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[6450-01-P]

DEPARTMENT OF ENERGY

[Case Number 2018-004; EERE-2018-BT-WAV-0007]

Energy Conservation Program: Decision and Order Granting a Waiver to LG Electronics USA, Inc. from the Department of Energy Portable Air Conditioner Test Procedure

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

ACTION: Notice of decision and order.

SUMMARY: The U.S. Department of Energy ("DOE") gives notice of a Decision and Order (Case Number 2018-004) that grants LG Electronics USA, Inc. ("LG") a waiver from specified portions of the DOE test procedure for determining the energy efficiency of listed portable air conditioner basic models. Under the Decision and Order, LG is required to test and rate the listed basic models of its portable air conditioners in accordance with the alternate test procedure specified in the Decision and Order.

DATES: The Decision and Order is effective on **[INSERT DATE OF PUBLICATION IN THE *FEDERAL REGISTER*]**. The Decision and Order will terminate upon the compliance date of any future amendment to the test procedure for portable air conditioners located in 10 CFR part 430, subpart B, appendix CC that addresses the issues presented in this waiver. At that time, LG must use the relevant test procedure for this product for any testing to demonstrate compliance with standards and any representations of energy use.

FOR FURTHER INFORMATION CONTACT:

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Ms. Sarah Butler, U.S. Department of Energy, Office of the General Counsel, GC-33, Forrestal Building, 1000 Independence Avenue SW., Washington, DC 20585-0103. Telephone: (202) 586-1777. Email: *Sarah.Butler@hq.doe.gov*.

SUPPLEMENTARY INFORMATION: In accordance with Title 10 of the Code of Federal Regulations ("CFR") (10 CFR 430.27(f)(2)), DOE gives notice of the issuance of its Decision and Order as set forth below. The Decision and Order grants LG a waiver from the applicable test procedure in 10 CFR part 430, subpart B, appendix CC ("Appendix CC") for listed basic models of portable air conditioners, if LG tests and rates those portable air conditioners using the alternate test procedure specified in the Decision and Order. LG's representations concerning the energy efficiency of the listed basic models must be based on testing according to the provisions and restrictions in the alternate test procedure set forth in the Decision and Order, and the representations must fairly disclose the test results. Distributors, retailers, and private labelers also must comply with the same requirements when making representations regarding the energy efficiency of these products. (42 U.S.C. 6293(c))

Consistent with 10 CFR 430.27(j), not later than [**INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***], any manufacturer currently distributing in commerce in the United States a product employing a technology or characteristic that results in the same need for a waiver from the applicable test procedure must submit a petition for waiver. Manufacturers not currently distributing such products in commerce in the United States must petition for and be granted a waiver prior to the distribution in commerce of those products in the United States. Manufacturers may also submit a request for interim waiver pursuant to the requirements of 10 CFR 430.27.

Signing Authority

This document of the Department of Energy was signed on May 8, 2020, by Alexander N. Fitzsimmons, Deputy Assistant Secretary for Energy Efficiency, 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 May 8, 2020.

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Treena V. Garrett,
Federal Register Liaison Officer,
U.S. Department of Energy.

I. Background and Authority

The Energy Policy and Conservation Act ("EPCA"),[1] authorizes the U.S. Department of Energy ("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 for certain types of consumer products. In addition to specifying a list of covered products and industrial equipment, EPCA contains provisions that enable the Secretary of Energy to classify additional types of consumer products as covered products. (42 U.S.C. 6292(a)(20)) In a final determination of coverage published in the *Federal Register* on April 18, 2016, DOE classified portable air conditioners as covered products under EPCA. 81 FR 22514.

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA include definitions (42 U.S.C. 6291), test procedures (42 U.S.C. 6293), labeling provisions (42 U.S.C. 6294), energy conservation

[1] All references to EPCA in this document refer to the statute as amended through America's Water Infrastructure Act of 2018, Public Law 115-270 (October 23, 2018).
[2] For editorial reasons, upon codification in the U.S. Code, Part B was redesignated as Part A.

standards (42 U.S.C. 6295), and the authority to require information and reports from manufacturers (42 U.S.C. 6296).

The Federal 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 pursuant to EPCA (42 U.S.C. 6295(s)), and (2) making other representations about the efficiency of that product (42 U.S.C. 6293(c)). Similarly, DOE must use these test procedures to determine whether the product complies with relevant standards promulgated under EPCA. (42 U.S.C. 6295(s))

Under 42 U.S.C. 6293, EPCA sets forth the criteria and procedures DOE is required to follow when prescribing or amending test procedures for covered products. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use or estimated annual operating cost of a covered product during a representative average use cycle or period of use and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6293(b)(3)) The test procedure for portable air conditioners is contained in the Code of Federal Regulations ("CFR") at 10 CFR part 430, subpart B, appendix CC, *Uniform Test Method for Measuring the Energy Consumption of Portable Air Conditioners* ("Appendix CC").

Any interested person may submit a petition for waiver from DOE's test procedure requirements. 10 CFR 430.27(a)(1). DOE will grant a waiver from the test procedure requirements if DOE determines either that the basic model for which the waiver was requested contains a design characteristic that prevents testing of the basic model according to the prescribed test procedures, or that the prescribed test procedures evaluate the basic model in a manner so unrepresentative of its true energy consumption characteristics as to provide materially inaccurate comparative data. 10 CFR 430.27(f)(2). DOE may grant the waiver subject to conditions, including adherence to an alternate test procedure. *Id*.

II. LG's Petition for Waiver: Assertions and Determinations

By letter dated May 15, 2018, LG submitted a petition for waiver and application for an interim waiver from the portable air conditioner test procedure set forth in Appendix CC.[3]

The portable air conditioner test procedure in Appendix CC provides test instructions for two configurations of portable air conditioners: dual-duct and single-duct. Dual-duct units use two parallel airflow paths: with the first airflow path, air from the conditioned space (*i.e.*, indoors) is drawn into the unit, passes over a cold heat exchanger (*i.e.*, the evaporator), and is discharged back into the room. With the second airflow path, air from outdoors is drawn into the unit, passes over a hot heat exchanger (*i.e.*, the condenser), and is discharged back outdoors. In this type of system, the heat that is removed from the indoor airflow path is essentially transferred to the outdoor airflow path and discharged outdoors. The temperature of the air flowing across the condenser significantly affects a portable air conditioner's cooling capacity. Because the air passing across the condenser is drawn from outdoors, and outdoor air temperatures vary during portable air conditioner use, the cooling capacity of a dual-duct unit is

[3] LG's petition for a waiver and petition for an interim waiver is provided in the docket located at: *https://www.regulations.gov/document?D=EERE-2018-BT-WAV-0007-0001*.

significantly affected by changes in outdoor air temperatures. Therefore, to produce representative test results, Appendix CC requires dual-duct units to be tested at two different "test conditions" in the test chamber that supplies the condenser inlet air, representing two different outdoor temperatures: 95 degrees Fahrenheit (°F) and 83 °F. Under both test conditions, the test chamber in which the unit is installed is maintained at a temperature of 80 °F, which is a representative indoor temperature, and the unit is operated at full load.[4]

Single-duct units also use two parallel airflow paths; however, in contrast to dual-duct units, the condenser airflow path draws air from inside the conditioned space rather than from outside. This air is drawn into the unit through air grates in the unit's chassis, passes over the condenser, and is discharged to the outdoors through the single duct. During the test, the indoor air temperature remains steady, and thus the condenser always sees the same temperature at its inlet. Therefore, Appendix CC requires only one test condition for single-duct portable air conditioners, 80 °F in the test chamber in which the unit is installed (corresponding to the specified indoor air temperature). As with the dual-duct unit tests, the single-duct unit is operated at full load throughout the duration of the test.

