factors

Test Condition	Evaporator Inlet Air, °*F*		Condenser Inlet Air, °*F*		CEER Weighting Factor
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb	
Test Condition 1	80	67	95	75	0.05
Test Condition 2	80	67	92	72.5	0.16
Test Condition 3	80	67	87	69	0.31
Test Condition 4	80	67	82	65	0.48

AHAM generally agreed with the waivers, which included the weighting factors above. (AHAM, No. 13 at p. 4)

ASAP, the Joint Commenters, and Rice expressed concern that DOE's proposed approach would not reflect seasonal efficiency, claiming it would result in underweighting performance at the higher outdoor temperature conditions and overweighting performance at the lower temperature conditions. ASAP commented that, under the weighted-average calculation proposed in the June 2020 NOPR delivered cooling from an hour of operation under the 95 °F test condition was equal to that under the 82 °F test condition, even though the delivered cooling, and energy consumption, at the 95 °F test condition is greater. (ASAP, Public Meeting Transcript, No. 12 at pp. 35−36) Rice suggested replacing the proposed performance weighting factors based on fractional bin hours with fractional delivered cooling output per bin because the proposed approach ignores that, at the lower ambient temperature bins, the delivered amount of cooling is proportionally lower (~50 percent at 82 °F ambient). Rice also recommended replacing the 92 °F test condition with a 75 °F test condition, to supplement the 82, 87, and 95 °F variable-speed ratings tests, to represent the missing ~40 percent of cooling load, as discussed in section III.C.2 of this document. For the proposed 75 °F test condition, Rice stated the variable-speed unit should be run at a reduced speed level to obtain ~30 percent of rated capacity at 95 °F ambient temperature. Rice expressed further concern that PAFs based on the wrong weighting factors and an inappropriately narrowed cooling range will give too much credit to variable-speed designs that operate best in this narrowed range, and may inadvertently favor variable-speed designs that seek ratings advantage by boosting performance at the 82 °F and higher test conditions at the expense of lower ambient temperature performance. (Joint Commenters, No. 15 at p. 2; Rice, No. 17 at pp. 1−2)

DOE agrees that the cooling delivered by room ACs at lower outdoor temperature test conditions is proportionally lower than at the appendix F single-speed test condition. Thus, calculating the test condition weighting factors using fractional delivered cooling output per temperature bin, as suggested by Rice, applied to the set of test conditions required by DOE above, would improve the representativeness of the test procedure. This change would not increase the testing burden as compared to the test procedure required under the waivers. While this change would diverge from the industry-accepted test procedure AHAM RAC-1-2020, the deviation is justified due to the improvements in representativeness of the test procedure. Therefore, DOE is adopting the test condition weighting factors shown in Table III-7, calculated by adjusting the weighting factors in Table III-6 by the expected cooling load at each condition based on the building load calculation in AHRI Standard 210/240 (Equation 11.60), and normalizing the resulting values so the final weighting factors sum to 1.0.

Table III-7: Final Rule Temperature Condition Weighting Factors

Test Condition	Evaporator Inlet Air, °*F*		Condenser Inlet Air, °*F*		CEER Weighting Factor
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb	
Test Condition 1	80	67	95	75	0.08
Test Condition 2	80	67	92	72.5	0.20
Test Condition 3	80	67	87	69	0.33
Test Condition 4	80	67	82	65	0.39

7. Weighted CEER and Performance Adjustment Factor

The final step in the waivers and the June 2020 NOPR proposed approach is to calculate the PAF, representing the improvement over a theoretical comparable single-speed room AC resulting from the implementation of a variable-speed compressor. 84 FR 20111 (May 8, 2019); 85 FR 31481 (May 26, 2020); 85 FR 35700, 35712 (Jun. 11, 2020). The PAF is calculated as the percent improvement of the weighted-average CEER value of the variable-speed room AC compared to the weighted-average CEER value of a theoretical comparable single-speed room AC under the four defined test conditions.

After calculating the PAF, it is added to one and the sum is multiplied by the CEER value of the variable-speed unit when tested at the 95 °F test condition according to appendix F, resulting in the final CEER metric for the variable-speed room AC. By adjusting the variable-speed room AC CEER values to be comparable to single-speed room AC CEER values, DOE expects that consumers will have the information they need to understand the relative efficiency of both types of room AC. In the June 2020 NOPR, DOE proposed calculations to determine a PAF, which would adjust the CEER of a variable-speed room AC to appropriately account for its efficiency improvements relative to a theoretical comparable single-speed room AC under varying operating conditions. 85 FR 35700, 35712 (Jun. 11, 2020).

Rice proposed a new method to calculate the weighted average CEER in which the individual weighting factors are divided by the tested CEER values, summed, and the reciprocal of the sum is the weighted CEER value. Rice noted that the result of this formulation exactly matches the result of the conventional binned method from AHRI 210/240. (Rice, No. 19 at pp. 3−4)

Rice provided little explanation or evidence supporting this new calculation approach and whether it provides more representative results than the approach proposed in the June 2020 NOPR, beyond indicating the result matches that of the binned method in AHRI 210/240. DOE notes that the calculation approach prescribed in the waivers and proposed in the June 2020 NOPR is the same approach specified in the AHAM RAC-1-2020, which is the latest version of the industry standard specific to room ACs.

Therefore, DOE is adopting the PAF and weighted CEER calculations proposed in the June 2020 NOPR that align with AHAM RAC-1-2020 and the waivers granted to date.

8. Air-Enthalpy Test Alternative

DOE recognized the additional test burden associated with testing variable-speed room ACs at multiple test conditions as proposed. In an effort to minimize that additional test burden, DOE initially provided for an optional test in the interim waiver granted to LG that allowed for use of the air-enthalpy method. 83 FR 30717 (Jun. 29, 2018; “LG Interim Waiver”). Following the publication of the LG Interim Waiver, DOE conducted investigative testing to further analyze the air-enthalpy method and its suitability for testing room ACs. This testing demonstrated that this method produced unrepresentative and inconsistent results and remedying these deficiencies likely would be unduly burdensome. *See* 84 FR 20111, 20117. (May 8, 2019) In addition, the air-enthalpy method does not measure any heat transfer within and through the unit chassis, while the calorimeter test does. *See Id.* Because of the unrepresentative and inconsistent results obtained with the air-enthalpy test equipment that testing laboratories are likely to already own, as well as the higher cost and limited availability of equipment that would be necessary to obtain consistent results for all room ACs of differing airflow rates, DOE contended that the air-enthalpy test method would be unduly burdensome for testing laboratories to implement for room ACs at this time. DOE further noted that, in the waivers granted since the publication of the LG Interim Waiver, DOE did not allow the air-enthalpy test method as an alternative to the calorimeter test method due to the concerns outlined above. 84 FR 20111, 20117 (May 8, 2019), 84 FR 68159, 68162 (Dec. 13, 2019). In the June 2020 NOPR, DOE did not propose to include an optional alternative air-enthalpy test method for variable-speed room ACs in appendix F. 85 FR 35700, 35712 (Jun. 11, 2020).

The California IOUs supported DOE's proposal to exclude the air-enthalpy test from the room AC test procedure. The California IOUs commented that DOE's testing demonstrated that this method was unrepresentative and inconsistent, and remedying those deficiencies would be unduly burdensome. (California IOUs, No. 14 at pp. 5–6)

For the reasons discussed in the preceding paragraphs and in the June 2020 NOPR, DOE is not adopting the air-enthalpy test method for the testing of variable-speed room ACs in this final rule.

9. Product Specific Reporting Provisions

As described, the amendments to appendix F to test variable-speed room ACs at multiple cooling mode test conditions will require the use of fixed temperature conditions with a unit thermostat setpoint of 75 °F, using the same specifications for single-speed room AC controls given in appendix F, rather than using the manufacturer instructions to fix the compressor speed for variable-speed room ACs at the 95 °F and 92 °F test conditions. The amendments to appendix F will also require the compressor speed to be fixed to intermediate speed at the 87 °F test condition and low speed at the 82 °F test condition, as discussed and defined in section III.D.1.b of this document and in Sections 2.15 and 2.16, respectively, in appendix F.

In the June 2020 NOPR, to ensure test reproducibility, DOE proposed requiring in 10 CFR 429.15 that manufacturers provide DOE all necessary instructions to maintain the compressor speeds required for each test condition for a variable-speed basic model, as additional product-specific information pursuant to 10 CFR 429.12 (b)(13). 85 FR 35700, 35713 (Jun. 11, 2020). DOE expected that this requirement would add a *de minimis* incremental burden to the existing reporting requirements. *Id.* DOE received no comments on this proposal.

DOE is including in 10 CFR 429.15 reporting requirements for compressor frequencies and control settings at the 87 °F and 82 °F test conditions as additional product-specific information for certification of each variable-speed room AC basic model. Note that, unlike the proposal in the June 2020 NOPR, DOE is not requiring reporting of the compressor frequency and control settings as additional product-specific information for certification for the 95 °F and 92 °F test conditions for variable-speed units, as discussed in section III.C.3 of this final rule. Manufacturers may request treatment of reported material as confidential business information pursuant to the regulations at 10 CFR 1004.11.

10. Estimated Annual Operating Cost Calculation

In the June 2020 NOPR, in conjunction with the amendments for testing variable-speed room ACs, DOE proposed corresponding amendments to the calculation that provides the basis of the annual energy consumption and operating cost information presented to consumers on the EnergyGuide Label. 85 FR 35700, 35713 (Jun. 11, 2020). These changes would allow for an appropriate comparison of the annual energy consumption and operating costs between single-speed room ACs and variable-speed room ACs. As such, in the June 2020 NOPR, DOE proposed that for variable-speed room ACs, the average annual energy consumption used in calculating the estimated annual operating cost in 10 CFR 430.23(f) would be a weighted average of the annual energy consumption at each of the four test conditions in newly added Table 1 of appendix F and the annual energy consumption in inactive mode or off mode. *Id.* DOE provided, however, that the electrical power input reported for variable-speed room ACs for purposes of certification in 10 CFR 429.15(b)(2) would be the value measured at the 95 °F rating condition, to maintain consistency with the cooling capacity measured at the same condition. *Id.*

The California IOUs asserted that the proposed methods for calculating the annual operating costs will create market confusion, mainly because the variable-speed annual operating energy consumption would be based on a weighted average that includes and heavily weights conditions at which the unit provides less cooling, whereas the average annual energy consumption of a single-speed unit would continue to be based on the 95 °F condition, at which the unit provides more cooling and thus consumes more energy. The California IOUs stated that using different test procedures and energy consumption calculations for different equipment that provide the same consumer utility, in this case, space conditioning, has the potential to create market distortions. (California IOUs, No. 14 at p. 2)

Conceptually, variable-speed room ACs and single-speed room ACs both deliver the same amount of cooling to a room, albeit in different ways. The variable-speed room

AC provides constant cooling at a reduced rate, while the single-speed room AC switches on to provide maximum cooling for a period of time before switching off and providing no cooling until the temperature in the room rises again. In both cases, the total amount of cooling provided to the room remains the same, only the power consumed by the unit to provide the cooling is different. Furthermore, the test procedure adopted in this final rule assesses the improved efficiency associated with variable-speed room ACs relative to single-speed room ACs, on the basis of adjusted operation at varying, reduced-temperature operating conditions and accounting for reduced energy use associated with eliminating cycling losses. This approach of factoring in reduced-temperature operation over the varying load conditions during the operating hours of the cooling season is thus appropriate for variable-speed units but not for single-speed units.

For the reasons discussed above, as proposed in the June 2020 NOPR, DOE is requiring that the average annual energy consumption used in calculating the estimated annual operating cost of variable-speed room ACs in 10 CFR 430.23(f) be a weighted average of the annual energy consumption at each of the four test conditions in newly added Table 1 of appendix F and the annual energy consumption in inactive mode or off mode, to reflect a realistic measure of energy use and operating costs in a representative average use cycle. Additionally, as proposed in the June 2020 NOPR, DOE is defining the electrical power input reported for variable-speed room ACs for purposes of certification in 10 CFR 429.15(b)(2) to be the value measured at the 95 °F rating condition, to maintain consistency with the cooling capacity measured at the same condition, and to provide consumers with the cooling capacity and power input expected at full load conditions.

D. Definitions

In the June 2020 NOPR, DOE proposed adding a number of definitions to appendix F to accompany the amendments made in this final rule. None of these definitions modified the scope of covered products. 85 FR 35700, 35713 (Jun. 11, 2020). The following section describes each definition in detail.

1. Key Terms

In the June 2020 NOPR, DOE proposed definitions for three key terms that appeared in appendix F but have no definitions: cooling mode, cooling capacity, and combined energy efficiency ratio. 85 FR 35700, 35713 (Jun. 11, 2020). Although room ACs may sometimes operate in other modes as discussed further in section III.E of this final rule, the room AC CEER metric determined in appendix F was based primarily on performance in cooling mode, and several of the amendments also reference “cooling mode.” Therefore, DOE proposed the following definitions for cooling mode, cooling capacity, and combined energy efficiency ratio in appendix F:

“Cooling mode” means an active mode in which a room air conditioner has activated the main cooling function according to the thermostat or temperature sensor signal or switch (including remote control).

“Cooling capacity” means the amount of cooling, in Btu/h, provided to an indoor conditioned space, determined in Section 4.1 of appendix F.

“Combined energy efficiency ratio” means the energy efficiency of a room air conditioner as measured in Btu/Wh and determined in Section 5.2.2 of appendix F for single-speed room air conditioners and Section 5.3.12 of appendix F for variable-speed room air conditioners. *Id.*

To support the amendments pertaining to variable-speed basic models, in the June 2020 NOPR, DOE proposed defining single-speed and variable-speed room ACs as follows:

"Single-speed room air conditioner" means a type of room air conditioner that cannot automatically adjust the compressor speed based on detected conditions.

"Variable-speed room air conditioner" means a type of room air conditioner that can automatically adjust compressor speed based on detected conditions. 85 FR 35700, 35714 (Jun. 11, 2020).

AHAM supported DOE's proposal to add these new definitions in appendix F. (AHAM, No. 13 at p. 6)

For the reasons discussed in the June 2020 NOPR, DOE is adopting these new definitions in appendix F.

2. Compressor Speeds

In the June 2020 NOPR, DOE also proposed defining the three compressor speeds required for variable-speed testing. 85 FR 35700, 35714 (Jun. 11, 2020). DOE referred to these compressor speeds as “full,” “intermediate,” and “low” based on the test procedure terminology of AHRI Standard 210/240, and were proposed as follows:

“Full compressor speed (full)” means the compressor speed at which the unit operates at full load test conditions, achieved by following the instructions certified by the manufacturer.