The cooling capacity of both dual-duct and single-duct portable air conditioners is reduced by the infiltration of hotter outside air (*i.e.*, "infiltration air") into the conditioned space

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[4] The requirement in section 3.1.2 of Appendix CC to set the controls on the unit to the lowest available temperature setpoint applies to both the 95 °F and 83 °F tests. The lowest available setpoint on any portable air conditioner is significantly less than the indoor air temperature of 80 °F, which is maintained by external reconditioning equipment throughout the duration of the test. Therefore, since the indoor temperature setpoint remains lower than the indoor air temperature throughout the duration of the test, the unit operates at full load throughout the duration of both tests.

due to any indoor air being exhausted outside the conditioned space through the condenser duct.[5] Appendix CC accounts for infiltration air at the two different outdoor temperature operating conditions (95 °F and 83 °F) for both single-duct and dual-duct portable air conditioners. The infiltration air heat transfer is calculated (as opposed to being directly measured) using a set of equations provided in section 4.1.2 of Appendix CC. Finally, the cooling capacity of both dual-duct and single-duct portable air conditioners is also reduced by the heat transferred from the duct surface(s) to the conditioned space; *i.e.*, "duct heat transfer." Duct heat transfer is accounted for in section 4.1.1 of Appendix CC based on measurements of the surface temperature of the duct(s) and the total surface area of the duct(s).

LG requested a waiver for the following portable air conditioner basic models: LP1419IVSM, LP1419HVSM, LP1219IVSM, LP1019IVSM, and LP0819IVSM, all of which are single-duct models.[6] LG noted that the current DOE test procedure for portable air conditioners has different requirements for dual-duct and single-duct products. For dual-duct products, testing must occur under two test conditions, (*i.e.*, at a high-temperature test condition and a lower-temperature test condition). For single-duct products, the test procedure requires testing at only a single full-load test condition. LG asserted that the current DOE test procedure for single-duct portable air conditioners does not take into account the specific performance and

[5] "Infiltration air" refers to air that infiltrates from outside the conditioned space (*e.g.*, from outdoors, attic, adjacent rooms) to inside the conditioned space as a result of negative air pressure induced as the outlet air is exhausted outside the conditioned space. This effect is particularly pronounced for single-duct units because single-duct units draw all of the air in the condenser airflow path from within the conditioned space and discharge that air outdoors. However, dual-duct units also typically draw a portion of their inlet air from the conditioned space (inadvertently), which creates a slight negative pressure in the conditioned space and results in some infiltration air for dual-duct units as well.

[6] LG provided these basic model numbers in an appendix to its May 15, 2018 petition.

efficiency benefits associated with single-duct variable-speed portable air conditioners under part-load conditions.

LG stated that single-duct variable-speed portable air conditioners use frequency controls to constantly adjust the compressor rotation speed to maintain the desired temperature in the home without turning the motor on and off; that the compressor responds automatically to surrounding conditions to operate in the most efficient possible manner; and that this results in both significant energy savings and faster cooling compared to a portable air conditioner without a variable-speed compressor. LG asserted that, because the DOE test procedure does not account for the general part-load performance benefits of single-duct variable-speed portable air conditioners or properly account for the favorable difference in "cycling losses"[7] for single-duct variable-speed portable air conditioners resulting from use of variable-speed technology, the results of the test procedure are not representative of the actual energy consumption of single-duct variable-speed portable air conditioners.

In its petition, LG requested an alternate test procedure, which would provide for testing the listed basic models according to Appendix CC, except that units of the listed single-duct variable-speed basic models would be tested at the two test conditions defined for dual-duct units, at two different fixed compressor speeds; specifically, at the high-temperature (95 °F)

[7] When the cooling load of the space is less than the full cooling power of the compressor, a single-speed compressor cycles on and off. This cycling behavior introduces inefficiencies, *i.e.*, "cycling losses," due to the surge in power draw at the beginning of each "on" cycle, before the compressor reaches steady-state performance. As described above, the current DOE test procedure measures the performance of a portable air conditioner while operating under a full cooling load; *i.e.*, the compressor is operated continuously in its "on" state. As a result, Appendix CC does not capture any inefficiencies due to compressor cycling.

outdoor air test condition with the compressor speed set to maximum; and at the lower-temperature (83 °F) outdoor air test condition with the compressor speed set to minimum. As discussed, the current single-duct portable air conditioner test procedure in Appendix CC relies on a single test condition. LG's suggested alternate approach for single-duct variable-speed portable air conditioners would involve measuring performance at two different outdoor temperature conditions, with two compressor speeds, which would reflect how a single-duct variable-speed portable air conditioner would reduce its compressor speed under reduced load conditions accompanying lower outdoor temperature operating conditions.

Under the requested alternate test procedure, a single-duct variable-speed portable air conditioner unit's final combined energy efficiency ratio ("CEER") metric would be calculated by multiplying a "performance adjustment factor" by the unit's measured weighted CEER value (as measured according to the existing procedure for a dual-duct portable air conditioner at two representative outdoor temperature test conditions). The performance adjustment factor would reflect the average performance improvement, relative to a theoretical comparable single-duct single-speed unit, resulting from the variable-speed unit avoiding cycling losses associated with the lower-temperature test condition currently used for testing dual-duct portable air conditioners. Determining a unit's performance adjustment factor would require calculating two CEER values for a theoretical comparable single-duct single-speed portable air conditioner (*i.e.*, a unit that has the same performance as the variable-speed test unit when operating at the full compressor speed). The two CEER values would reflect the unit's efficiency with and without efficiency losses due to compressor cycling. The performance adjustment factor would be calculated as the percent change of the weighted CEER value of the theoretical comparable single-duct single-speed portable air conditioner with accounting for cycling losses compared to the weighted CEER value of the theoretical comparable single-duct single-speed portable air conditioner without accounting for cycling losses. The performance adjustment factor represents the difference in real-world performance between the variable-speed unit and an actual comparable single-speed unit.

The requested alternate test procedure implements a performance adjustment factor because use of a performance adjustment factor allows for an appropriate comparison between a single-duct variable-speed portable air conditioner tested at two different compressor speeds and a single-duct single-speed portable air conditioner tested at a single speed. The performance adjustment factor represents the relative benefit under the conditions represented by the test of a variable-speed unit's avoidance of compressor cycling that would otherwise occur in a comparable single-speed unit. Applying it to the measured single-duct variable-speed portable air conditioner weighted CEER accounts for the avoidance of efficiency losses due to cycling and provides a more appropriate comparison to the existing CEER metric for single-duct single-speed portable air conditioners.

On August 9, 2019, DOE published a notice that announced its receipt of the petition for waiver and granted LG an interim waiver ("August 2019 Notice of Petition for Waiver"). 84 FR 39274. In the August 2019 Notice of Petition for Waiver, DOE presented LG's claim that the results of the test procedure in Appendix CC are not representative of the actual energy consumption of the variable-speed single-duct portable air conditioner basic models listed in LG's petition for waiver and LG's requested alternate test procedure described above.

In the August 2019 Notice of Petition for Waiver, DOE specified an alternate test procedure as suggested by LG with certain modifications and additional requirements. First, the alternate test procedure specified in the interim waiver provides compressor speed nomenclature and definitions that are derived from those in an industry standard for testing consumer central air conditioning products with variable-speed compressors. DOE clarified the low compressor speed definition to ensure the test unit provides adequate cooling capacity under reduced loads, based on the expected load at those conditions.[8] Second, LG must maintain the compressor speed required for each test condition in accordance with the instructions LG submitted to DOE on July 8, 2019.[9] DOE did not include measuring performance at two different outdoor temperature conditions, each at a different compressor speed, as suggested by LG. Given that the condenser airflow path on a single-duct unit draws air from inside the conditioned space rather than from outside, and the indoor air temperature is held constant during testing, changing

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[8] The compressor speed nomenclature and definition clarifications are derived from Air Conditioning, Heating, and Refrigeration Institute Standard (AHRI) 210/240–2017, "Performance Rating of Unitary Air-conditioning & Air source Heat Pump Equipment," and adapted to apply to portable air conditioners. Equation 11.60 in AHRI 210/240–2017 relates the building load to an AC's full-load cooling capacity and outdoor temperature, and assumes full-load operation at 98 °F outdoor temperature. DOE adjusted (*i.e.* normalized) this equation to reflect full-load operation at 95 °F outdoor temperature, to provide consistency with the full-load test condition for portable air conditioners. Using the adjusted equation suggests that the representative cooling load at the 83 °F rating condition would be 60 percent of the full-load cooling capacity for portable air conditioners. DOE recognizes that variable-speed portable air conditioners may use compressors that vary their speed in discrete steps and may not be able to operate at a speed that provides exactly 60-percent cooling capacity; therefore, the defined cooling capacity associated with the low compressor speed is presented as a 10-percent range rather than a single value. A 60-percent cooling load is the upper bound of the 10-percent range defining the cooling capacity associated with the lower compressor speed (*i.e.*, the range is defined as 50 to 60 percent). This ensures that the variable-speed portable air conditioner is capable of matching the representative cooling load (60 percent of the maximum) at the 83 °F rating condition, while providing the performance benefits associated with variable-speed operation. In contrast, if the 10-percent range were to be defined as, for example, 55 to 65 percent (with 60 percent as the midpoint), a variable-speed portable air conditioner could be tested at 63 percent, for example, without demonstrating that the unit is capable of maintaining variable-speed performance down to 60 percent.

[9] The instructions provided by LG were marked as confidential and, as such, the instructions will be treated as confidential. The document is located in the docket at *https://www.regulations.gov/document?D=EERE-2018-BT-WAV-0007*.

the outdoor temperature conditions between each test would add unnecessary test burden with no impact on test results. Therefore, DOE specified a single temperature for only the condenser inlet air for the two test conditions, one at each compressor speed, and not the outdoor air test conditions in August 2019 Notice of Petition for Waiver.

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For the reasons explained here and in the August 2019 Notice of Petition for Waiver, without a waiver, the five portable air conditioner basic models identified in the interim waiver, to which this Order applies, contain a design characteristic—variable-speed compressors—that yields test results unrepresentative of their true energy consumption, and thus efficiency. Thus, DOE is requiring LG to test and rate the five portable air conditioner basic models identified in this Order according to the alternate test procedure in this Order. The alternate test procedure in this Order is a modified version of the procedure in the interim waiver.

In the August 2019 Notice of Petition for Waiver, DOE also solicited comments from interested parties on all aspects of the petition. *Id*. DOE received comments from the Appliance Standards Awareness Project and the Natural Resources Defense Council, jointly (hereinafter the "Joint Advocates"); the Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison, commenting jointly as the California Investor Owned Utilities (hereinafter the "California IOUs"); GE Appliances, a Haier Company ("GEA"), and the Midea

America Research Center ("Midea"). On September 27, 2019, LG subsequently submitted a rebuttal statement (pursuant to 10 CFR 430.27(d)(3)) in response to these comments.[10]

Commenters generally agreed that the current test procedure for portable air conditions does not produce results representative of the actual performance of single-duct variable speed portable air conditions. GEA generally supported the need for a test procedure waiver for portable air conditioners with variable-speed compressors, asserting that the current test procedure is not representative of the actual performance of single-duct variable-speed units. (GEA, No. 7 at p. 1)[11] Midea stated that it fully supports granting a final waiver to LG, subject to minor revisions that are discussed in the following paragraphs. (Midea, No. 8 at p. 3) The Joint Advocates stated that they share LG's concern that the current test procedure for portable air conditioners does not capture the potential benefits of variable-speed technology. (Joint Advocates, No. 5 at p. 1) The California IOUs stated that an alternate test procedure is warranted to demonstrate the benefits of variable-speed compressor technology, whose primary benefit in improving energy efficiency is the reduction of cyclic losses. (California IOUs, No. 6 at pp. 1–2)

The California IOUs urged DOE to make various changes. First, they asked DOE to ensure the test procedure was representative of real-world use, consistent with previously developed concepts, and justified with data. Second, they asked DOE to ensure the alternate test

[10] Comments submitted by the Joint Advocates, California IOUs, GEA, and Midea, and the rebuttal statement submitted by LG can be accessed at: *https://www.regulations.gov/docket?D=EERE-2018-BT-WAV-0007*.
[11] A notation in the form "GEA, No. 7 at p. 1" identifies a written comment: (1) made by GE Appliances, a Haier Company; (2) recorded in document number 7 that is filed in the docket of this waiver (Docket No. EERE-2018-BT-WAV-0007) and available for review at *http://www.regulations.gov*; and (3) which appears on page 1 of document number 7.

procedure results are comparable with existing single-speed units, assumptions are clearly justified, and methods are representative and reproducible. They also asked DOE to address a number of additional issues prior to granting the waiver. (California IOUs, No. 6 at pp. 1–2)

The Joint Advocates argued that, instead of granting a test procedure waiver to LG to address single-duct portable air conditioners with variable-speed compressors, DOE should instead investigate a load-based test procedure for all portable air conditioners to capture part-load operation for all unit configurations. Because the current test procedure is a fixed-conditions test, they argued it is not representative of how either single-speed or variable-speed units perform in the field. Specifically, variable-speed units are not allowed to adjust to reduced loads, and single-speed units do not cycle under the current fixed-conditions test. (Joint Advocates, No. 5 at p. 1)