“Intermediate compressor speed (intermediate)” means a compressor speed higher than the low compressor speed by one third of the difference between low compressor speed and full compressor speed with a tolerance of plus 5 percent (designs with non-discrete speed stages) or the next highest inverter frequency step (designs with discrete speed steps), achieved by following the instructions certified by the manufacturer.

“Low compressor speed (low)” means the compressor speed at which the unit operates at low load test conditions, achieved by following the instructions certified by the manufacturer, such that $Capacity_4$, the measured cooling capacity at test condition 4 in Table 1 of appendix F, is not less than 47 percent and not greater than 57 percent of $Capacity_1$, the measured cooling capacity with the full compressor speed at test condition 1 in Table 1 of appendix F.[33] *Id.*

[33] Further information about the acceptable range of delivered cooling at the low compressor speed and lowest test condition, and how they were derived, can be found in the June 2020 TP NOPR. 85 FR 35700, 35714.

AHAM generally agreed with the waivers, which included the proposed 10-percent range and 57-percent cooling load as its upper bound above. (AHAM, No. 13 at p. 6)

The Joint Commenters, NEAA, and the California IOUs urged DOE to ensure that the proposed fixed compressor speeds are representative of real-world operation. The Joint Commenters, NEAA, and the California IOUs expressed concern that the proposed definition for low compressor speed could lead to measured efficiency values that are not representative. NEAA and the California IOUs pointed to the potential that energy values can subsequently be better than the unit can actually produce in the real world under conditions of less than 95 °F, allowing manufacturers to "game" efficiency ratings as a unit may run differently if its full-load speed does not match how the unit runs in the real world under 95 °F outdoor conditions. Thus, NEAA and the California IOUs suggested that DOE perform additional investigative testing under the 95 °F test condition under native controls and reference variable refrigerant flow air conditioning test procedures regarding whether speed represents use. (NEAA, Public Meeting Transcript, No. 12 at pp. 37−42; California IOUs, Public Meeting Transcript, No. 12 at pp. 30−33; California IOUs, No. 14 at p. 4) Similarly, the Joint Commenters asserted that, under DOE's proposal, manufacturers may have an incentive to test at the 82 °F condition at the compressor speed that provides a cooling capacity as close as possible to 47 percent of the full-load capacity since efficiency typically increases at lower compressor speeds. The Joint Commenters stated that providing 47 percent of the full-load cooling capacity would not meet the cooling load at 82 °F, and that a low compressor speed lower than the operating speed in the field could also result in the intermediate compressor speed being artificially low. The Joint Commenters noted that a variable-speed unit that cannot provide 57 percent of the full-load cooling capacity cannot in fact “match” the representative cooling load at the 82 °F condition. The Joint Commenters stated the test procedure should reflect the potential efficiency gains of variable-speed units that can vary their speed continuously (or in smaller discrete steps) relative to units with compressors with larger discrete steps. (Joint Commenters, No. 15 at pp. 1−2)

As discussed in section III.D of the June 2020 NOPR, the 10-percent range allows for discrete variable-speed compressor stages while maintaining the representativeness of the test procedure. While a variable-speed room AC that cannot operate at precisely 57 percent of the full-load cooling capacity cannot exactly match the cooling load at the 82 °F test condition, it could compensate for this in real world operation at an 82 °F outdoor temperature by operating at a lower compressor speed and moving to a higher compressor speed if the room becomes too hot. DOE observed variable-speed compressors with this behavior during load-based testing, though noted that the compressor speed adjustments did not occur frequently, resulting in extended periods of operation at a single compressor speed. Furthermore, the difference in power consumption between the two speeds observed in these scenarios was only about 5% of the full load operating power, and therefore this style of operation would still result in more efficient operation compared to cycling a single-speed compressor on and off to maintain the reduced load. These variable-speed units still provide significant energy savings , so it is important to account for this sort of variable-speed compressor behavior and ensure the test procedure is applicable to even those variable-speed room ACs that have discrete compressor speed steps that may not provide exactly 57 percent of the full-load cooling capacity. DOE further notes that requiring a low compressor speed that results in a single loading percentage (*i.e.,* 57 percent of the full-load cooling capacity) with no tolerance could greatly increase design and manufacturing burden, and thus may disincentivize the adoption of more efficient technology being newly introduced for room ACs. A 10-percent range would allow for the various types of variable-speed compressors (*i.e.,* discrete and non-discrete), avoid significant burden on manufacturers, and avoid disincentivizing the adoption of this technology. An upper compressor speed limit of 57 percent of the full-load cooling capacity would ensure that the unit does not cycle on and off under the cooling load expected at an outdoor temperature of 82 °F, which would negate much of the efficiency benefits relative to single-speed room ACs). Therefore, DOE proposed a lower limit of 47 percent to maintain the desired 10-percent range of cooling loads while setting 57 percent of the full-load cooling capacity as the upper limit.

In this final rule, DOE is revising the definition of "full compressor speed" proposed in the June 2020 NOPR, to account for the new requirements discussed in section III.C.3.a (*i.e.,* to require that user settings be implemented to achieve maximum cooling capacity when testing using full compressor speed, rather than fixing the compressor speed using instructions provided by the manufacturer).

Furthermore, DOE is also revising the "intermediate compressor speed" definition proposed in the June 2020 NOPR, to clarify that the intermediate compressor speed is defined based on the measured capacity at the 95 °F and 82 °F test condition, using the full and low compressor speeds, respectively.

Thus, DOE is adopting its proposals from the June 2020 NOPR, as detailed below.

In summary, DOE defines the following in newly added Sections 2.14, 2.15, and 2.16 of appendix F:

"Full compressor speed (full)" means the compressor speed at which the unit operates at full load test conditions, achieved by using user settings to achieve maximum cooling capacity, according to the instructions in ANSI/ASHRAE Standard 16-2016 Section 6.1.1.4.

"Intermediate compressor speed (intermediate)" means a compressor speed higher than the low compressor speed at which the measured capacity is higher than the capacity at low compressor speed by one third of the difference between $Capacity_4$, the measured cooling capacity at test condition 4 in Table 1 of this appendix, and $Capacity_1$, the measured cooling capacity with the full compressor speed at test condition 1 in Table 1 of this appendix, with a tolerance of plus 5 percent (designs with non-discrete speed stages) or the next highest inverter frequency step (designs with discrete speed steps), achieved by following the instructions certified by the manufacturer.

"Low compressor speed (low)" as the compressor speed specified by the manufacturer at which the unit operates at low load test conditions, such that $Capacity_4$, the measured cooling capacity at test condition 4 in Table 1 of this appendix, is no less than 47 percent and no greater than 57 percent of $Capacity_1$, the measured cooling capacity with the full compressor speed test condition 1 in Table 1 of this appendix.

E. Active Mode Testing

The following sections describe amendments and other considerations regarding the active mode testing provisions of appendix F.

1. Cooling Mode

The DOE room AC test procedure uses a calorimeter test method to determine the cooling capacity and associated electrical power input of a room AC. See Sections 3.1 and 4.1 of appendix F, as amended. Under this approach, the test unit is installed between two chambers, one representing the indoor side and the other representing the outdoor side, which are both maintained at constant conditions by reconditioning equipment. The room AC operates in cooling mode, transferring heat from the indoor side to the outdoor side, while the reconditioning equipment counteracts the effects of the room AC to maintain constant test chamber conditions. The room AC cooling capacity is determined by measuring the required energy inputs to the reconditioning equipment.

a. Test Setup and Air Sampling

In the June 2020 NOPR, DOE discussed concerns about whether the measured calorimeter chamber temperature reading is representative of conditions at the test unit condenser and evaporator inlet, which may be affected by recirculation from the condenser and evaporator exhaust, respectively, thereby potentially reducing test repeatability and reproducibility. 85 FR 35700, 35715 (Jun. 11, 2020). DOE noted that the size, capability, and orientation of components within calorimeter test chambers may vary significantly, and that third-party laboratories extensively analyze their chambers and testing apparatus to maintain consistent and accurate air sampling measurements. DOE also understood that temperature gradients and unique airflow patterns can result from the interaction of a chamber reconditioning apparatus and the room AC under test, and that these interactions are particular to and dependent upon factors such as chamber size and shape, chamber equipment arrangement, size of reconditioning apparatus, and others, as noted in ANSI/ASHRAE Standard 16-2016 Section 8.2.7. Therefore, in the June 2020 NOPR, DOE contended that universal requirements for air sampling instrumentation and thermocouple placement could potentially reduce test accuracy and reproducibility. As discussed in section III.B.2 of this document, DOE proposed to update the reference to ANSI/ASHRAE Standard 16 to the most current 2016 version, which includes additional clarification on best practices for air sampler and thermocouple placement. *Id.*

DOE received no comments on the test setup and air sampling discussion and proposals from the June 2020 NOPR. For the reasons discussed in the preceding paragraph, DOE is updating the reference to ANSI/ASHRAE Standard 16 to the most current 2016 version, which includes additional clarification on best practices for air sampler and thermocouple placement.

b. Air-Enthalpy Test

In the June 2020 NOPR, as discussed in section III.B.2 of this document, DOE proposed to adopt the use of the calorimeter test method specified in ANSI/ASHRAE Standard 16-2016 for determining the cooling mode performance in appendix F. ANSI/ASHRAE Standard 16-2016 additionally permits an air-enthalpy test method (also referred to as a psychrometric test method), in which a technician places instruments in or near the evaporator air stream to measure the rate of cooled air added to the conditioned space. DOE conducted testing to investigate any differences in test results between air-enthalpy and calorimeter approaches and found a wide range of discrepancies between the two, for both cooling capacity and efficiency. DOE expected that obtaining more accurate results would require specialized test equipment that is limited in availability and costly to design, develop, and produce and, hence, DOE did not propose to include an air-enthalpy test approach for determining cooling mode performance of room ACs. 85 FR 35700, 35715 (Jun. 11, 2020).

The California IOUs agreed with DOE's conclusion to exclude the air-enthalpy test procedure in ANSI/ASHRAE Standard 16-2016. The California IOUs noted that DOE's testing, shown in the June 2020 NOPR, demonstrated that this method was unrepresentative and inconsistent, and remedying these deficiencies would be unduly burdensome. (California IOUs, No. 14 at pp. 5–6)

Based on DOE's investigative testing data, DOE maintains its proposal to not allow the use of the air-enthalpy method for determining room AC cooling mode performance.[34]

c. Side Curtain Heat Leakage and Infiltration Air

i. Non-Louvered (Through-The-Wall) Room Air Conditioners

In the June 2020 NOPR, DOE proposed to specify in appendix F that non-louvered room ACs, which are designed for through-the-wall installation, must be installed using a compatible wall sleeve (per manufacturer instructions), with the provided or manufacturer-required rear grille, and with the included trim frame and other manufacturer-provided installation materials. 85 FR 35700, 35716 (Jun. 11, 2020).

The California IOUs supported DOE's language on the use of manufacturer-provided wall sleeves. However, the California IOUs expressed concern that it may not be apparent to laboratories that they should not use additional material beyond that supplied by the manufacturer. The California IOUs suggested adding the following sentence to the proposed appendix F to 10 CRF Part 430: *"No sealing or insulation material other than that provided by the manufacturer shall be installed between the wall sleeve and the cabinet of the room air conditioner."* (California IOUs, No. 14 at p. 6) DOE understands the concern about test laboratories using additional sealing and insulation material between the unit and the wall sleeve. As discussed in the June 2020

[34] Although DOE incorporates by reference ANSI/ASHRAE Standard 16-2016, which includes an optional air-enthalpy method, only those sections in ANSI/ASHRAE Standard 16-2016 that apply to the calorimeter method are referenced in Appendix F.

NOPR, DOE determined that testing non-louvered room ACs, with the provided or manufacturer-required rear grille, and with the included trim frame and other manufacturer-provided installation materials maximized repeatability and reproducibility. 85 FR 35700, 35716 (Jun. 11, 2020). To address the concern that test laboratories might provide additional sealing or insulation for a non-louvered room AC, DOE is clarifying in this final rule that these units should only be tested using the manufacturer-provided materials.

Therefore, DOE is modifying its proposal from the June 2020 NOPR in this final rule, specifying in appendix F that non-louvered room ACs, which are designed for through-the-wall installation, must be installed using a compatible wall sleeve (per manufacturer instructions), with a provided or manufacturer-required rear grille, and with only the included trim frame and other manufacturer-provided installation materials.

ii. Louvered (Window) Room Air Conditioners

In the June 2020 NOPR, DOE proposed, consistent with Sections 6.1.1.4 and Section 8.4.2 of ANSI/ASHRAE Standard 16-2016, not to require installing louvered room ACs with the manufacturer-provided installation materials, including side curtains, and instead to require testing with the partition wall sealed to the unit. 85 FR 35700, 35717 (Jun. 11, 2020).

AHAM agreed with DOE's proposal to not require the use of manufacturer-provided installation materials in appendix F for louvered room ACs. AHAM cited previous DOE testing which showed that using manufacturer-provided materials included in the retail packaging led to only a 2.5-percent increase in cooling capacity, while not using manufacturer-provided installation materials led to a 4.7-percent reduction in cooling capacity. AHAM stated that this testing did now show consistent or significant change in cooling capacity. (AHAM, No. 13 at p. 6)

The California IOUs and Joint Commenters asserted the need for DOE to capture the effects of real-world installations of room AC units. (California IOUs, No. 14 at p. 6; Joint Commenters, No. 15 at pp. 5−6) The California IOUs commented that with the requirement for indoor and outdoor test rooms to have virtually no pressure differential, the inclusion of side curtains would not have a significant effect in laboratory testing. The California IOUs also stated that repeatability of testing is likely to decrease with side curtains included in the operational test. However, the California IOUs also asserted that testing with side curtains during only the operational test of window room AC units is unlikely to be representative of an average-use cycle. The California IOUs commented that the consumer incurs energy losses during all hours when the room AC is installed, not just while the compressor is on. The California IOUs further commented that the method for calculating the annual cost of operation assumes that the unit is installed for at least 5,865 hours annually, with only 750 hours of compressor operation, and thus including energy losses from side curtains is important to ensure a fair comparison between room ACs with side curtains and competing products that do not incur side curtain losses, such as through-the-wall room ACs and mini-split air conditioners. The California IOUs recommended that DOE evaluate energy losses due to side curtains regardless of the mode of operation and determine a constant representative adjustment factor to account for the losses based on the size of the window room AC in the CEER. (California IOUs, No. 14 at p. 6) The Joint Commenters cited laboratory performance testing of louvered units in which the National Renewable Energy Laboratory found that standard testing simulations do not account for leakage in operation due to manufacturer-provided installation materials. According to the Joint Commenters, leakage from the manufacturer-provided materials was equivalent to a 27–42 square inch hole in the wall, and an improved installation has the potential to reduce this leakage by 65–85 percent. The Joint Commenters commented that, in the preliminary 2020-06 Technical Support Document ("TSD"), DOE explained that because DOE's investigative testing was conducted with no pressure difference between the rooms, the tests were not able to measure the real-world impacts of infiltration.[35] The Joint Commenters asserted that the test procedure does not capture potentially significant inefficiencies in typical installations. The Joint Commenters encouraged DOE to investigate how the test procedure could capture the effects of real-world installations of room AC units, which would provide an incentive to manufacturers to offer improved installation materials such that leakage is reduced. The Joint Commenters further stated that, in addition to saving energy, reducing leakage would also improve cooling performance by reducing the amount of hot air entering from outdoors, which ultimately would improve consumer comfort. (Joint Commenters, No. 15 at pp. 5−6)

[35] 2020-06 Technical Support Document: Energy Efficiency Program For Consumer Products And Commercial And Industrial Equipment: Room Air Conditioners (EERE-2014-BT-STD-0059-0013).