In its rebuttal statement, LG stated that granting this test procedure waiver does not preclude DOE from investigating a load-based test procedure in a future portable air conditioner test procedure rulemaking that DOE must conduct after granting a test procedure waiver. LG stated that the current DOE test procedure misrepresents the actual energy consumption of LG's portable air conditioners that use variable-speed compressors, and that denying this test procedure waiver for these units would, contrary to statutory requirements, mislead consumers about the energy efficiency of variable-speed portable air conditioners until DOE completes a test procedure rulemaking. LG asserted that, because it has met all the criteria for a test procedure waiver, DOE must grant the waiver. (LG, No. 9, at pp. 3−4)

DOE has determined that the alternate test procedure in the August 2019 Notice of Petition for Waiver, as modified in this order, produces efficiency results for variable-speed portable air conditioners which are comparable with the results for single-speed units. The alternate test procedure accomplishes this by adjusting the efficiency rating of the variable-speed portable air conditioner by the amount the variable-speed unit would outperform a theoretical comparable single-speed unit in a representative period of use. The alternate test procedure is based on industry-accepted test procedures. Values used for the cycling loss factor at the 83 °F test condition are based on Air-Conditioning, Heating, and Refrigeration Institute ("AHRI") Standard 210/240, "Performance Rating of Unitary Air-conditioning & Air-source Heat Pump Equipment" ("AHRI Standard 210/240"), as discussed below. The building load calculation is widely accepted by industry, used in AHRI Standard 210/240, and is constructed to be broadly applicable to a number of building cooling configurations. It also specifies that the compressor speed must be fixed at each test condition. LG has provided DOE instructions for fixing the compressor, to ensure that the alternate test procedure is repeatable and reproducible.

Portable air conditioners are tested in psychometric chambers[12] that are designed to maintain specific constant temperature conditions throughout the duration of the test (*i.e.*, a constant-temperature test). DOE agrees that the concept of a load-based test may be more representative of typical portable air conditioner operation, where the conditions within a room vary and the portable air conditioner operates to maintain the room conditions based on the set point and monitored conditions. However, implementing a load-based test for portable air

[12] A psychometric chamber uses ducts installed on the evaporator and condenser exhausts to measure the air-enthalpy and calculate cooling capacity.

conditioners would present a number of significant challenges.[13] First, implementing a part-load test condition would require first determining the full cooling capacity of a portable air conditioner unit, which is most easily and repeatably achieved with a constant-temperature test. In practice, this would result in the need for chambers to accommodate both constant-temperature and constant-load operation, which could require significant chamber redesigns associated with new or upgraded chamber reconditioning equipment and software adjustments. Second, the external reconditioning equipment in existing psychometric chambers is controlled using software with feedback control to maintain constant temperature conditions. Operating the chamber to provide a constant load—and thus allowing the temperature to vary—would require continuous manual override of the software controls, thus requiring more technician involvement, and resulting expense, throughout the test. Alternatively, the software controls could be redesigned to accommodate constant-load operation; however, this would require significant financial and time investments by test laboratories.. Third, the current test procedure does not provide any requirements for the type of instrumentation, hardware, or other equipment that can occupy existing chambers. The thermal mass of such equipment inside the chamber can affect the variation in chamber temperature as a function of the cooling load, and therefore could affect the test results under a constant-load test in which the temperature is allowed to change. Ensuring the reproducibility of the test would require closely specifying every aspect of the test chamber, including instrumentation, hardware, and other equipment inside the test chamber, which would increase test burden by adding complexities to the test method beyond what is already specified, although DOE is unable to exactly quantify this test burden increase at this

[13] DOE found that the same challenges applied to load-based testing for room air conditioners in calorimeter chambers in the notice of decision and order published on May 8, 2019, in which DOE granted a waiver to LG for variable-speed room air conditioners. 84 FR 20111, 20114.

time, particularly given the variability in existing test chamber designs. Further, DOE is unable to quantify the potential benefits of requiring a load-based test procedure at this time. For these reasons, DOE is not specifying a load-based test for variable-speed portable air conditioners in this Decision and Order. This does not preclude DOE from considering such testing in a future rulemaking, particularly if industry and third-party test laboratories were to implement load-based testing capabilities into psychrometric chambers, which are the type of test chamber typically used for portable air conditioner testing.

In addition to preferring a load-based test, the Joint Advocates expressed concern that the alternate test procedure in the interim waiver does not reflect real-world performance of variable-speed portable air conditioners, because the compressor speeds are fixed for each of the two test conditions (full speed at the 95 °F condition and low speed at the 83 °F condition). The Joint Advocates prefer capturing how the programmed control strategies change speeds in response to load changes and thus affect overall efficiency. (Joint Advocates, No. 5 at pp. 1–2)

DOE agrees that variable-speed portable air conditioners in the field are likely to adjust their compressor speed in real time in response to variations in the cooling load. However, as DOE discussed for variable-speed room air conditioners in the May 2019 RAC Decision and Order, because of the large variation in cooling loads, both for rooms within a house, and among different housing types and geographical areas, identifying a single or multiple representative cooling loads would not be feasible. (84 FR 20111, 20115) Furthermore, DOE determined in the May RAC 2019 Decision and Order that load-based testing would impose undue cost and burden on manufacturers and test laboratories due to the unique construction and capabilities of existing calorimeter chambers and unit response variability during load-based testing. *Id.* DOE concludes that the same burdens would be imposed by load-based testing of variable-speed portable air conditioners in psychrometric chambers, but the approach suggested by LG to measure performance for a representative range of variable-speed operation (*i.e.*, at low and full compressor speed under relevant outdoor temperature operating conditions), as modified in this order, provides a sufficient determination of variable-speed portable air conditioner performance.

The Joint Advocates stated that, according to LG, these variable-speed portable air conditioners can operate over a range of compressor speeds, and if a variable-speed unit provides sustained cooling at the high compressor speed (*i.e.*, at a higher compressor speed than a comparable single-speed unit at full-load operating conditions), the faster cooling would come at the expense of higher energy consumption, an effect that would not be captured by the waiver test procedure. (Joint Advocates, No. 5 at p. 2)

In its rebuttal statement, LG explained that its variable-speed portable air conditioners only cool the room at boost compressor speed (*i.e.*, a speed faster than full speed – the speed at full-load testing conditions) for less than 10 minutes when they begin cooling the room, making the energy consumption of this phase of cooling "very small" compared to the energy consumed during the remainder of cooling mode operation. LG noted that AHRI Standard 210/240 describes this operation as "boost compressor speed," and that boost compressor speed is standard at start-up in all air conditioners with variable-speed compressors. (LG, No. 9 at pp. 5−6)

DOE has observed that a variable-speed room air conditioner operates at boost compressor speed to provide initial cooling to the conditioned space during testing. DOE expects its experience with boost compressor speed for variable-speed room air conditioners to be analogous to boost compressor speed operation in variable-speed portable air conditioners; this experience indicates that the amount of energy consumed in this operation is insignificant compared to the energy consumed during the remainder of cooling mode operation. As a result, the potential improvements in test procedure representativeness do not warrant the additional test burden associated with measuring variable-speed portable air conditioner performance at the boost compressor speed.

The Joint Advocates questioned what they stated is LG's apparent claim that the performance of dual-duct units, but not single-duct units, under reduced load conditions is accounted for in the DOE test procedure by testing at two test conditions. The Joint Advocates, however, assert that both dual-duct test conditions are full-load tests, and that Seasonally Adjusted Cooling Capacity ("SACC") and Combined Energy Efficiency Ratio ("CEER") are calculated to provide a direct comparison between dual-duct and single-duct units. (Joint Advocates, No. 5 at pp. 2–3)

DOE agrees that the portable air conditioner test procedure for dual-duct units at Appendix CC does not measure part-load performance. Instead, it requires full-load tests at each test condition, and as a result does not account for single-speed unit cycling under part-load conditions or variable-speed compressor speed adjustments to match part-load conditions. However, LG's claims regarding the test conditions and procedure for dual-duct portable air conditioners are not directly relevant to the August 2019 Notice of Petition for Waiver and this Decision and Order, which only address the single-duct variable-speed portable air conditioners listed in the LG petition for waiver submitted on May 15, 2018.

The Joint Advocates and the California IOUs stated that the portable air conditioner test procedure is only conducted at one outdoor temperature test condition for single-duct units because such portable air conditioners draw condenser inlet air from the conditioned space, so the indoor and outdoor temperature for each test condition should always be equal. (Joint Advocates, No. 5 at p. 3; California IOUs, No. 6 at p. 2) The Joint Advocates questioned why the alternate test procedure in the interim waiver provides for testing single-duct variable-speed portable air conditioners at two different condenser inlet test conditions. (Joint Advocates, No. 5 at p. 3) The California IOUs recommended that these units be tested at only the single test condition required by Appendix CC, but with varying compressor speeds. (California IOUs, No. 6 at p. 2)

In response to comments pertaining to the two test conditions listed in the August 2019 Notice of Petition for Waiver, LG stated that while outdoor air temperature minimally affects the cooling capacity test measurement, it does affect the calculation of CEER and SACC due to the influence of infiltration air. The outdoor air temperature affects the magnitude of the infiltration air impact on portable air conditioners, and, therefore, it is necessary to calculate infiltration at two different test conditions.

DOE agrees with the Joint Commenters and the California IOUs that the specification for condenser inlet air found in Table 1 of the alternate test procedure in the interim waiver should be the same as the indoor temperature for single-duct portable air conditioners because the condenser inlet air for a single-duct unit is drawn from indoors. DOE notes that the alternate test procedure in the interim waiver included a note specifying that, for the purposes of this cooling mode test procedure, condenser inlet air is considered the "outdoor air" outside of the conditioned space. 84 FR 39274, 39277. As such, the outdoor air temperatures of 95 °F and 83 °F shown in Table 1 represent the outdoor temperature operating conditions, rather than the actual condenser inlet air test conditions, as the column heading would imply.[14] To alleviate any potential confusion about the distinction between outdoor air temperature and condenser inlet air temperature, in this Decision and Order DOE specifies in Table 1 of the alternate test procedure that variable-speed single-duct portable air conditioners must be tested at the same condenser inlet temperature as the indoor-side air temperature for both test conditions (*i.e.*, 80 °F).

The California IOUs and Midea suggested that the alternate calculation for infiltration air mass flowrate is incorrect because condenser inlet air for a single-duct portable air conditioner is drawn from the indoors, thus making the infiltration air associated with single-duct units independent of condenser inlet air. These commenters urged DOE to require that the mass flow rate of infiltration air for all single-duct portable air conditioners, including variable-speed units, be calculated using the existing formula in the DOE test procedure at Appendix CC, thus

[14] DOE further notes that, for a single-duct portable air conditioner, because both the evaporator air and condenser air are drawn from the conditioned space through air grates that are integral to the unit itself, the evaporator and condenser inlet air temperature test conditions are necessarily the same.

removing the terms in the mass flow rate of infiltration air accounting for condenser inlet air flow in the alternate test procedure. (California IOUs, No. 6 at p. 3; Midea, No. 8 at pp. 2–3)

LG responded that the alternate calculation in section 4.1.2 of the interim waiver test procedure provides the correct value for infiltration air mass flow. Because, for single-duct units, the average volumetric flow rate of the condenser inlet duct air is zero, the second term of the equation, referring to the condenser inlet duct air, is reduced to zero. (LG, No. 9, at pp. 2, 7)

DOE agrees that the equation for infiltration air mass flow from the interim waiver alternate test procedure produces the correct results when the average volumetric flow rate of the condenser inlet duct air is appropriately set to zero, given that single-duct portable air conditioners do not have a condenser inlet duct. However, DOE recognizes that including the condenser inlet air term for single-duct units may lead to confusion. To reduce the possibility of such confusion, the equation in the alternate test procedure specified in this Decision and Order to calculate the mass flow rate of infiltration air for variable-speed single-duct portable air conditioners is based on only the condenser exhaust air mass flow, like the current equation for single-speed single-duct portable air conditioners. Because the value of the condenser inlet air term is zero, as explained above, this revision does not change any values calculated using the interim waiver alternate test procedure.

The California IOUs suggested that DOE correct an error in the equation for adjusted cooling capacity at the higher outdoor temperature condition in section 5.1 of the alternate test procedure specified in the August 2019 Notice of Petition for Waiver. They noted that the two adjusted cooling capacity equations erroneously used two different equations to calculate the same Adjusted Cooling Capacity ("ACC") value (*i.e.*, ACC_{83}), which the California IOUs stated should be two different values representing the two outdoor temperature conditions. The California IOUs further recommended subscripts for these two values based on compressor speed rather than outdoor temperature. (California IOUs, No. 6 at p. 4)

DOE acknowledges there was a typographical error in August 2019 Notice of Petition of Waiver. The two equations identified by the California IOUs calculate different adjusted cooling capacity values (*i.e.*, ACC_{95} and ACC_{83}), but were both labeled as calculating ACC_{83}. In this Decision and Order, DOE has corrected this typographical error and provides additional clarification of the alternate test procedure by implementing "Full" and "Low" subscripts to represent the compressor speed setting for each calculation. DOE also has standardized subscripts accordingly throughout the alternate test procedure to be consistent with this approach.