DOE is not aware of an industry-accepted method to evaluate heat losses to the outdoors during the room AC representative use cycle or during times when the room AC is installed but not operating, or of any data quantifying the magnitude of these losses.

DOE has preliminarily investigated applying a pressure difference between the indoor and outdoor chambers during the standard appendix F test procedure, as the Joint Commenters suggested. While it was possible to create a pressure difference between the rooms, temperature and humidity within the chamber did not stabilize and the resulting test data did not meet the tolerance requirements from ASHRAE 16-2016 required in appendix F. Furthermore, for some larger-capacity units, it was difficult for the chamber to maintain the pressure difference throughout the rating test period given the air flow interaction between the unit operation and the chamber reconditioning equipment. It is therefore unclear how the influence of infiltration air could be measured within the DOE test procedure for room ACs, given the difficulties associated with testing using a fixed pressure difference between the indoor and outdoor test chambers.

Therefore, as proposed, DOE is not requiring in this final rule installation of louvered room ACs with the manufacturer-provided installation materials, including side curtains, and instead is requiring the partition wall be sealed to the unit during testing, as specified in Section 6.1.1.4 of ANSI/ASHRAE Standard 16-2016. Accordingly, as discussed above, DOE is not adopting a test to evaluate, or a constant representative adjustment factor to account for, heat losses to the outdoors during the room AC representative use cycle or during times when the room AC is installed but not operating and is not adopting a test requiring a pressure differential between the indoor and outdoor chambers at this time.

d. Test Conditions

Multiple Test Conditions

In the June 2020 NOPR, DOE did not propose additional cooling mode test conditions for single-speed room ACs because a test procedure that measures performance at both peak temperature conditions and a less extreme temperature would require a new overall weighted metric, room AC performance has historically been based on peak performance under elevated outdoor temperature conditions and peak performance would not be clearly portrayed by a weighted metric, and information about variable-speed room ACs is too limited to justify the expected substantial increase in test burden, utility impacts, and consumer confusion associated with measuring performance at reduced outdoor temperature test conditions for all room ACs. 85 FR 35700, 35723 (Jun. 11, 2020).

AHAM agreed with maintaining a single test condition for single-speed room ACs. (AHAM, Public Meeting Transcript, No. 12 at pp. 50−53) ASAP, the California IOUs, and NEAA stated that testing only at the 95 °F outdoor test condition may not provide an accurate relative ranking of different single-speed room AC units as they are likely to have varying efficiency and performance at lower temperature conditions. (ASAP, Public Meeting Transcript, No. 12 at pp. 11−12; California IOUs, Public Meeting Transcript, No. 12 at pp. 30−33) NEAA suggested that single-speed room AC units be given the option to test at multiple test conditions to allow better single-speed options to demonstrate improved performance, while not requiring all products to retest. (NEAA, No. 16 at p. 3)

The California IOUs encouraged DOE to amend the room AC test procedure to improve representativeness and facilitate product comparison with air conditioners tested under appendix M1 to 10 CFR part 430. The California IOUs stated that DOE's proposal to create a part-load test for room ACs with variable-speed compressors recognizes that testing single-speed room ACs only at full capacity is unrepresentative of an average-use cycle. The California IOUs stated that, in their experience, using different test procedures and energy consumption calculations for equipment that provides the same consumer utility, in this case, space conditioning, has the potential to create market distortions. The California IOUs further stated that the rest of the air conditioning industry has moved towards testing at part load, and recommended that DOE consider a consistent approach for room ACs.[36] To minimize market confusion, the California IOUs suggested that the room AC test procedure should be as similar as possible for the test procedure for central air conditioners and heat pumps, including measuring part-load performance for room ACs, as defined for central air conditioners and heat pumps in appendix M1 to 10 CFR part 430. The California IOUs stated that aligning test procedures and energy efficiency metrics for room ACs with a cooling capacity greater than or equal to 9,000 Btu/h and central air conditioners and heat pumps would enhance

[36] Based on the context of the California IOUs' comment, it is understood that the California IOUs are referring to how appendix M1 accounts for operation at reduced cooling loads and not load-based testing as discussed above.

consumers' ability to choose the product that best fits their needs. The California IOUs further stated that, because many room AC manufacturers also make products that fall under appendix M1 to 10 CFR part 430 and are familiar with the test procedure, the transition to a test procedure for room ACs aligned with appendix M1 would be relatively easy. (California IOUs, No. 14 at pp. 1–3)

While certain single-speed room ACs may perform differently under reduced outdoor temperature test conditions, requiring two or more tests for every single-speed room AC, either by testing at multiple test conditions or aligning the room AC test procedure with appendix M1, would at least double the test burden on manufacturers of single-speed room ACs that represent the vast majority of the market. A voluntary reduced outdoor temperature test would require a revision of the test procedure and the CEER metric to account for a multiple-condition single-speed room AC test. Such an option may be confusing to consumers who are trying to compare single-speed room ACs with metrics that are not directly comparable. Additionally, because single-speed units cannot cycle on and off during a reduced outdoor temperature test (*i.e.,* because the chamber conditions are held constant throughout the test), the reduced outdoor temperature test alone would not be representative of the single-speed room AC's real world operation, and cycling would need to additionally be considered. Aligning the room AC test procedure with the appendix M1 test procedure would greatly increase the test burden on manufacturers for typically inexpensive and seasonal units. Therefore, in this final rule, DOE is not establishing multiple test conditions for single-speed room

ACs or adopting provisions to align the room AC test procedure with the central air conditioner test procedure at appendix M1.

Cooling Test Alternatives

DOE is aware of two approaches to measure part-load performance of a room AC, dynamic-cooling-load testing and constant-cooling-load testing. In both a dynamic-cooling-load test and a constant-cooling-load test, the chamber indoor cooling load was provided at a specified rate or value throughout testing instead of maintaining specific temperature conditions within the test chamber. In the June 2020 NOPR, DOE explored a constant-cooling-load test and concluded that increased test burden, reduced repeatability and reproducibility, and a current lack of industry consensus on a constant-cooling-load or dynamic-cooling-load test procedure outweighed potential benefits. 85 FR 35700, 35723 (Jun. 11, 2020). Thus, in the June 2020 NOPR, DOE did not propose a constant-cooling-load or dynamic-cooling-load test for room ACs. *Id.*

AHAM agreed with DOE's initial conclusion that the potential benefits of constant-cooling-load or dynamic-cooling-load tests do not justify the increase in test burden or the negative impact on repeatability and reproducibility. According to AHAM, DOE’s testing demonstrated that conducting a constant-cooling-load test in a calorimeter test chamber would impact the repeatability and reproducibility—at cooling loads less than 75 percent of the tested unit cooling capacity, the indoor wet-bulb temperature variation in DOE’s test sample sometimes exceeded 0.3 °F. AHAM cited that DOE also observed challenges with the test chamber—the chamber controls were not capable of automatically achieving a specific cooling load condition. Additionally, AHAM commented that this type of testing would significantly increase test burden. (AHAM, No. 13 p. 6)

ASAP, Joint Commenters, NEAA, and the California IOUs disagreed with DOE's initial conclusion and proposal in the June 2020 NOPR and urged DOE to use a load-based test to better represent real-world efficiency of both single-speed and variable-speed units. (ASAP, Public Meeting Transcript, No. 12 at p. 1; Joint Commenters, No. 15 at pp. 3−4; NEAA, No. 16 at pp. 4−5) ASAP commented that using a load-based test procedure for all room ACs would provide the most representative efficiency ratings and accurate information for customers. (ASAP, Public Meeting Transcript, No. 12 at p. 1) The Joint Commenters noted that, for single-speed units, a load-based test would capture the impact of cycling losses. The Joint Commenters further noted that, for variable-speed units, load-based testing would capture the impact of control strategies that determine compressor and fan speed operation and would ensure that the test procedure reflects the real-world operation of these units. (Joint Commenters, No. 15 at pp. 3−5) NEAA commented that its initial load-based testing of ductless heat pumps indicated that controls can dramatically affect performance and suggested the same effects could be found with room ACs. (NEAA, No. 16 at pp. 4−5)

DOE acknowledges that a constant-cooling-load or dynamic-cooling-load test for all room ACs has the potential to be more representative of real-world operation. However, a load-based test would reduce repeatability and reproducibility due to limitations in current test chamber capabilities, as discussed in the June 2020 NOPR, which would negatively impact the representativeness of the results and potentially be unduly burdensome. 85 FR 35700, 35723–35726 (Jun. 11, 2020). Therefore, based on DOE's investigative testing and to maintain test procedure alignment with AHAM RAC-1-2020, in this final rule DOE maintains its proposal not to include a constant-cooling-load or dynamic-cooling-load test for room ACs in appendix F.

e. Power Factor

In the June 2020 NOPR, DOE did not propose requirements for measuring and reporting the power factor[37] for room ACs. 85 FR 35700, 35726 (Jun. 11, 2020). Based on investigative testing DOE found that there was no significant difference between the actual power drawn by a room AC and the apparent power supplied to the unit, meaning the additional burden of measuring and reporting the power factor would outweigh any benefits this information would provide. *Id.* The California IOUs agreed that the results —an average power factor of 0.97 on 23 units—do not provide evidence that warrants the inclusion of power factor in the test procedure. However, the California IOUs commented that variable-speed motor controllers often have lower power factors compared to direct-on-line motors used in single-speed room ACs[38] and requested that DOE indicate whether the room ACs tested included representative variable-speed compressor room ACs. If not, the California IOUs requested that DOE consider

[37] The power factor of an alternating current electrical power system is defined as the ratio of the real power flowing to the load to the apparent power in the circuit. A load with a low power factor draws more electrical current than a load with a high power factor for the same amount of useful power transferred. The higher currents associated with low power factor increase the amount of energy lost in the electricity distribution system.

[38] Greenberg, S. (1988). Technology Assessment: Adjustable-Speed Motors and Motor Drives. Lawrence Berkeley National Laboratory. LBNL Report #: LBL-25080. Retrieved from *https://escholarship.org/uc/item/41z9k3q3*.

conducting power factor testing of variable-speed room ACs and reporting the results. (California IOUs, No. 14 at p. 5)

None of the 23 units DOE tested during the power factor investigation for the June 2020 NOPR were variable-speed units. To date, DOE has been unable to gather power factor data for variable-speed room ACs due to instrumentation limitations. In the absence of data that suggest that variable-speed power factors are significantly different than single-speed power factors, DOE is not adopting a power factor measurement or reporting requirements for room ACs at appendix F in this final rule.

2. Heating Mode

When a reverse cycle room AC is in heating mode, the indoor evaporator coil switches roles and becomes the condenser coil, providing heat to the indoor room. The outdoor condenser unit also switches roles to serve as the evaporator and discharges cold air to the outdoors. Appendix F does not include a method for measuring room AC energy consumption in heating mode.

In the June 2020 NOPR, DOE did not propose a heating mode test procedure for room ACs based on the lack of data of room AC used for heating and given the potential concerns raised by stakeholders that combining cooling mode and heating mode performance into a single metric may limit a consumer's ability to recognize the mode-specific performance and compare performance with room ACs that only provide cooling, and may lead to a reduction in cooling mode efficiency. 85 FR 35700, 35726 (Jun. 11, 2020).

AHAM supported DOE's proposal, noting that there are insufficient data to support developing a test to measure heating mode as current data suggest it is not a significant operating mode for room ACs. AHAM stated that national, statistically significant consumer use data must be used to justify changes in order to satisfy the requirements of the Data Quality Act. In urging DOE to adopt AHAM RAC-1-2020 (formerly AHAM RAC-1-2019), which does not include a heating mode test, AHAM further agreed with DOE's proposal. (AHAM, Public Meeting Transcript, No. 12 at pp. 9−10; AHAM, No. 13 at pp. 2, 7)

For the reasons discussed, and in the June 2020 NOPR, DOE is not establishing a heating mode test procedure for room ACs in appendix F.