The California IOUs requested clarification on the use of the 83 °F outdoor temperature condition rather than the 95 °F condition in the equation when calculating the theoretical single-speed unit capacity at 83 °F. The California IOUs commented that both conditions hold true, because capacity is independent of the outdoor air temperature. The California IOU's had similar concerns about the mass flow of infiltration air equation, requesting clarification as to why the mass flow equation for the theoretical single-speed unit at 83 °F uses the volumetric air flow rate measured at 95 °F. (California IOUs, No. 6 at p. 5)

As noted above, DOE recognizes that, unlike for a dual-duct unit, for a single-duct unit, the outdoor air temperature has no direct bearing on the cooling capacity, because the condenser inlet air for a single-duct unit is drawn from within the conditioned space. DOE notes that section 5.5.1 of the alternate test procedure explicitly defines the theoretical comparable single-speed portable air conditioner capacity at the 83 °F outdoor temperature operating condition as equal to the full-load capacity of the variable-speed portable air conditioner at the 95 °F outdoor temperature operating condition because the theoretical comparable single-speed unit is based upon the full compressor speed of the variable-speed unit. DOE recognizes the confusion that may arise from these equations. This Decision and Order revises the nomenclature of the two variable-speed unit tests to refer to the compressor speed (*e.g.*, $Capacity_{Full}$) instead of the "outdoor temperature test condition". Further, in contrast to the alternate test procedure granted in the interim waiver, this Decision and Order specifies a condenser inlet air temperature of 80 °F – consistent with the 80 °F evaporator inlet air temperature – rather than specifying condenser inlet air temperatures of 83 °F and 95 °F for the two test conditions. DOE maintains the distinction between theoretical comparable single-speed unit capacity at 83 °F and 95 °F because the respective adjusted cooling capacities at each of these conditions reflect the impact of infiltration air at these two temperatures. While the infiltration air mass flow rate for the theoretical comparable single-speed unit remains constant, the heat entering the room due to infiltration air will differ based on the outdoor temperature. Therefore, DOE has provided equations for calculating the infiltration air mass flow rates at both temperatures for a theoretical comparable single-speed portable air conditioner.

The California IOUs requested that the manufacturer justify the cyclic loss factor proposed by citing references or providing data, although they stated that the value appears reasonable. (California IOUs, No. 6 at p. 5)

In response to this comment, LG noted that the cycling loss factor it suggested in the alternate test procedure was the value DOE provided based on DOE's research. (LG, No. 9, at pp. 7–8)

The cycling loss factor in the alternate test procedure is based on the default cycling loss factors in Section 11.2 of AHRI Standard 210/240, an industry-accepted test procedure. The cycling loss factor at the 83 °F condition for a theoretical comparable single-speed single-duct portable air conditioner is calculated using the default cooling degradation coefficient 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.

GEA commented that LG's proposed alternate test procedure calculates a weighted efficiency for a unit with a variable-speed compressor that reflects only decreased energy use but not reduced cooling capacity when the unit runs at a lower speed. GEA suggested the test procedure account for both the reduced energy usage and the reduced cooling capacity of a variable-speed compressor by incorporating the reduced cooling capacity in the SACC calculation equations. (GEA, No. 7 at p. 1)

GEA's suggestion that the alternate test procedure does not reflect decreased cooling capacity is incorrect. The reduced cooling capacity at the low compressor speed is used when calculating the adjusted cooling capacity at the lower outdoor temperature operating condition, ACC_{83}, in section 5.1 of the alternate test procedure. This lower adjusted cooling capacity is included in the weighted-average overall adjusted cooling capacity calculated in section 5.3 of the alternate test procedure. By calculating the adjusted cooling capacity based on performance at both outdoor temperature operating conditions and compressor speeds, the alternate test procedure accounts for not only the reduced energy usage of the variable-speed portable air conditioner but also the reduced cooling capacity from operation at the low compressor speed.

For the reasons explained here and in the August 2019 Notice of Petition for Waiver, the basic models identified by LG in its petition cannot be tested and rated for energy consumption on a basis representative of their true energy consumption characteristics using Appendix CC. DOE has reviewed the procedure suggested by LG and concludes that, subject to the modifications discussed in this Decision and Order, the test procedure in this Decision and Order will allow for the accurate measurement of the energy consumption of the listed models, while alleviating the problems associated with testing these models following DOE's portable air conditioner test procedure. LG must test and rate the five listed portable air conditioner basic models according to the alternate test procedure specified in the Decision and Order. This alternate test procedure is substantively consistent with the interim waiver's alternate test procedure but includes clarifying modifications.

Based on further review of the alternate test procedure required under the interim waiver order and the comments received, the alternate test procedure required under today's Decision and Order: (1) Corrects a typographical error in the Adjusted Cooling Capacity equations; (2) changes certain calculated value subscripts to refer to the compressor speed for which the value is being calculated, rather than the outdoor temperature test condition; (3) specifies in Table 1 of the alternate test procedure that single-duct portable air conditioners are only tested at one condenser inlet air temperature (*i.e.* the indoor air temperature), although two different outdoor temperatures are represented by the two tests required by the alternate test procedure, and makes corresponding changes to references to Table 1 throughout the text; and (4) removes a term describing condenser inlet air from the air infiltration mass flow equation. DOE has determined that these changes ensure better repeatability and reproducibility of the alternate test procedure, improving the representativeness of the results. The changes will not affect the performance of single-duct variable-speed portable air conditioners as measured under the alternate test procedure specified in the interim waiver. Below is a more detailed discussion of each change.

DOE is changing a subscript to correct a typographical error in the two Adjusted Cooling Capacity equations in section 5.1, *Adjusted Cooling Capacity*. The interim waiver erroneously labeled both calculations for the adjusted cooling capacity at each test condition as ACC_{83}. This Order changes the label in the first calculation to ACC_{95}.

DOE is changing subscripts throughout the alternate test procedure to refer to specified compressor speed instead of the outdoor temperature test condition represented by the compressor speed setting (*i.e.*, instead of "95" and "83," the subscripts now read "Full" and "Low"). DOE made this change to clarify the compressor speed setting required.

DOE is revising Table 1 in the alternate test procedure to specify that the alternate test procedure only requires one condenser inlet air temperature for both tests. The condenser inlet air temperature is the same as the indoor air temperature because single-duct units draw air from the indoor room. While the outdoor temperature test condition represented by each test is different, it does not directly impact the performance of a test unit.

DOE is simplifying the equation to calculate the mass flow rate of infiltration air for variable-speed single-duct portable air conditioners using only the condenser exhaust air mass flow, reflecting the current approach for single-speed single-duct portable air conditioners in Appendix CC. This revision removes a second term that accounted for infiltration air due to condenser inlet air, which does not impact the mass flow rate of infiltration air for single-duct units, because single-duct units intake condenser inlet air from indoors, unlike dual-duct portable air conditioners, which intake condenser inlet air from the outdoors.

DOE further requires in this Decision and Order, testing of the listed basic models in accordance with the instructions submitted by LG on July 8, 2019, regarding the compressor frequencies and control settings used at each test condition for each basic model.[15]

[15] The instructions provided by LG were marked as confidential and, as such, the instructions will be treated as confidential. The document is located in the docket at *https://www.regulations.gov/document?D=EERE-2018-BT-WAV-0007-0002*.

This Decision and Order applies only to the five basic models listed in the Order and does not extend to any other basic models. DOE evaluates and grants waivers for only those basic models specifically set out in the petition, not future models that may be manufactured by the petitioner. LG may request that DOE extend the scope of this waiver to include additional basic models that employ the same technology as those listed in the Order. 10 CFR 430.27(g). LG may also submit another petition for waiver from the test procedure for additional basic models that employ a different technology and meet the criteria for test procedure waivers. 10 CFR 430.27(a)(1).

DOE notes that it may modify or rescind the waiver at any time upon a determination that the factual basis underlying the petition for waiver is incorrect, or that the results from the alternate test procedure are unrepresentative of the basic models' true energy consumption characteristics. 10 CFR 430.27(k)(1). Likewise, LG may request that DOE rescind or modify the waiver if the company discovers an error in the information provided to DOE as part of its petition, determines that the waiver is no longer needed, or for other appropriate reasons. 10 CFR 430.27(k)(2).

As set forth above, the test procedure specified in this Decision and Order is not the same as the test procedure offered by LG. If LG believes that the alternate test method it suggested provides representative results and is less burdensome than the test method required by this Decision and Order, LG may submit a request for modification under 10 CFR 430.27(k)(2) that addresses the concerns that DOE has articulated about the procedure LG suggested. LG may also submit another less burdensome alternative test procedure not expressly considered in this notice under the same provision.

III. Consultations with Other Agencies

In accordance with 10 CFR 430.27(f)(2), DOE consulted with the Federal Trade Commission staff concerning the LG petition for waiver.

IV. Order

After careful consideration of all the material that LG and commenters submitted in this matter, it is **ORDERED** that:

(1) LG must, as of the date of publication of this Order in the *Federal Register*, test and rate the following portable air conditioner basic models with the alternate test procedure as set forth in paragraph (2):

Brand	**Basic Model**
LG Electronics USA, Inc	LP1419IVSM
LG Electronics USA, Inc	LP1419HVSM
LG Electronics USA, Inc	LP1219IVSM
LG Electronics USA, Inc	LP1019IVSM
LG Electronics USA, Inc	LP0819IVSM

(2) The alternate test procedure for the LG basic models listed in paragraph (1) of this Order is the test procedure for portable air conditioners prescribed by DOE at appendix CC to subpart B of 10 CFR part 430 (“Appendix CC”) and 10 CFR 430.23(dd), except: (i) Determine the combined energy efficiency ratio (“CEER”) as detailed below, and (ii) calculate the estimated annual operating cost in 10 CFR 430.23(dd)(2) as detailed below. In addition, for each basic model listed in paragraph (1), maintain compressor speeds at each test condition and set control settings for the variable components according to the instructions LG submitted to DOE (Docket No. EERE-2018-BT-WAV-0007-0002). Upon the compliance date of any new energy conservation standards for portable air conditioners, LG must report product-specific information pursuant to 10 CFR 429.12(b)(13) and 10 CFR 429.62(b). All other requirements of Appendix CC and DOE's other relevant regulations remain applicable.

In 10 CFR 430.23, in paragraph (dd) revise paragraph (2) to read as follows:

(2) Determine the estimated annual operating cost for a single-duct variable-speed portable air conditioner, expressed in dollars per year, by multiplying the following two factors:

(i) The sum of AEC_{95} multiplied by 0.2, AEC_{83} multiplied by 0.8, and AEC_T as measured in accordance with section 5.3 of appendix CC of this subpart; and

(ii) A representative average unit cost of electrical energy in dollars per kilowatt-hour as provided by the Secretary.

(iii) Round the resulting product to the nearest dollar per year.

In Appendix CC:

Add in Section 2, Definitions:

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

2.12 *Variable-speed* means a type of portable air conditioner that can automatically adjust the compressor speed based on detected conditions.

2.13 *Full compressor speed (full)* means the compressor speed specified by LG (Docket No. EERE-2018-BT-WAV-0007-0002) at which the unit operates at full load testing conditions.

2.14 *Low compressor speed (low)* means the compressor speed specified by LG (Docket No. EERE-2018-BT-WAV-0007-0002), at which the unit operates at low load test conditions, such that $Capacity_{Low}$, the measured cooling capacity at this speed at the test condition in Table 1 of this appendix, is no less than 50 percent and no greater than 60 percent of $Capacity_{Full}$, the measured cooling capacity with the full compressor speed at the test condition in Table 1 of this appendix.

2.15 *Theoretical comparable single-speed portable air conditioner* means a theoretical single-speed portable air conditioner with the same cooling capacity and electrical power input as the single-duct variable-speed portable air conditioner under test, with no cycling losses considered, when operating with the full compressor speed and at the test conditions in Table 1 of this appendix.

Add to the end of Section 3.1.2, *Control settings*:

Set the compressor speed during cooling mode testing as described in section 4.1 of this appendix, as amended by this Order.

Replace Section 4.1, *Cooling mode* with the following:

Cooling mode. Instead of the test conditions in Table 3 of ANSI/AHAM PAC-1-2015, establish the test conditions presented in Table 1 of this appendix. Test each sample unit twice, once at each test condition in Table 1. For each test condition, measure the sample unit's indoor room cooling capacity and overall power input in cooling mode in accordance with Section 7.1.b and 7.1.c of ANSI/AHAM PAC-1-2015 (incorporated by reference; see § 430.3), respectively, and determine the test duration in accordance with Section 8.7 of ASHRAE Standard 37-2009 (incorporated by reference; § 430.3). Conduct the first test in accordance with ambient conditions for Test Condition 1 in Table 1 of this appendix, with the compressor speed set to full, for the duration of cooling mode testing ($Capacity_{Full}$, P_{Full}), which represents an outdoor temperature operating condition of 95 °F dry-bulb and 67 °F wet-bulb temperatures. Conduct the second test in accordance with the ambient conditions for Test Condition 2, in Table 1 of this appendix, with the compressor speed set to low, for the duration of cooling mode testing ($Capacity_{Low}$, P_{Low}), which represents an outdoor temperature operating condition of 83 °F dry-bulb and 67.5 °F wet-bulb temperatures. Set the compressor speed required for each test condition in accordance with the instructions LG submitted to DOE (Docket No. EERE-2018-BT-WAV-0007-0002).

TABLE 1—EVAPORATOR AND CONDENSER (INDOOR) INLET TEST CONDITIONS

Test Condition	Evaporator and Condenser Inlet Air °F (°C)		Compressor Speed
	Dry Bulb	**Wet Bulb**	
Test Condition 1	80 (26.7)	67 (19.4)	Full
Test Condition 2	80 (26.7)	67 (19.4)	Low

Replace the provisions in Section 4.1.1, *Duct Heat Transfer* that follow "j represents the condenser exhaust duct and, for dual-duct units, the condenser exhaust duct and the condenser inlet duct." to read as follows:

Calculate the total heat transferred from the surface of the condenser exhaust duct to the indoor conditioned space while operating in cooling mode at each test condition in Table 1 of this appendix, as follows:

$Q_{duct\_Full} = 3 \times A_{duct} \times (T_{duct\_Full} - T_{ei})$

$Q_{duct\_Low} = 3 \times A_{duct} \times (T_{duct\_Low} - T_{ei})$

Where:

Q_{duct_Full} and Q_{duct_Low} = the total heat transferred from the condenser exhaust duct to the indoor conditioned space in cooling mode, in Btu/h, when tested at Test Condition 1 and Test Condition 2 in Table 1 of this appendix, respectively.

3 = convection coefficient in Btu/h per square foot per °F.

A_{duct} = surface area of the condenser exhaust duct, in square feet.

T_{duct_Full} and T_{duct_Low} = average surface temperature for the condenser exhaust duct, as measured at Test Condition 1 and Test Condition 2 in Table 1 of this appendix, respectively, as required in section 4.1 of this appendix.