3. Off-Cycle Mode

Single-speed room ACs typically operate with a compressor on-off control strategy, where the compressor runs until the room temperature drops below a consumer-determined setpoint, then ceases to operate (*i.e.*, the unit operates in off-cycle mode[39]) until the room temperature rises above the setpoint, at which time the compressor starts again. The points at which the compressor stops and restarts depend on the setpoint temperature defined by the user and the deadband[40] programmed by the manufacturer. During the period in which the compressor remains off (*i.e.,* off-cycle mode), the fan may operate in different ways depending on manufacturer implementation: (1) the fan ceases

[39] "Off-cycle mode" is distinct from "off mode," in which a room AC not only ceases compressor and fan operation but also may remain in that state for an indefinite time, not subject to restart by thermostat or temperature sensor signal.
[40] The term "deadband" refers to the range of ambient air temperatures around the setpoint for which the compressor remains off, and above which cooling mode is triggered on.

operation entirely; (2) the fan continues to operate for a short period of time after the setpoint is reached and then stops until the compressor is reactivated; (3) the fan continues to operate continuously for a short period of time, after which it cycles on and off periodically until the compressor is reactivated; or (4) the fan continues to operate continuously until the compressor is reactivated.[41]

In the June 2020 NOPR, DOE did not propose a definition or test procedure for off-cycle mode. 85 FR 35700, 35728 (Jun. 11, 2020) Through investigative testing, DOE found that average power use in off-cycle mode was relatively low (*i.e.,* approximately 10 percent or less) compared to the average power used in cooling mode. *Id.* Thus, DOE initally determined that the additional 2-hour test burden that would be required to establish a test procedure for off-cycle mode would outweigh the benefits of measuring off-cycle mode power for room ACs. *Id.*

AHAM agreed with DOE's proposal, commenting that EPCA requires test procedures to measure only a representative average use cycle/period of use, not every possible mode. AHAM further commented that the cooling cycle continues to be the most representative average use cycle for this purpose, with no data on the prevalence of consumer use of off-cycle mode. (AHAM, No. 13 at p. 7)

The California IOUs, the Joint Commenters, and NEAA disagreed with DOE's

[41] Unlike air circulation mode, off-cycle mode is not user-initiated and only occurs when the ambient temperature has satisfied the setpoint.

proposal, stating the exclusion of off-cycle mode testing would result in non-representative efficiency ratings. (California IOUs, No. 14 at pp. 4−5; Joint Commenters, No. 15 at p. 3; NEAA, No. 16 at pp. 3−4) The California IOUs commented that ENERGY STAR finds off-cycle power consumption sufficiently important to require qualifying room ACs to enable Energy Saver Mode ("ESM") by default when the unit is switched on. The California IOUs expressed concern that assuming all room ACs typically operate in ESM may be unwarranted. (California IOUs, No. 14 at pp. 4−5) The Joint Commenters commented that room AC units with continuous fan operation can consume close to 240 kilowatt-hours per year of energy in off-cycle mode alone, pointing to its prevalence and importance in testing. (Joint Commenters, No. 15 at p. 3) NEAA stated that, while more data are needed on the number of hours spent in off-cycle and recirculation mode, these modes have the potential to account for a significant percentage of annual energy use. For example, NEAA commented that if a unit in the 6,000–7,900 Btu/h capacity range spent 25 percent of the amount of time in the off-cycle mode than it does in compressor mode (*i.e.*, 187.5 hours, DOE estimates 750 compressor hours per year on average), the off-cycle mode would account for 9 percent of annual energy use for an average continuous operation fan. NEAA further commented that if this same room AC spent the same number of hours in off-cycle hours as in compressor mode, the off-cycle mode would account for 37 percent of its annual energy use. (NEAA, No. 16 at pp. 3−4) The California IOUs, the Joint Commenters, and NEAA urged DOE to capture off-cycle mode power consumption, including fan operation, to provide a better representation of actual efficiency in the field and more accurate information to consumers. (California IOUs, No. 14 at pp. 4−5; Joint Commenters, No. 15 at p. 3;

NEAA, No. 16 at pp. 3−4) The California IOUs specifically requested that DOE investigate consumer use of ESM compared to always-on fan operation modes, and determine the proportion of operating hours where the fan runs with the compressor off in order to accurately determine average power consumption during off-cycle mode and to include that power consumption in the test procedure. The California IOUs also requested that DOE create a definition for "off-cycle mode". (California IOUs, No. 14 at pp. 4−5)

EPCA requires that the test procedures be reasonably designed to produce test results which measure the energy efficiency of room air conditioners during a representative average use cycle or period of use and not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(2)) EPCA does not require the test procedure to evaluate every mode of operation. DOE notes that there are insufficient available data on the amount of time room ACs spend in off-cycle mode to support a conclusion that a test procedure capturing such operation would be representative of an average use cycle. Furthermore, as discussed in the June 2020 NOPR, DOE found that energy consumption in off-cycle mode was relatively low, approximately 10 percent or less, of the power used during cooling mode. 85 FR 35700, 35728 (Jun. 11, 2020). While DOE understands that units with continuous fan modes during off-cycle mode may consume a higher percentage of energy relative to cooling mode, the units in DOE's test sample that operated the fan continuously during off-cycle mode were older models which are no longer in production and are not likely prevalent on the market.

Because of the lack of data regarding operation in off-cycle, DOE is not adopting test procedures to address this mode.

F. Standby Modes and Off Mode

Section 1.5 of appendix F defines inactive mode as a mode that facilitates the activation of active mode by remote switch (including by remote control) or internal sensor, or provides continuous status display. Section 1.6 of appendix F defines off mode as a mode distinct from inactive mode in which a room AC is connected to a mains power source and is not providing any active or standby mode function and where the mode may persist for an indefinite time. An indicator that only shows the user that the product is in the off position is included within the classification of an off mode. Section 1.7 of appendix F defines standby mode as any mode where a room AC is connected to a mains power source and offers one or more of the following user-oriented or protective functions which may persist for an indefinite time: (a) to facilitate the activation of other modes (including activation or deactivation of active mode) by remote switch (including remote control), internal sensor, or timer; or (b) continuous functions, including information or status displays (including clocks) or sensor-based functions.

1. Referenced Standby Mode and Off Mode Test Standard

In the January 2011 Final Rule, DOE amended the room AC test procedure by incorporating provisions from IEC Standard 62301 First Edition for measuring standby mode and off mode power. 76 FR 971, 979–980 (Jan. 6, 2011). At that time, DOE reviewed the IEC Standard 62301 First Edition and concluded that it would generally apply to room ACs, with some clarifications, including allowance for testing standby mode and off mode in either the test chamber used for cooling mode testing, or in a separate test room that meets the specified standby mode and off mode test conditions. 76 FR 971, 986.

On January 27, 2011, IEC published IEC Standard 62301 Second Edition, an internationally accepted test procedure for measuring standby power in residential appliances, which included various clarifications to IEC Standard 62301 First Edition. Provisions from IEC Standard 62301 Second Edition are currently referenced in DOE test procedures for multiple consumer products for which standby mode and off mode energy use are measured (*e.g.,* dehumidifiers, portable ACs, dishwashers, clothes washers, clothes dryers, conventional cooking products, microwave ovens).

Based on its previous determinations for similar consumer products, DOE has determined that use of IEC Standard 62301 Second Edition for measuring the standby mode and off mode energy use for room ACs would improve the accuracy and representativeness of the test measurements and would not be unduly burdensome, compared to IEC Standard 62301 First Edition. 80 FR 45801, 45822 (Jul. 31, 2015); 81 FR 35241, 35242 (Jun. 1, 2016); 77 FR 65942, 55943 (Oct. 31, 2012); 80 FR 46729, 46746 (Aug. 5, 2015); 78 FR 49607, 49609 (Aug. 14, 2013); 85 FR 50757, 50758 (Aug. 8, 2020); 78 FR 4015, 4016 (Jan. 18, 2013). Accordingly, DOE references relevant paragraphs of IEC Standard 62301 Second Edition in appendix F in place of those from IEC Standard 62301 First Edition, as follows:

a. Power Measurement Uncertainty

In the June 2020 NOPR, DOE proposed to reference the power equipment specifications from Section 4.4 of IEC Standard 62301 Second Edition for determining standby mode and off mode power in appendix F. 85 FR 35700, 35729 (Jun. 11, 2020). DOE received no comments on these proposals from the June 2020 NOPR. For the reasons discussed on the June 2020 NOPR and in this document, DOE is requiring in this final rule that the power equipment specifications from Section 4.4 of IEC Standard 62301 Second Edition be used for determining standby mode and off mode power in appendix F.

b. Power Consumption Measurement Procedure

In the June 2020 NOPR, DOE proposed to adopt through reference the sampling method from Section 5.3.2 of IEC Standard 62301 Second Edition to determine standby mode and off mode average power in appendix F. DOE initially determined the proposed update to the sampling method for all standby mode and off mode testing would not increase test burden, because power meters that can measure, store, and output readings at the required proposed sampling rate and accuracy for the sampling method are already widely used by test laboratories. DOE also initially determined that the power consumption measured with the sampling method would not substantively vary from that measured with the direct meter or average reading methods. 85 FR 35700, 35729 (Jun. 11, 2020).

DOE received no comments on the proposal discussed above. For the reasons discussed on the June 2020 NOPR and in this document, DOE is adopting and referencing the sampling method from Section 5.3.2 of IEC Standard 62301 Second Edition to determine standby mode and off mode average power in appendix F.

G. Network Functionality

Network functionality on room ACs may enable functions such as communicating with a network to provide real-time information on the temperature conditions in the room or receiving commands via a remote user interface such as a smartphone. DOE has observed that network features on room ACs are designed to operate in the background while the room AC performs other functions. These network functions may operate continuously during all operating modes, and therefore may impact the power consumption in all operating modes.

DOE declined to adopt provisions to account for energy consumption associated with network functionality in the January 2011 Final Rule due to the lack of information about room ACs with network functionality. 76 FR 971, 983–984 (Jan. 6, 2011). On September 17, 2018, DOE published a request for information ("RFI") on the emerging smart technology appliance and equipment market. 83 FR 46886. In that RFI, DOE sought information to better understand market trends and issues in the emerging market for appliances and commercial equipment that incorporate smart technology. DOE's intent in issuing the RFI was to ensure that DOE did not inadvertently impede such innovation in fulfilling its statutory obligations in setting efficiency standards for covered products and equipment.

In the June 2020 NOPR, DOE requested comment on the same issues presented in the emerging smart technologies RFI, as they may be applicable to room ACs and on the proposal to specify that all network or connectivity settings must be disabled during testing. 85 FR 35700, 35730 (Jun. 11, 2020).

AHAM and GEA supported DOE's proposal to test units with network capabilities with network settings disabled for all operating modes. AHAM noted this proposal is in accordance with AHAM RAC-1-2020, AHAM commented that there is not yet adequate consumer use data to justify amending the room AC test procedure. AHAM further stated that they are aware that some consumers do not even connect their network-enabled appliances to use the available features. AHAM recommended that DOE ensure that the room AC test procedure does not prematurely address new designs which may not yet have an average use or be in common use, which could stifle innovation. Similarly, GEA commented that regulating the already small energy consumption of connected features risks stifling innovation, including the further development of energy saving features. (AHAM, No. 13 at pp. 8; GEA at No. 18, pp. 2) GEA reiterated these sentiments in comments on the energy conservation standards ("ECS") Preliminary Analysis. (GEA, Preliminary Analysis, No. 26 at p. 2)

ASAP, the Joint Commenters, and NEAA expressed concern that testing units with network capabilities with network settings disabled for all operating modes would significantly underrepresent energy consumption. They asserted that this would result in non-representative efficiency ratings. ASAP commented that units with network capabilities may consume additional power continuously in all operating modes. (ASAP, Public Meeting Transcript, No. 12 at pp. 12, 80−81; Joint Commenters, No. 15 at p. 3; NEAA, No. 16 at pp. 5−6)

As stated in the June 2020 NOPR, DOE is not aware of any data regarding how often consumers use these features or how much energy the features consume during an average representative use cycle, and commenters did not provide any such data. Absent consumer usage data, DOE is unable at this time to evaluate potential test procedure provisions related to network capabilities.

Similarly, DOE declined to adopt provisions to account for energy consumption associated with network functionality in the January 2011 Final Rule due to the lack of information about room ACs with network functionality. 76 FR 971, 983–984 (Jan. 6, 2011). The test procedure adopted, however, did not affirmatively require that network capabilities of units under test be disabled. As a result, due to the growth in the number of network-enabled models of room ACs on the market, it has become increasingly likely that the test procedure adopted in January 2011 Final Rule may unintentionally capture energy use attributable to network functions. The amendment adopted in this rule precludes this possibility by reinforcing the intent of the January 2011 Final Rule.

While there are a number of connected room ACs on the market with varying implementations of connected features, DOE is not aware of any data available, nor did interested parties provide any such data, regarding the consumer use of connected features. Without this data, DOE is unable to establish a representative test configuration for assessing the energy consumption of connected functionality for room ACs.

DOE therefore maintains its proposal to test room ACs with network capabilities disabled. DOE is specifying in Section 3.1.4 of appendix F that units with network capabilities must be tested with the network settings disabled, and that those network settings remain disabled for all tested operating modes (*i.e.*, cooling mode, standby mode, and off mode).

H. Demand Response

The current U.S. Environmental Protection Agency's ("EPA's") ENERGY STAR Product Specification for Room Air Conditioners Version 4.1[42] specifies optional criteria for room ACs designed to provide additional functionality to consumers, such as alerts and messages, remote control and energy information, as well as demand response ("DR") capabilities, which support the inclusion of room ACs in smart grid applications (hereafter "connected room ACs"). These capabilities are network capabilities, as they require the room AC maintain communication continuously or intermittently with a server; however, DR functionality is a unique subset that enables smart grid communication and active modified operation in response to DR signals from an electric utility.

On June 7, 2017, DOE and EPA published the final ENERGY STAR Program Requirements Product Specification for Room Air Conditioners: Test Method to Validate Demand Response (hereafter the "June 2017 ENERGY STAR Test Method"). This test

[42] The ENERGY STAR Certification Criteria V4.1 is available at *https://www.energystar.gov/sites/default/files/ENERGY%20STAR%20Version %204.0%20Room%20Air%20Conditioners %20Program%20Requirements.pdf*

method validates that a unit complies with ENERGY STAR's DR requirements, which are designed to reduce energy consumption upon receipt of a DR signal. However, DOE notes that the June 2017 ENERGY STAR Test Method does not measure the total energy consumption or average power while a unit responds to a DR signal. DOE noted in the June 2020 NOPR that no connected room ACs were available at that time on the market that complied with the full set of ENERGY STAR Version 4.1 connected criteria, and therefore, the energy consumption could not be determined for a range of products and manufacturers. 85 FR 35700, 35731 (Jun. 11, 2020). DOE also stated that there is little available information indicating the frequency of received DR signals that are specified in the ENERGY STAR connected criteria, and as a result, it is not possible to determine annual energy use attributed to DR signals. *Id.* Given the issues raised in the September 17, 2018 emerging smart technologies RFI, the lack of available connected room ACs on the market, and the lack of energy consumption and usage data regarding the DR signals, DOE did not propose to amend its room AC test procedure to measure energy consumption while a connected room AC is responding to a DR signal. *Id.*

AHAM supported DOE's proposal, stating that products are continuously evolving with new features and with greater functionality. AHAM stated that these new features, including connectivity, are in the early stages of development and consumers are only beginning to use and understand them. AHAM commented that there are not yet adequate consumer use data to justify amending the room AC test procedure to include energy consumption while a connected room AC responds to a DR signal. AHAM further commented that consumer use and understanding of new technologies continues to evolve and to inform manufacturers' designs. As DOE evaluates potential changes, AHAM recommended that DOE be mindful that it will take time before many new features, designs, and technologies lend themselves to a "representative average" consumer use. AHAM further recommended that DOE ensure that the room AC test procedure does not prematurely address new designs which may not yet have an average use or be in common use, as doing so could stifle innovation. (AHAM, No. 13 at p. 8) AHAM reiterated these points in comments on the ECS Preliminary Analysis. (AHAM, Preliminary Analysis, No. 19 at pp. 15−16)

DOE continues to find that there are insufficient consumer usage data to support amending the room AC test procedure to include connected energy consumption, and that the test procedure should not prematurely address new technologies absent sufficient average use data. Therefore, DOE is not amending the DOE test procedure for room ACs to include energy consumption while a connected room AC responds to a DR signal.

I. Combined Energy Efficiency Ratio

The room AC energy efficiency metric, CEER, accounts for the cooling provided by the room AC in cooling mode as a function of the total energy consumption in cooling mode and inactive mode or off mode. In the June 2020 NOPR, DOE proposed to maintain the current CEER calculations for single-speed room ACs, given the proposals discussed above. 85 FR 35700, 35731 (Jun. 11, 2020).

AHAM supported DOE's proposal to maintain the current CEER calculations for single-speed room ACs, stating that there was no need to or justification for amending the CEER calculations at this time. (AHAM, No. 13 at p. 8).

NEAA supported implementing a seasonal metric for all room ACs that would represent the performance at multiple outdoor temperature conditions, similar to the seasonal energy efficiency ratio ("SEER") metric used for central air conditioners. NEAA suggested that in the near-term to reduce test burden, single-speed equipment should be allowed to use the current test procedure and to calculate a seasonal rating using a PAF. NEAA recommended that DOE maintain the peak CEER metric as a voluntary reporting metric. NEAA noted that this peak-load efficiency can continue to be used by utility programs and energy modelers but would not be the basis for energy conservation standards. (NEAA, No. 16 at p. 3; *see also* NEAA, Preliminary Analysis, No. 24 at pp. 3−4)

DOE is not amending the energy efficiency metric for room ACs. While DOE recognizes the utility of a single test approach for all room ACs, as discussed in section III.E.1 of this document, DOE has determined that testing single-speed room ACs at multiple outdoor temperature conditions would result in an unwarranted increase in test burden on manufacturers. While this increase in test burden could be mitigated using NEEA's suggestion to test single-speed room ACs using the current test procedure and applying a PAF, DOE notes that this approach would require the recertification of all room ACs currently on the market, and for most models would likely change the cooling capacity and efficiency, both of which are metrics that are familiar to consumers and are used as a basis for purchasing decisions. Thus, a fundamental change to the cooling capacity and CEER metric, by adopting multiple test conditions or applying an adjustment factor for all single-speed room ACs would result in recertification costs and potential consumer confusion. Based on this reasoning, DOE is proceeding with its proposal to maintain the current CEER calculations for single-speed room ACs.

J. Certification and Verification Requirements

In the June 2020 NOPR, DOE proposed to update the sampling plan and certification reporting requirements in 10 CFR 429.15(a)(2)(ii) and (b)(2) to conform the current metric by requiring the reporting of the CEER metric and to remove references to the previous performance metric, EER. 85 FR 35700, 35731(Jun. 11, 2020). For variable-speed room ACs, DOE proposed to require additional reporting of cooling capacity and electrical input power for each of the three additional test conditions as part of a supplemental PDF that would be referenced within the manufacturer's certification report. *Id.* DOE received no comments on the proposed changes to 10 CFR 429.15.

DOE is amending the certification requirements as proposed to conform the reporting requirements to the current CEER metric and removing references to the previous performance metric, EER. For variable-speed room ACs, DOE requires the additional reporting of cooling capacity and electrical input power for each of the three additional test conditions as part of a supplemental PDF that would be referenced within the manufacturer's certification report.

K. Reorganization of Calculations in 10 CFR 430.23

Previously, 10 CFR 430.23(f) contained instructions for determining a room AC's estimated annual operating cost, with calculations described for the average annual energy consumption, combined annual energy consumption, EER, and CEER.

In the June 2020 NOPR, DOE proposed to remove the obsolete EER calculation. 85 FR 35700, 35731 (Jun. 11, 2020).

The California IOUs expressed concern with DOE removing the EER calculation and metric, as doing so would prevent manufacturers from showing information if they so choose. The California IOUs supported its removal as long as DOE continues to require reporting of the full-load capacity and power consumption, which is a substitute for EER. With the retention of the full-load capacity and power consumption metrics, the California IOUs stated that consumers are unlikely to be harmed, as knowing power consumption and efficiency at full load is essential to consumers in hot climates. Alternatively, the California IOUs recommended that DOE require reporting of the EER metric in the Compliance Certification Management System ("CCMS") database, but that it not be the metric for energy conservation standards. (California IOUs, Public Meeting Transcript, No. 12 at pp. 72–75) AHAM commented that everything that is recorded is an additional burden and, in this case, continuing to report the EER metric in the CCMS database would be an unnecessary, additional burden. (AHAM, Public Meeting Transcript, No. 12 at p. 74)

DOE agrees that requiring manufacturers to report the EER metric would be an unnecessary, additional burden on manufacturers. DOE also notes that maintaining the EER metric in public-facing materials may be confusing to consumers but that consumers will still have access to similarly important information through the full-load capacity and power consumption metrics that are currently reported to DOE and listed in the CCMS. Therefore, DOE is proceeding with its proposal from the June 2020 NOPR to remove the obsolete EER calculation and maintain the requirement to report full-load capacity and power consumption.

In the June 2020 NOPR, DOE further proposed moving the CEER calculation from 10 CFR 430.23(f) to appendix F, to mitigate potential confusion, harmonize with the approach used for other products, and improve the readability of the calculations previously in 10 CFR 430.23(f) and appendix F. 85 FR 35700, 35731 (Jun. 11, 2020). Similarly, DOE proposed removing the calculations for average annual energy consumption in cooling mode and combined annual energy consumption from 10 CFR 430.23(f) and instead adding calculations for annual energy consumption for each operating mode in appendix F. *Id.* DOE also proposed to include in 10 CFR 429.15(a)(3) through (5),10 CFR 429.15 (b)(3), and 10 CFR 430.23(f) instructions to round cooling capacity to the nearest 100 Btu/h, electrical input power to the nearest 10 W, and CEER to the nearest 0.1 British thermal units per watt-hour ("Btu/Wh"), to provide consistency in room AC capacity, electrical input power, and efficiency representations. *Id.*

In the June 2020 NOPR, DOE similarly proposed to establish instructions in appendix F to round cooling capacity to the nearest 100 Btu/h, electrical input power to the nearest 10 W, and CEER to the nearest 0.1 Btu/Wh, to provide consistency in room AC capacity, electrical input power, and efficiency representations. *Id.* DOE also proposed to revise the estimated annual operating cost calculation to reference the annual energy consumption for each operating mode as calculated in appendix F, as opposed to the annual energy consumption calculation previously located in 10 CFR 430.23. *Id.*

AHAM understood DOE's proposal to be that rounding would take place on both the tested and reported values and opposed such an approach. AHAM stated that rounding both the tested and reported values would add too much variation; for example, it could add 1 percent error just due to rounding for an 8,000 Btu/h unit. AHAM further commented that there is a significant difference in results if only the mean is rounded versus both the individual test measurements and the mean being rounded. Accordingly, AHAM instead proposed rounding should take place only on the rated values (*i.e.*, the cooling capacity) and that rounding should be to the hundreds of Btu/h because it is clearer to communicate round numbers to retailers and consumers. (AHAM, No. 13 at p. 9)

DOE agrees with AHAM that rounding both the tested and reported values may introduce too much variance in the rated values. In the June 2020 NOPR, DOE proposed to include rounding instructions to provide consistency in room AC capacity, electrical input power, and efficiency representations when conducting the test. 85 FR 35700, 35731 (Jun. 11, 2020). While consistency in rounding between reported values and tested values is important, the accuracy of reported values outweighs concerns about consistency with the rounding for tested values. The proposed rounding instructions at 10 CFR 429.15 will ensure that there is consistency in reported results, while not affecting the accuracy of those reported values. Therefore, DOE is removing the proposed rounding instructions from 10 CFR 430.23(f) but maintaining the rounding instructions proposed in for 10 CFR 429.15.

L. Effective Date, Compliance Date and Waivers

The effective date for the adopted test procedure amendment will be 30 days after publication of this final rule in the *Federal Register*. EPCA prescribes that 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 180 days after publication of the test procedure final rule in the *Federal Register*. (42 U.S.C. 6293(c)(2)) EPCA provides an allowance for individual manufacturers to petition DOE for an extension of the 180-day period if the manufacturer would experience undue hardship in meeting the 180-day deadline. (42 U.S.C. 6293(c)(3)) To receive such an extension, a manufacturer must file a petition with DOE no later than 60 days before the end of the 180-day period and detail how the manufacturer will experience undue hardship. *Id.*

Upon the compliance date of test procedure provisions in this final rule any waivers that had been previously issued and are in effect that pertain to issues addressed by such provisions are terminated. 10 CFR 430.27(h)(2). Recipients of any such waivers are required to test products subject to the waiver according to the amended test procedure as of the effective date of the amended test procedure. The amendments adopted in this document pertain to issues addressed by waivers and interim waivers granted to LG (Case No. 2020-011), Midea (Case No. 2020-017), and GEA (Case No. 2020-004). This final rule also addresses issues identified in pending waivers for Danby

(Case No. 2020-019),[43] Electrolux (Case No. 2020-016),[44] MARS (Case No. 2020-021),[45] and Perfect Aire (Case No. 2020-018).[46] Per 10 CFR 430.27(l), the publication of this final rule eliminates the need for the continuation of granted waivers. Publication of this final rule also eliminates the need for the pending petitions for waivers which have been requested for certain room AC models with variable-speed capabilities, as this final test procedure incorporates testing and certification requirements for variable-speed room ACs.

M. Test Procedure Costs, Impacts, and Other Topics

1. Test Procedure Costs and Impacts

In this document, DOE amends the existing test procedure for room ACs by: (1) referencing current versions of industry standards, as appropriate; (2) including test provisions to reflect the relative performance improvements for variable-speed room ACs compared to single-speed room ACs, including tests at multiple temperature conditions, based on the alternate test procedure from recent waivers; (3) updating definitions in support of the provisions for testing variable-speed room ACs, to ensure the test procedure is self-contained, reflects existing test procedure terminology, and distinguishes between variable-speed and single-speed units; and (4) incorporating

[43] The Danby waiver docket can be found at *https://beta.regulations.gov/docket/EERE-2020-BT-WAV-0036/document*.
[44] The Electrolux waiver docket can be found at *https://beta.regulations.gov/document/EERE-2020-BT-WAV-0033-0001*.
[45] The MARS waiver docket can be found at *https://beta.regulations.gov/docket/EERE-2020-BT-WAV-0038/document*.
[46] The Perfect Aire waiver docket can be found at *https://beta.regulations.gov/docket/EERE-2020-BT-WAV-0034*.

specifications and minor corrections to improve the test procedure repeatability, reproducibility, and overall readability. DOE has determined that the test procedure as amended by this final rule will not be unduly burdensome for manufacturers to conduct.

Further discussion of the cost impacts of the test procedure amendments are presented in the following paragraphs.

Appendix F

This final rule generally adopts the latest industry standard test procedure, AHAM RAC-1-2020, for determining the CEER for variable-speed room ACs, consistent with the procedure prescribed in the test procedure waivers. There are 10 basic models (four from LG and six from Midea) currently on the market subject to the test procedure waivers for variable-speed room ACs. 84 FR 20111 (May 8, 2019); 85 FR 31481 (May 26, 2020). DOE expects that as many as 18 additional basic models will soon be introduced to the market subject to the GEA interim waiver for their variable-speed room ACs. 85 FR 59770 (Sep. 23, 2020). However, the final rule differs from those waivers in that it requires the use of fixed temperature conditions with a unit setpoint of 75 °F when testing at the 92 °F and 95 °F outdoor conditions, and therefore, the 28 variable-speed room AC basic models identified by DOE would need to be re-tested and re-certified according to this final rule. DOE did not identify any other manufacturers currently producing variable-speed room ACs that are sold in the United States.

DOE estimates that it would require approximately 8 hours for manufacturers to conduct a variable-speed test for a room AC unit, as specified in this final rule.

Additionally, DOE requires that at least two units must be tested per basic model. Therefore, a manufacturer would spend approximately 16 hours to test one variable-speed room AC basic model. DOE used the wage rate of a mechanical engineering technician from the Bureau of Labor Statistics ("BLS") to estimate the wage rate of an employee performing these tests.[47] Additionally, DOE used data from the BLS to estimate the percent of wages that account for the total employee compensation.[48] Using data from these sources, DOE estimates the hourly employer cost of an employee performing these test to be approximately $40.63.[49] Using these estimates, DOE determines that there will be a one-time cost of approximately $18,202 for the 28 variable-speed room AC basic models to be re-tested.[50]

In addition to the re-testing costs, DOE estimates these three manufacturers may have to re-certify their variable-speed room AC basic models to DOE. DOE estimates that manufacturers spend approximately 35 hours per manufacturer to submit a certification report to DOE, which may contain multiple models per report. DOE used an hourly wage rate of $100 for an employee to complete this certification report.[51]

[47] Based on data from BLS's May 2019 publication of the "Occupational Employment and Wages," the mean hourly wage for mechanical engineering technologists and technicians is $28.44. See: *https://www.bls.gov/oes/current/oes173027.htm*. Last Accessed on November 12, 2020.
[48] Based on data from BLS's June 2020 publication of the "Employer Costs for Employee Compensation," wages and salary are 70.0 percent of the total employer costs for a private industry worker. See: *https://www.bls.gov/bls/news-release/ecec.htm#2020*. Last Accessed on November 12, 2020.
[49] $28.44 / 0.700 = $40.63
[50] 28 (number of variable-speed room AC basic models potentially requiring re-testing) x 2 (units tested per basic model) x 8 (hours per test for variable-speed room ACs) x $40.63 (fully burdened hourly labor rate of employee performing the tests) = $18,202.24
[51] The 35-hour estimate and the $100 hourly wage estimate are based on information from 82 FR 57240; 57242 (December 4, 2017).

Therefore, DOE estimates that the three manufacturers would spend approximately $10,500 to re-certify their variable-speed room AC basic models.[52]

Additional Amendments

The additional amendments adopted in this final rule (*e.g.,* those applicable to the test procedure for single-speed room ACs) will not alter the measured energy efficiency as compared to the previous test procedure. The manufacturers of single-speed room ACs are able to continue relying on data generated under the previous test procedure for single-speed room ACs. The remainder of the amendments adopted in this final rule are as follows and will not impact test costs or results: (i) modify the room AC definition in 10 CFR 430.2; (ii) adopt new definitions in appendix F for "cooling mode," "cooling capacity," "combined energy efficiency ratio," and "single-speed room air conditioner;" (iii) update reference to ANSI/ASHRAE Standard 16 to the most current 2016 version, which includes additional clarification on best practices for air sampler and thermocouple placement; (iv) specify in appendix F that non-louvered room ACs, which are designed for through-the-wall installation, must be installed using a compatible wall sleeve (per manufacturer instructions), with a provided or manufacturer-required rear grille, and with only the included trim frame and other manufacturer-provided installation materials; (v) require that the power equipment specifications from Section 4.4 of IEC Standard 62301 Second Edition be used for determining standby mode and off mode power in appendix F; (vi) adopt and reference the sampling method from Section 5.3.2 of IEC Standard 62301 Second Edition to determine standby mode and off mode average power in

[52] 3 (number of manufacturers with variable-speed room ACs) x 35 (hours per certification report) x $100 (hourly labor rate) = $10,500.

appendix F; (vii) modify the certification requirements to conform the reporting requirements to the current CEER metric, and remove references to the previous performance metric, EER; and (viii) remove the proposed rounding instructions from the edits made to 10 CFR 430.23(f) but maintain the rounding instructions proposed in for 10 CFR 429.15.

The amendments described above update referenced standards, modify or add definitions, and provide further instructions and clarification to the existing test procedures, and thus have no impact on testing cost.

2. Other Test Procedure Topics

In this final rule, DOE is adopting a number of modifications to the Federal room AC test procedure to clarify provisions where the applicable industry consensus standard may either be silent or not fully address the matter in question. DOE has determined that the modifications are necessary so that the DOE test method satisfies the requirements of EPCA.

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget ("OMB") has determined that this test procedure rulemaking does not constitute a "significant regulatory action" under section 3(f) of Executive Order ("E.O.") 12866, Regulatory Planning and Review, 58 FR 51735

(Oct. 4, 1993). Accordingly, this action was not subject to review under the Executive Order by the Office of Information and Regulatory Affairs ("OIRA") in OMB.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq*.) requires preparation of a final regulatory flexibility analysis ("FRFA") for any final rule where the agency was first required by law to publish a proposed rule 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: *http://energy.gov/gc/office-general-counsel*.

DOE reviewed this adopted rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. The final rule prescribes amended test procedures to measure the energy consumption of room ACs in cooling mode, standby modes, and off mode. DOE concludes that this final rule will not have a significant impact on a substantial number of small entities, and the factual basis for this certification is set forth in the following paragraphs.

The Small Business Administration ("SBA") considers a business entity to be small business, if, together with its affiliates, it employs less than a threshold number of workers specified in 13 CFR part 121. These size standards and codes are established by the North American Industry Classification System ("NAICS") and are available at *https://www.sba.gov/document/support--table-size-standards.* Room AC manufacturing is classified under NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." 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 used DOE's Compliance Certification Database to create a list of companies that sell room ACs covered by this rulemaking in the United States. Additionally, DOE surveyed the AHAM member directory to identify manufacturers of room ACs. DOE then consulted other publicly available data, purchased company reports from vendors such as Dun and Bradstreet, and contacted manufacturers, where needed, to determine if they meet the SBA's definition of a "small business manufacturing facility" and have their manufacturing facilities located within the United States. Based on this analysis, DOE did not identify any small businesses that currently manufacture room ACs in the United States. DOE requested comment on its initial determination that there are no small businesses that manufacture room ACs in the United States. 85 FR 35700, 35733 (Jun. 11, 2020). DOE received no comment on this issue.

Because DOE did not identify any small businesses that manufacture room ACs in the United States, DOE concludes that the impacts of the test procedure amendments adopted in this final rule will not have a "significant economic impact on a substantial number of small entities," and that the preparation of an FRFA is not warranted.

DOE has submitted a certification and supporting statement of factual basis to the Chief Counsel for Advocacy of the Small Business Administration for review under 5 U.S.C. 605(b).

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of room ACs 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 room ACs. (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.

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

Pursuant to the National Environmental Policy Act of 1969 ("NEPA"), DOE has analyzed this action in accordance with NEPA and DOE's NEPA implementing regulations (10 CFR part 1021). DOE has determined that this rule qualifies for categorical exclusion under 10 CFR part 1021, Subpart D, Appendix A5 because it is an interpretive rulemaking that does not change the environmental effect of the rule and meets the requirements for application of a CX. See 10 CFR 1021.410. Therefore, DOE has determined that promulgation of this rule is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, and does not require an EA or EIS.

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (August 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 examined this final rule and determined that it will 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 final 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, this final 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 regulatory action resulting 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 *http://energy.gov/gc/office-general-counsel*. DOE examined this final 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 (Public Law 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This final rule will 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 regulation will 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 *https://www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf*. DOE has reviewed this final 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 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 significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use if the regulation is implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

This regulatory action 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 (Public Law 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 modifications to the test procedure for room ACs adopted in this final rule incorporates testing methods contained in certain sections of the following commercial standards: AHAM RAC-1-2020, ANSI/ASHRAE Standard 16-2016, ANSI/ASHRAE Standard 41.1-2013, ANSI/ASHRAE Standard 41.2-1987 (RA 1992), ANSI/ASHRAE

Standard 41.3-2014, ANSI/ASHRAE Standard 41.6-2014, ANSI/ASHRAE Standard 41.11-2014, and IEC Standard 62301 Second Edition. DOE has evaluated these standards and is unable to conclude whether it fully complies 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 has consulted with both the Attorney General and the Chairman of the FTC about the impact on competition of using the methods contained in these standards and has received no comments objecting to their use.

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule before its effective date. The report will state that it has been determined that the rule is not a "major rule" as defined by 5 U.S.C. 804(2).

N. Description of Materials Incorporated by Reference

In this final rule, DOE incorporates by reference the industry standard published by AHAM, titled “AHAM RAC-1-2020, ‘Room Air Conditioners’ (AHAM RAC-1-2020).” AHAM RAC-1-2020 establishes standard methods for measuring performance and includes sections on definitions, test conditions, tests for standard measurements, performance tests, and safety which apply to room air conditioners.

Copies of AHAM RAC-1-2020 can be purchased from the Association of Home Appliance Manufacturers at 1111 19th Street NW, Suite 402, Washington, DC 20036, 202-872-5955, or by going to *http://www.aham.org.*

In this final rule, DOE incorporates by reference the industry test standard published by ASHRAE, titled “ANSI/ASHRAE 16-2016 (“ANSI/ASHRAE 16-2016”), Method of Testing for Rating Room Air Conditioners and Packaged Terminal Air Conditioners.” The amendments in this final rule include updated general references to ANSI/ASHRAE Standard 16–2016, that address all areas of testing including installation, test setup, instrumentation, test conduct, data collection, and calculations. Specifically, the test procedure codified by this final rule references section 5.6.2 "Electrical Instruments" of ANSI/ASHRAE 16-2016, which provides requirements of accuracy for instruments used for measuring all electrical inputs to the calorimeter compartments.

In this final rule, DOE incorporates by reference the industry test standards published by ASHRAE, titled "Standard Method for Temperature Measurement," ANSI/ASHRAE Standard 41.1–2013, "Standard Methods for Air Velocity and Airflow Measurement," ANSI/ASHRAE Standard 41.2–1987 (RA 1992), "Standard Methods for Pressure Measurement," ANSI/ASHRAE Standard 41.3–2014, "Standard Methods for Humidity Measurement," ANSI/ASHRAE Standard 41.6–2014, and "Standard Methods for Power Measurement," ANSI/ASHRAE Standard 41.11–2014. These standards are industry-accepted test procedures that prescribe methods and instruments for measuring temperature, air velocity, pressure, humidity, and power, respectively. These standards are cited by ANSI/ASHRAE Standard 16–2016, which this final rule incorporates by reference.

Copies of the ASHRAE Standards may be purchased from the American Society of Heating and Air-Conditioning Engineers at 1255 23rd Street NW, Suite #825, Washington DC 20037, (202) 833-1830, or by going to *https://webstore.ansi.org/*.

In this final rule, DOE incorporates by reference the industry standard by IEC, titled ''IEC 62301 Household electrical appliances—Measurement of standby power,'' (Edition 2.0, 2011–01) for appendix F. Specifically, the test procedure codified by this final rule references Section 5, Paragraph 5.3.2 “Sampling Method” of IEC 62301, which provides test conditions, testing equipment, and methods for measuring standby mode and off mode power consumption, and Section 4.4 “Power measuring instruments” of IEC 62301, which provides specifications for determining standby mode and off mode power in appendix F. The amendments in this final rule include updating general references to IEC 62301 from the First Edition to the Second Edition and adopting a new standby power test approach.

Copies of IEC Standard 62301 may be purchased from the International Electrotechnical Commission at 3 rue de Varembé, PO Box 131, CH-1211, Geneva 20, Switzerland, or by going to *https:// webstore.iec.ch/* and *http:// www.webstore.ansi.org*.

V. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects

10 CFR Part 429

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Reporting and recordkeeping requirements.

10 CFR Part 430

Administrative practice and procedure, Confidential business information, Energy conservation, Household appliances, Imports, Incorporation by reference, Intergovernmental relations, Small businesses.

Signing Authority

This document of the Department of Energy was signed on March 8, 2021, by Kelly Speakes-Backman, Principal Deputy Assistant Secretary and 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 March 8, 2021

X Kelly Speakes-

Digitally signed by Kelly Speakes-Backman
Date: 2021.03.08 20:17:31 -05'00'

Kelly Speakes-Backman
Principal Deputy Assistant Secretary and
Acting Assistant Secretary
Energy Efficiency Renewable Energy

For the reasons stated in the preamble, DOE amends parts 429 and 430 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. Section 429.15 is amended by:

a. Removing the words “energy efficiency ratio” in paragraph (a)(2)(ii) and adding, in its place the words “combined energy efficiency ratio (CEER) (determined in §430.23(f)(3) for each unit in the sample)”;

b. Adding paragraphs (a)(3), (4) and (5);

c. Revising paragraph (b)(2); and

d. Adding paragraph (b)(3).

The revision and additions read as follows:

§ 429.15 Room air conditioners.

(a) * * *

(3) The cooling capacity of a basic model is the mean of the measured cooling capacities for each tested unit of the basic model, as determined in §430.23(f)(1) of this chapter. Round the cooling capacity value to the nearest hundred.

(4) The electrical power input of a basic model is the mean of the measured electrical power inputs for each tested unit of the basic model, as determined in §430.23(f)(2) of this chapter. Round the electrical power input to the nearest ten.

(5) Round the value of CEER for a basic model to one decimal place.

(b) * * *

(2) Pursuant to §429.12(b)(13), a certification report shall include the following public product-specific information: The combined energy efficiency ratio in British thermal units per Watt-hour (Btu/Wh)), cooling capacity in British thermal units per hour (Btu/h), and the electrical power input in watts (W).

(3) Pursuant to §429.12(b)(13), a certification report for a variable-speed room air conditioner basic model must include supplemental information and instructions in PDF format that include –

(i) The mean measured cooling capacity for the units tested at each additional test condition (i.e., respectively, the mean of $Capacity_2$, $Capacity_3$, and $Capacity_4$, each expressed in Btu/h and rounded to the nearest 100 Btu/h, as determined in accordance with section 4.1.2 of appendix F of subpart B of part 430 of this chapter);

(ii) The mean electrical power input at each additional test condition (respectively, the mean of $Power_2$, $Power_3$, and $Power_4$, each expressed in W and rounded to the nearest 10 W, as determined in accordance with section 4.1.2 of appendix F of subpart B of part 430 of this chapter); and

(iii) All additional testing and testing set up instructions (e.g., specific operational or control codes or settings) necessary to operate the basic model under the required conditions specified by the relevant test procedure.

PART 430 -- ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

3. The authority citation for part 430 continues to read as follows:

Authority: 42 U.S.C. 6291–6309; 28 U.S.C. 2461 note.

4. Section 430.2 is amended by revising the definition of “Room air conditioner” to read as follows:

§ 430.2 Definitions.

* * * * *

Room air conditioner means a window-mounted or through-the-wall-mounted encased assembly, other than a “packaged terminal air conditioner,” that delivers cooled, conditioned air to an enclosed space, and is powered by single-phase electric current. It includes a source of refrigeration and may include additional means for ventilating and heating.

* * * * *

5. Section 430.3 is amended by:

a. Revising paragraph (g)(1);

b. In paragraph (g)(6), removing, “appendix X1”, and adding in its place, “appendices F and X1”;

c. Redesignating paragraphs (g)(11) through (14) as (g)(15) through (18), respectively;

d. Redesignating paragraphs (g)(9) as (g)(12), and (g)(10) as (g)(13);

e. Redesignating paragraph (g)(8) as (g)(9);

f. Adding new paragraphs (g)(8), (10), (11), and (14);

g. Revising paragraph (i)(6);

h. In paragraph (o)(5), removing “appendix F, and”; and

i. In paragraph (o)(6), adding “F,” before “G”.

The revisions and additions read as follows:

§ 430.3 Materials incorporated by reference.

* * * * *

(g) * * *

(1) ANSI/ASHRAE Standard 16-2016 (“ANSI/ASHRAE 16”), 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, IBR approved for appendix F to subpart B.

* * * * *

(8) ANSI/ASHRAE Standard 41.2-1987 (RA 92), (“ASHRAE 41.2-1987 (RA 1992)”), Standard Methods for Laboratory Airflow Measurement, ANSI reaffirmed April 20, 1992, IBR approved for appendix F to subpart B.

* * * * *

(10) ANSI/ASHRAE Standard 41.3-2014, ("ASHRAE 41.3-2014"), Standard Methods for Pressure Measurement, ANSI approved July 3, 2014, IBR approved for appendix F to subpart B.

(11) ANSI/ASHRAE Standard 41.6-2014, ("ASHRAE 41.6-2014"), Standard Method for Humidity Measurement, ANSI approved July 3, 2014, IBR approved for appendix F to subpart B.

* * * * *

(14) ANSI/ASHRAE Standard 41.11-2014, ("ASHRAE 41.11-2014"), Standard Methods for Power Measurement, ANSI approved July 3, 2014, IBR approved for appendix F to subpart B.

* * * * *

(i) * * *

(6) AHAM RAC-1-2020 ("AHAM RAC-1"), Energy Measurement Test Procedure for Room Air Conditioners, approved 2020, IBR approved for appendix F to subpart B.

* * * * *

6. Section 430.23 is amended by revising paragraph (f) to read as follows:

§ 430.23 Test procedures for the measurement of energy and water consumption.

* * * * *

(f) *Room air conditioners.* (1) Determine cooling capacity, expressed in British thermal units per hour (Btu/h), as follows:

(i) For a single-speed room air conditioner, determine the cooling capacity in accordance with section 4.1.2 of appendix F of this subpart.

(ii) For a variable-speed room air conditioner, determine the cooling capacity in accordance with section 4.1.2 of appendix F of this subpart for test condition 1 in Table 1 of appendix F of this subpart.

(2) Determine electrical power input, expressed in watts (W) as follows:

(i) For a single-speed room air conditioner, determine the electrical power input in accordance with section 4.1.2 of appendix F of this subpart.

(ii) For a variable-speed room air conditioner, determine the electrical power input in accordance with section 4.1.2 of appendix F of this subpart, for test condition 1 in Table 1 of appendix F of this subpart.

(3) Determine the combined energy efficiency ratio (CEER), expressed in British thermal units per watt-hour (Btu/Wh) and as follows:

(i) For a single-speed room air conditioner, determine the CEER in accordance with section 5.2.2 of appendix F of this subpart.

(ii) For a variable-speed room air conditioner, determine the CEER in accordance with section 5.3.11 of appendix F of this subpart.

(4) Determine the estimated annual operating cost for a room air conditioner, expressed in dollars per year, by multiplying the following two factors and rounding as directed:

(i) For single-speed room air conditioners, the sum of AEC_{cool} and $AEC_{ia/om}$, determined in accordance with section 5.2.1 and section 5.1, respectively, of appendix F of this subpart. For variable-speed room air conditioners, the sum of AEC_{wt} and $AEC_{ia/om}$, determined in accordance with section 5.3.4 and section 5.1, respectively, of appendix F of this subpart; and

(ii) A representative average unit cost of electrical energy in dollars per kilowatt-hour as provided by the Secretary. Round the resulting product to the nearest dollar per year.

* * * * *

7. Appendix F to subpart B of part 430 is revised to read as follows:

APPENDIX F TO SUBPART B OF PART 430–UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF ROOM AIR CONDITIONERS

NOTE: On or after [**INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***], any representations made with respect to the energy use or efficiency of room air conditioners must be made in accordance with the results of testing pursuant to this appendix.

Prior to [**INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***], manufacturers must either test room air conditioners in accordance with this appendix, or the previous version of this appendix as it appeared in the Code of Federal Regulations on January 1, 2020. DOE notes that, because representations made on or after **[INSERT DATE 180 DAYS AFTER DATE OF**

PUBLICATION IN THE *FEDERAL REGISTER*] must be made in accordance with this appendix, manufacturers may wish to begin using this test procedure immediately.

0. *Incorporation by Reference*

DOE incorporated by reference the entire standard for AHAM RAC-1, ANSI/ASHRAE 16, ANSI/ASHRAE 41.1, ASHRAE 41.2-1987 (RA 1992), ASHRAE 41.3-2014, ASHRAE 41.6-2014, ASHRAE 41.11-2014 and IEC 62301 in §430.3. However, only enumerated provisions of AHAM RAC-1 and ANSI/ASHRAE 16 apply to this appendix, as follows:

(1) ANSI/AHAM RAC-1:

(i) Section 4—Testing Conditions, Section 4.1—General

(ii) Section 5—Standard Measurement Test, Section 5.2—Standard Test Conditions: 5.2.1.1

(iii) Section 6—Tests and Measurements, Section 6.1—Cooling capacity

(iv) Section 6— Tests and Measurements, Section 6.2—Electrical Input

(2) ANSI/ASHRAE 16:

(i) Section 3—Definitions

(ii) Section 5—Instruments

(iii) Section 6—Apparatus, Section 6.1—Calorimeters, Sections 6.1.1-6.1.1., 6.1.1.3a, 6.1.1.4-6.1.4, including Table 1

(iv) Section 7—Methods of Testing, Section 7.1—Standard Test Methods, Section 7.1a, 7.1.1a

(v) Section 8—Test Procedures, Section 8.1—General

(vi) Section 8—Test Procedures, Section 8.2—Test Room Requirements

(viii) Section 8—Test Procedures, Section 8.3—Air Conditioner Break-In

(ix) Section 8—Test Procedures, Section 8.4—Air Conditioner Installation

(x) Section 8 —Test Procedures, Section 8.5—Cooling Capacity Test

(xi) Section 9—Data To Be Recorded, Section 9.1

(xii) Section 10—Measurement Uncertainty

(xiii) Normative Appendix A Cooling Capacity Calculations—Calorimeter Test Indoor and Calorimeter Test Outdoor

If there is any conflict between any industry standard(s) and this appendix, follow the language of the test procedure in this appendix, disregarding the conflicting industry standard language.

1. Scope

This appendix contains the test requirements to measure the energy performance of a room air conditioner.

2. Definitions

2.1 "Active mode" means a mode in which the room air conditioner is connected to a mains power source, has been activated and is performing any of the following functions: cooling or heating the conditioned space, or circulating air through activation of its fan or blower, with or without energizing active air-cleaning components or devices such as ultra-violet (UV) radiation, electrostatic filters, ozone generators, or other air-cleaning devices.

2.2 “ANSI/AHAM RAC-1” means the test standard published jointly by the American National Standards Institute and the Association of Home Appliance Manufacturers, titled “Energy Measurement Test Procedure for Room Air Conditioners,” Standard RAC-1-2020 (incorporated by reference; see §430.3).

2.3 “ANSI/ASHRAE 16” means the test standard published jointly by the American National Standards Institute and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers titled “Method of Testing for Rating Room Air Conditioners and Packaged Terminal Air Conditioners,” Standard 16-2016 (incorporated by reference; see §430.3).

2.4 “ANSI/ASHRAE 41.1” means the test standard published jointly by the American National Standards Institute and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers titled “Standard Method for Temperature Measurement,” Standard 41.1-2013 (incorporated by reference; see §430.3).

2.5 “ASHRAE 41.2-1987 (RA 1992)” means the test standard published jointly by the American National Standards Institute and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers titled “Standard Methods for Laboratory Airflow Measurement,” Standard 41.2-1987 (RA 1992) (incorporated by reference; see §430.3).

2.6 “ASHRAE 41.3-2014” means the test standard published jointly by the American National Standards Institute and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers titled "Standard Methods for Pressure Measurement," Standard 41.3-2014 (incorporated by reference; see §430.3).

2.7 "ASHRAE 41.6-2014" means the test standard published jointly by the American National Standards Institute and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers titled "Standard Method for Humidity Measurement," Standard 41.6-2014 (incorporated by reference; see §430.3).

2.8 "ASHRAE 41.11-2014" means the test standard published jointly by the American National Standards Institute and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers titled "Standard Methods for Power Measurement," Standard 41.11-2014 (incorporated by reference; see §430.3).

2.9 "Combined energy efficiency ratio" means the energy efficiency of a room air conditioner in British thermal units per watt-hour (Btu/Wh) and determined in section 5.2.2 of this appendix for single-speed room air conditioners and section 5.3.12 of this appendix for variable-speed room air conditioners.

2.10 "Cooling capacity" means the amount of cooling, in British thermal units per hour (Btu/h), provided to a conditioned space, measured under the specified conditions and determined in section 4.1 of this appendix.

2.11 "Cooling mode" means an active mode in which a room air conditioner has activated the main cooling function according to the thermostat or temperature sensor signal or switch (including remote control).

2.12 "Full compressor speed (full)" means the compressor speed at which the unit operates at full load test conditions, when using user settings to achieve maximum cooling capacity, according to the instructions in ANSI/ASHRAE Standard 16-2016.

2.13 “IEC 62301” means the test standard published by the International Electrotechnical Commission, titled “Household electrical appliances—Measurement of standby power,” Publication 62301 (Edition 2.0 2011-01), (incorporated by reference; see §430.3).

2.14 “Inactive mode” means a standby mode that facilitates the activation of active mode by remote switch (including remote control) or internal sensor or which provides continuous status display.

2.15 “Intermediate compressor speed (intermediate)” means the compressor speed higher than the low compressor speed at which the measured capacity is higher than the capacity at low compressor speed by one third of the difference between $Capacity_4$, the measured cooling capacity at test condition 4 in Table 1 of this appendix, and $Capacity_1$, the measured cooling capacity with the full compressor speed at test condition 1 in Table 1 of this appendix, with a tolerance of plus 5 percent (designs with non-discrete speed stages) or the next highest inverter frequency step (designs with discrete speed steps), achieved by following the instructions certified by the manufacturer.

2.16 “Low compressor speed (low)” means the compressor speed at which the unit operates at low load test conditions, achieved by following the instructions certified by the manufacturer, such that $Capacity_4$, the measured cooling capacity at test condition 4 in Table 1 of this appendix, is no less than 47 percent and no greater than 57 percent of $Capacity_1$, the measured cooling capacity with the full compressor speed at test condition 1 in Table 1 of this appendix.

2.17 “Off mode” means a mode in which a room air conditioner is connected to a mains power source and is not providing any active or standby mode function and where the mode may persist for an indefinite time, including an indicator that only shows the user that the product is in the off position.

2.18 “Single-speed room air conditioner” means a type of room air conditioner that cannot automatically adjust the compressor speed based on detected conditions.

2.19 “Standby mode” means any product mode where the unit is connected to a mains power source and offers one or more of the following user-oriented or protective functions which may persist for an indefinite time:

(a) To facilitate the activation of other modes (including activation or deactivation of active mode) by remote switch (including remote control), internal sensor, or timer. A timer is a continuous clock function (which may or may not be associated with a display) that provides regular scheduled tasks (*e.g.*, switching) and that operates on a continuous basis.

(b) Continuous functions, including information or status displays (including clocks) or sensor-based functions.

2.20 “Theoretical comparable single-speed room air conditioner” means a theoretical single-speed room air conditioner with the same cooling capacity and electrical power input as the variable-speed room air conditioner under test, with no cycling losses considered, at test condition 1 in Table 1 of this appendix.

2.21 “Variable-speed compressor” means a compressor that can vary its rotational speed in non-discrete stages or discrete steps from low to full.

2.22 “Variable-speed room air conditioner” means a type of room air conditioner that can automatically adjust compressor speed based on detected conditions.

3. Test Methods and General Instructions

3.1 *Cooling mode.* The test method for testing room air conditioners in cooling mode ("cooling mode test") consists of applying the methods and conditions in AHAM RAC-1 Section 4, Paragraph 4.1 and for single-speed room air conditioners, Section 5, Paragraph 5.2.1.1, and for variable-speed room air conditioners, Section 5, Paragraph 5.2.1.2, except in accordance with ANSI/ASHRAE 16, including the references to ANSI/ASHRAE 41.1, ANSI/ASHRAE 41.2-1987 (RA 1992), ANSI/ASHRAE 41.3-2014, ANSI/ASHRAE 41.6-2014, and ANSI/ASHRAE 41.11-2014, all referenced therein, as defined in sections 2.3 through 2.8 of this appendix. Use the cooling capacity simultaneous indoor calorimeter and outdoor calorimeter test method in Section 7.1.a and Sections 8.1 through 8.5 of ANSI/ASHRAE 16, except as otherwise specified in this appendix. If a unit can operate on multiple operating voltages as distributed in commerce by the manufacturer, test it and rate the corresponding basic models at all nameplate operating voltages. For a variable-speed room air conditioner, test the unit following the cooling mode test a total of four times: one test at each of the test conditions listed in Table 1 of this appendix, consistent with section 4.1 of this appendix.

3.1.1 *Through-the-wall installation.* Install a non-louvered room air conditioner inside a compatible wall sleeve with the provided or manufacturer-required rear grille, and with only the included trim frame and other manufacturer-provided installation materials, per manufacturer instructions provided to consumers.

3.1.2 *Power measurement accuracy.* All instruments used for measuring electrical inputs to the test unit, reconditioning equipment, and any other equipment that operates within the calorimeter walls must be accurate to ±0.5 percent of the quantity measured.

3.1.3 *Electrical supply.* For cooling mode testing, test at each nameplate operating voltage, and maintain the input standard voltage within ±1 percent. Test at the rated frequency, maintained within ±1 percent.

3.1.4 *Control settings.* If the room air conditioner has network capabilities, all network features must be disabled throughout testing.

3.1.5 *Measurement resolution.* Record measurements at the resolution of the test instrumentation.

3.1.6 *Temperature tolerances.* Maintain each of the measured chamber dry-bulb and wet-bulb temperatures within a range of 1.0 °F.

3.2 Standby and off modes.

3.2.1 Install the room air conditioner in accordance with Section 5, Paragraph 5.2 of IEC 62301 and maintain the indoor test conditions (and outdoor test conditions where applicable) as required by Section 4, Paragraph 4.2 of IEC 62301. If testing is not conducted in a facility used for testing cooling mode performance, the test facility must comply with Section 4, Paragraph 4.2 of IEC 62301.

3.2.2 *Electrical supply.* For standby mode and off mode testing, maintain the electrical supply voltage and frequency according to the requirements in Section 4, Paragraph 4.3.1 of IEC 62301.

3.2.3 *Supply voltage waveform.* For the standby mode and off mode testing, maintain the electrical supply voltage waveform indicated in Section 4, Paragraph 4.3.2 of IEC 62301.

3.2.4 *Wattmeter.* The wattmeter used to measure standby mode and off mode power consumption must meet the resolution and accuracy requirements in Section 4, Paragraph 4.4 of IEC 62301.

3.2.5 *Air ventilation damper.* If the unit is equipped with an outdoor air ventilation damper, close this damper during standby mode and off mode testing.

4. Test Conditions and Measurements

4.1 Cooling mode.

4.1.1 *Temperature conditions.* Establish the test conditions described in Sections 4 and 5 of AHAM RAC-1 and in accordance with ANSI/ASHRAE 16, including the references to ANSI/ASHRAE 41.1 and ANSI/ASHRAE 41.6-2014, for cooling mode testing, with the following exceptions for variable-speed room air conditioners: Conduct the set of four cooling mode tests with the test conditions presented in Table 1 of this appendix. For test condition 1 and test condition 2, achieve the full compressor speed with user settings, as defined in section 2.12 of this appendix. For test condition 3 and test condition 4, set the required compressor speed in accordance with instructions the manufacturer provided to DOE.

Table 1: Indoor and Outdoor Inlet Air Test Conditions – Variable-Speed Room Air Conditioners

Test Condition	Evaporator Inlet (Indoor) Air, °*F*		Condenser Inlet (Outdoor) Air, °*F*		Compressor Speed
	Dry Bulb	Wet Bulb	Dry Bulb	Wet Bulb	
Test Condition 1	80	67	95	75	Full
Test Condition 2	80	67	92	72.5	Full
Test Condition 3	80	67	87	69	Intermediate
Test Condition 4	80	67	82	65	Low

4.1.2 *Cooling capacity and power measurements.* For single-speed units, measure the cooling mode cooling capacity (expressed in Btu/h), Capacity, and electrical power input (expressed in watts), P_{cool}, in accordance with Section 6, Paragraphs 6.1 and 6.2 of AHAM RAC-1, respectively, and in accordance with ANSI/ASHRAE 16, including the references to ANSI/ASHRAE 41.2-1987 (RA 1992) and ANSI/ASHRAE 41.11-2014. For variable-speed room air conditioners, measure the condition-specific cooling capacity (expressed in Btu/h), $Capacity_{tc}$, and electrical power input (expressed in watts), P_{tc}, for each of the four cooling mode rating test conditions (tc), as required in Section 6, Paragraphs 6.1 and 6.2, respectively, of AHAM RAC-1, respectively, and in accordance with ANSI/ASHRAE 16, including the references to ANSI/ASHRAE 41.2-1987 (RA 1992) and ANSI/ASHRAE 41.11-2014.

4.2 *Standby and off modes.* Establish the testing conditions set forth in section 3.2 of this appendix, ensuring the unit does not enter any active mode during the test. For a unit that drops from a higher power state to a lower power state as discussed in Section 5, Paragraph 5.1, Note 1 of IEC 62301, allow sufficient time for the room air conditioner to reach the lower power state before proceeding with the test measurement. Use the sampling method test procedure specified in Section 5, Paragraph 5.3.2 of IEC 62301 for testing all standby and off modes, with the following modifications: allow the product to stabilize for 5 to 10 minutes and use an energy use measurement period of 5 minutes.

4.2.1 If the unit has an inactive mode, as defined in section 2.14 of this appendix, as defined in section 2.17 of this appendix, measure and record the average inactive mode power, P_{ia}, in watts.

4.2.2 If the unit has an off mode, as defined in section 2.17 of this appendix, measure and record the average off mode power, P_{om}, in watts.

5. Calculations

5.1 *Annual energy consumption in inactive mode and off mode.* Calculate the annual energy consumption in inactive mode and off mode, $AEC_{ia/om}$, expressed in kilowatt-hours per year (kWh/year).

$$AEC_{ia/om} = (Pia \quad \times t_{ia}) + (P_{om} + t_{om})$$

Where:

$AEC_{ia/om}$ = annual energy consumption in inactive mode and off mode, in kWh/year.

P_{ia} = average power in inactive mode, in watts, determined in section 4.2 of this appendix.

P_{om} = average power in off mode, in watts, determined in section 4.2 of this appendix.

t_{ia} = annual operating hours in inactive mode and multiplied by a 0.001 kWh/Wh conversion factor from watt-hours to kilowatt-hours. This value is 5.115 kWh/W if the unit has inactive mode and no off mode, 2.5575 kWh/W if the unit has both inactive and off mode, and 0 kWh/W if the unit does not have inactive mode.

t_{om} = annual operating hours in off mode and multiplied by a 0.001 kWh/Wh conversion factor from watt-hours to kilowatt-hours. This value is 5.115 kWh/W if the unit has off mode and no inactive mode, 2.5575 kWh/W if the unit has both inactive and off mode, and 0 kWh/W if the unit does not have off mode.

5.2 Combined energy efficiency ratio for single-speed room air conditioners. Calculate the combined energy efficiency ratio for single-speed room air conditioners as follows:

5.2.1 *Single-speed room air conditioner annual energy consumption in cooling mode.* Calculate the annual energy consumption in cooling mode for a single-speed room air conditioner, AEC_{cool}, expressed in kWh/year.

$$AEC_{cool} = 0.75 \times P_{cool}$$

Where:

AEC_{cool} = single-speed room air conditioner annual energy consumption in cooling mode, in kWh/year.

P_{cool} = single-speed room air conditioner average power in cooling mode, in watts, determined in section 4.1.2 of this appendix.

0.75 is 750 annual operating hours in cooling mode multiplied by a 0.001 kWh/Wh conversion factor from watt-hours to kilowatt-hours.

5.2.2 Single-speed room air conditioner combined energy efficiency ratio. Calculate the combined energy efficiency ratio, CEER, expressed in Btu/Wh, as follows:

$$CEER = [\frac{Capacity}{(\frac{AEC_{cool} + AEC_{ia/om}}{0.75})}]$$

Where:

CEER = combined energy efficiency ratio, in Btu/Wh.

Capacity = single-speed room air conditioner cooling capacity, in Btu/h, determined in section 4.1.2 of this appendix.

AEC_{cool} = single-speed room air conditioner annual energy consumption in cooling mode, in kWh/year, calculated in section 5.2.1 of this appendix.

$AEC_{ia/om}$ = annual energy consumption in inactive mode or off mode, in kWh/year, calculated in section 5.1 of this appendix.

0.75 as defined in section 5.2.1 of this appendix.

5.3 Combined energy efficiency ratio for variable-speed room air conditioners. Calculate the combined energy efficiency ratio for variable-speed room air conditioners as follows:

5.3.1 *Weighted electrical power input.* Calculate the weighted electrical power input in cooling mode, P_{wt}, expressed in watts, as follows:

$$P_{wt} = \sum_{tc} P_{tc} \times W_{tc}$$

Where:

P_{wt} = weighted electrical power input, in watts, in cooling mode.

P_{tc} = electrical power input, in watts, in cooling mode for each test condition in Table 1 of this appendix.

W_{tc} = weighting factors for each cooling mode test condition: 0.08 for test condition 1, 0.20 for test condition 2, 0.33 for test condition 3, and 0.39 for test condition 4.

tc represents the cooling mode test condition: “1” for test condition 1 (95 °F condenser inlet dry-bulb temperature), “2” for test condition 2 (92 °F), “3” for test condition 3 (87 °F), and “4” for test condition 4 (82 °F).

5.3.2 *Theoretical comparable single-speed room air conditioner*. Calculate the cooling capacity, expressed in Btu/h, and the electrical power input, expressed in watts, for a theoretical comparable single-speed room air conditioner at all cooling mode test conditions.

$Capacity_{ss\_tc} = Capacity_1 \times (1 + (M_c \times (95 - T_{tc})))$

$P_{ss\_tc} = P_1 \times (1 - (M_p \times (95 - T_{tc})))$

Where:

$Capacity_{ss\_tc}$ = theoretical comparable single-speed room air conditioner cooling capacity, in Btu/h, calculated for each of the cooling mode test conditions in Table 1 of this appendix.

$Capacity_1$ = variable-speed room air conditioner unit's cooling capacity, in Btu/h, determined in section 4.1.2 of this appendix for test condition 1 in Table 1 of this appendix.

P_{ss_tc} = theoretical comparable single-speed room air conditioner electrical power input, in watts, calculated for each of the cooling mode test conditions in Table 1 of this appendix.

P_1 = variable-speed room air conditioner unit's electrical power input, in watts, determined in section 4.1.2 of this appendix for test condition 1 in Table 1 of this appendix.

M_c = adjustment factor to determine the increased capacity at lower outdoor test conditions, 0.0099 per °F.

M_p = adjustment factor to determine the reduced electrical power input at lower outdoor test conditions, 0.0076 per °F.

95 is the condenser inlet dry-bulb temperature for test condition 1 in Table 1 of this appendix, 95 °F.

T_{tc} = condenser inlet dry-bulb temperature for each of the test conditions in Table 1 of this appendix (in °F).

tc as explained in section 5.3.1 of this appendix.

5.3.3 *Variable-speed room air conditioner unit's annual energy consumption for cooling mode at each cooling mode test condition.* Calculate the annual energy consumption for cooling mode under each test condition, AEC_{tc}, expressed in kilowatt-hours per year (kWh/year), as follows:

$$AEC_{tc} = 0.75 \times P_{tc}$$

Where:

AEC_{tc} = variable-speed room air conditioner unit's annual energy consumption, in kWh/year, in cooling mode for each test condition in Table 1 of this appendix.

P_{tc} = as defined in section 5.3.1 of this appendix.

0.75 as defined in section 5.2.1 of this appendix.

tc as explained in section 5.3.1 of this appendix.

5.3.4 Variable-speed room air conditioner weighted annual energy consumption. Calculate the weighted annual energy consumption in cooling mode for a variable-speed room air conditioner, AEC_{wt}, expressed in kWh/year.

$$AEC_{wt} = \sum_{tc} AEC_{tc} \times W_{tc}$$

Where:

AEC_{wt} = weighted annual energy consumption in cooling mode for a variable-speed room air conditioner, expressed in kWh/year.

AEC_{tc} = variable-speed room air conditioner unit's annual energy consumption, in kWh/year, in cooling mode for each test condition in Table 1 of this appendix, determined in section 5.3.3 of this appendix.

W_{tc} = weighting factors for each cooling mode test condition: 0.08 for test condition 1, 0.20 for test condition 2, 0.33 for test condition 3, and 0.39 for test condition 4.

tc as explained in section 5.3.1 of this appendix.

5.3.5 *Theoretical comparable single-speed room air conditioner annual energy consumption in cooling mode at each cooling mode test condition*. Calculate the annual energy consumption in cooling mode for a theoretical comparable single-speed room air conditioner for cooling mode under each test condition, AEC_{ss_tc}, expressed in kWh/year.

$$AEC_{ss\_tc} = 0.75 \times P_{ss\_tc}$$

Where:

AEC_{ss_tc} = theoretical comparable single-speed room air conditioner annual energy consumption, in kWh/year, in cooling mode for each test condition in Table 1 of this appendix.

P_{ss_tc} = theoretical comparable single-speed room air conditioner electrical power input, in watts, in cooling mode for each test condition in Table 1 of this appendix, determined in section 5.3.2 of this appendix.

0.75 as defined in section 5.2.1 of this appendix.

tc as explained in section 5.3.1 of this appendix.

5.3.6 *Variable-speed room air conditioner combined energy efficiency ratio at each cooling mode test condition.* Calculate the variable-speed room air conditioner unit's combined energy efficiency ratio, $CEER_{tc}$, for each test condition, expressed in Btu/Wh.

$$CEER_{tc} = \frac{Capacity_{tc}}{\left(\frac{AEC_{tc} + AEC_{ia/om}}{0.75}\right)}$$

Where:

$CEER_{tc}$ = variable-speed room air conditioner unit's combined energy efficiency ratio, in Btu/Wh, for each test condition in Table 1 of this appendix.

$Capacity_{tc}$ = variable-speed room air conditioner unit's cooling capacity, in Btu/h, for each test condition in Table 1 of this appendix, determined in section 4.1.2 of this appendix.

AEC_{tc} = variable-speed room air conditioner unit's annual energy consumption, in kWh/year, in cooling mode for each test condition in Table 1 of this appendix, determined in section 5.3.3 of this appendix.

$AEC_{ia/om}$ = annual energy consumption in inactive mode of off mode, in kWh/year, determined in section 5.1 of this appendix.

0.75 as defined in section 5.2.1 of this appendix.

tc as explained in section 5.3.1 of this appendix.

5.3.7 *Theoretical comparable single-speed room air conditioner combined energy efficiency ratio.* Calculate the combined energy efficiency ratio for a theoretical comparable single-speed room air conditioner, $CEER_{ss\_tc}$, for each test condition, expressed in Btu/Wh.

$$CEER_{ss\_tc} = \frac{Capacity_{ss\_tc}}{\left(\frac{AEC_{ss\_tc} + AEC_{ia/om}}{0.75}\right)}$$

Where:

$CEER_{ss\_tc}$ = theoretical comparable single-speed room air conditioner combined energy efficiency ratio, in Btu/Wh, for each test condition in Table 1 of this appendix.

$Capacity_{ss\_tc}$ = theoretical comparable single-speed room air conditioner cooling capacity, in Btu/h, for each test condition in Table 1 of this appendix, determined in section 5.3.2 of this appendix.

AEC_{ss_tc} = theoretical comparable single-speed room air conditioner annual energy consumption, in kWh/year, in cooling mode for each test condition in Table 1 of this appendix, determined in section 5.3.5 of this appendix.

$AEC_{ia/om}$ = annual energy consumption in inactive mode or off mode, in kWh/year, determined in section 5.1 of this appendix.

0.75 as defined in section 5.2.1 of this appendix.

tc as explained in section 5.3.1 of this appendix.

5.3.8 Theoretical comparable single-speed room air conditioner adjusted c*ombined energy efficiency ratio.* Calculate the adjusted combined energy efficiency ratio, for a theoretical comparable single-speed room air conditioner, $CEER_{ss\_tc\_adj}$, with cycling losses considered, for each test condition, expressed in Btu/Wh.

$CEER_{ss\_tc\_adj} = CEER_{ss\_tc} \times CLF_{tc}$

Where:

$CEER_{ss\_tc\_adj}$ = theoretical comparable single-speed room air conditioner adjusted combined energy efficiency ratio, in Btu/Wh, for each test condition in Table 1 of this appendix.

$CEER_{ss\_tc}$ = theoretical comparable single-speed room air conditioner combined energy efficiency ratio, in Btu/Wh, for each test condition in Table 1 of this appendix, determined in section 5.3.7 of this appendix.

CLF_{tc} = cycling loss factor for each test condition; 1 for test condition 1, 0.956 for test condition 2, 0.883 for test condition 3, and 0.810 for test condition 4.

tc as explained in section 5.3.1 of this appendix.

5.3.9 *Weighted combined energy efficiency ratio.* Calculate the weighted combined energy efficiency ratio for the variable-speed room air conditioner unit, $CEER_{wt}$, and theoretical comparable single-speed room air conditioner, $CEER_{ss\_wt}$, expressed in Btu/Wh.

$$CEER_{wt} = \sum_{tc} CEER_{tc} \times W_{tc}$$

$$CEER_{ss\_wt} = \sum_{tc} CEER_{ss\_tc\_adj} \times W_{tc}$$

Where:

$CEER_{wt}$ = variable-speed room air conditioner unit's weighted combined energy efficiency ratio, in Btu/Wh.

$CEER_{ss\_wt}$ = theoretical comparable single-speed room air conditioner weighted combined energy efficiency ratio, in Btu/Wh.

$CEER_{tc}$ = variable-speed room air conditioner unit's combined energy efficiency ratio, in Btu/Wh, at each test condition in Table 1 of this appendix, determined in section 5.3.6 of this appendix.

$CEER_{ss\_tc\_adj}$ = theoretical comparable single-speed room air conditioner adjusted combined energy efficiency ratio, in Btu/Wh, at each test condition in Table 1 of this appendix, determined in section 5.3.8 of this appendix.

W_{tc} as defined in section 5.3.4 of this appendix.

tc as explained in section 5.3.1 of this appendix.

5.3.10 Variable-speed room air conditioner performance adjustment factor. Calculate the variable-speed room air conditioner unit's performance adjustment factor, F_p.

$$F_p = \frac{(CEER_{wt} - CEER_{ss\_wt})}{CEER_{ss\_wt}}$$

Where:

F_p = variable-speed room air conditioner unit's performance adjustment factor.

$CEER_{wt}$ = variable-speed room air conditioner unit's weighted combined energy efficiency ratio, in Btu/Wh, determined in section 5.3.9 of this appendix.

$CEER_{ss\_wt}$ = theoretical comparable single-speed room air conditioner weighted combined energy efficiency ratio, in Btu/Wh, determined in section 5.3.9 of this appendix.

5.3.11 Variable-speed room air conditioner combined energy efficiency ratio. Calculate the combined energy efficiency ratio, CEER, expressed in Btu/Wh, for variable-speed air conditioners.

$$CEER = CEER_1 \times (1 + F_p)$$

Where:

CEER = combined energy efficiency ratio, in Btu/Wh.

$CEER_1$ = variable-speed room air conditioner combined energy efficiency ratio for test condition 1 in Table 1 of this appendix, in Btu/Wh, determined in section 5.3.6 of this appendix.

F_p = variable-speed room air conditioner performance adjustment factor, determined in section 5.3.10 of this appendix.