T_{ei} = average evaporator inlet air dry-bulb temperature, as measured in this section, in °F.

Replace Section 4.1.2, *Infiltration Air Heat Transfer* with the following:

Infiltration Air Heat Transfer. Calculate the sample unit's heat contribution from infiltration air into the conditioned space for both cooling mode tests, which represent the 95 °F and the 83 °F dry-bulb outdoor temperature operating conditions, as described in this section. Calculate the dry air mass flow rate of infiltration air according to the following equations:

$$\dot{m}_{95} = \frac{V_{co\_Full} \times \rho_{co\_Full}}{(1 + \omega_{co\_Full})}$$

$$\dot{m}_{83} = \frac{V_{co\_Low} \times \rho_{co\_Low}}{(1 + \omega_{co\_Low})}$$

Where:

$\dot{m}_{95}$ and $\dot{m}_{83}$ = dry air mass flow rate of infiltration air, as calculated for Test Condition 1 and Test Condition 2 in Table 1 of this appendix, representative of the 95 °F and 83 °F dry-bulb outdoor temperature operating conditions, respectively, in pounds per minute (lb/m).

V_{co_Full} and V_{co_Low} = average volumetric flow rate of the condenser outlet air as determined in section 4.1 of this appendix, during cooling mode testing for Test Condition 1 and Test Condition 2 in Table 1 of this appendix, respectively, in cubic feet per minute (cfm).

ρ_{co_Full} and ρ_{co_Low} = average density of the condenser outlet air as determined in section 4.1 of this appendix, during cooling mode testing at Test Condition 1 and Test Condition 2 in Table 1 of this appendix, respectively, in pounds mass per cubic foot (lb_m/ft^3).

ω_{co_Full} and ω_{co_Low} = average humidity ratio of condenser outlet air as determined in section 4.1 of this appendix, during cooling mode testing at Test Condition 1 and Test Condition 2 in Table

1 of this appendix , respectively, in pounds mass of water vapor per pounds mass of dry air (lb_w/lb_{da}).

Replace Section 5.1, *Adjusted Cooling Capacity* with the following:

Adjusted Cooling Capacity. Calculate the adjusted cooling capacity at each outdoor temperature operating condition, ACC_{95} and $ACC_{83,}$ expressed in Btu/h, according to the following equations:

$$ACC_{95} = Capacity_{Full} - Q_{duct\_Full} - Q_{infiltration\_95}$$

$$ACC_{83} = Capacity_{Low} - Q_{duct\_Low} - Q_{infiltration\_83}$$

Where:

$Capacity_{Full}$ and $Capacity_{Low}$ = cooling capacity, as measured in section 4.1 of this appendix, at Test Condition 1 and Test Condition 2 in Table 1 of this appendix, respectively, in Btu/h.

Q_{duct_Full} and Q_{duct_Low} = duct heat transfer while operating in cooling mode as calculated in section 4.1.1 of this appendix.

$Q_{infiltration\_95}$ and $Q_{infiltration\_83}$ = total infiltration air heat transfer in cooling mode as calculated in section 4.1.2 of this appendix, representative of the 95 °F and 83 °F dry-bulb outdoor temperature operating conditions, respectively, in Btu/h.

Replace Section 5.3, *Annual Energy Consumption* with the following:

Annual Energy Consumption. Calculate the sample unit's annual energy consumption in each operating mode according to the equation below. Use the following annual hours of operation and equation for each operating mode:

Operating Mode	Subscript	Annual Operating Hours
Cooling Mode, Full[1]	full	750
Cooling Mode, Low[1]	low	750
Off-Cycle	oc	880
Inactive or Off	ia or om	1,355

[1] These operating mode hours are for the purposes of calculating annual energy consumption under different ambient conditions and are not a division of the total cooling mode operating hours. The total cooling mode operating hours are 750 hours.

$$AEC_m = P_m \times t_m \times 0.001$$

Where:

AEC_m = annual energy consumption in each operating mode, in kWh/year.

P_m = average power in each operating mode, in watts.

m represents the operating mode ("Full" and "Low" cooling mode compressor speeds that represent operation at 95 °F and 83 °F dry-bulb outdoor temperature operating conditions, respectively, "oc" off-cycle, and "ia" inactive or "om" off mode).

t_m = number of annual operating time in each operating mode, in hours.

0.001 kWh/Wh = conversion factor from watt-hours to kilowatt-hours.

Calculate the sample unit's total annual energy consumption in off cycle mode and inactive or off mode according to the equation below:

$$AEC_T = \sum_m AEC_m$$

Where:

AEC_T = total annual energy consumption attributed to off cycle mode and inactive or off mode, in kWh/year;

AEC_m = total annual energy consumption in each operating mode, in kWh/year.

m represents the operating modes, off cycle mode and inactive or off mode.

Replace Section 5.4, *Combined Energy Efficiency Ratio* with the following:

Unadjusted Combined Energy Efficiency Ratio. Using the annual operating hours, as outlined in section 5.3 of this appendix, calculate the sample unit's unadjusted combined energy efficiency ratio, $CEER_{UA,}$ expressed in Btu/Wh, according to the following equation:

$$CEER_{UA} = \left[\frac{ACC_{95}}{\left(\frac{AEC_{Full} + AEC_T}{750 \times 0.001}\right)}\right] \times 0.2 + \left[\frac{ACC_{83}}{\left(\frac{AEC_{Low} + AEC_T}{750 \times 0.001}\right)}\right] \times 0.8$$

Where:

$CEER_{UA}$ = unadjusted combined energy efficiency ratio for the sample unit, in Btu/Wh.

ACC_{95} and ACC_{83} = adjusted cooling capacity, tested at Test Condition 1 and Test Condition 2 in Table 1 of this appendix, respectively, that are representative of operation at the 95 °F and 83 °F dry-bulb outdoor temperature operating conditions, respectively, as calculated in section 5.1 of this appendix, in Btu/h.

AEC_{Full} and AEC_{Low} = annual energy consumption for cooling mode operation at Test Condition 1 and Test Condition 2 in Table 1 in this appendix that represent operation at 95 °F and 83 °F dry-bulb outdoor temperature operating conditions, respectively, as calculated in section 5.3 of this appendix, in kWh/year.

AEC_T = total annual energy consumption attributed to off cycle mode and inactive or off mode, in kWh/year, calculated in section 5.3 of this appendix.

750 = number of cooling mode hours per year

0.001 kWh/Wh = conversion factor for watt-hours to kilowatt-hours.

0.2 = weighting factor for the 95 °F dry-bulb outdoor temperature operating condition.

0.8 = weighting factor for the 83 °F dry-bulb outdoor temperature operating condition.

Add after Section 5.4, *Combined Energy Efficiency Ratio:*

5.5 *Adjustment of the Combined Energy Efficiency Ratio.* Adjust the sample unit's combined energy efficiency ratio as follows.

5.5.1 *Theoretical Comparable Single-Speed Portable Air Conditioner Cooling Capacity and Power at the Lower Outdoor Temperature Operating Condition.* Calculate the cooling capacity and cooling capacity with cycling losses, expressed in British thermal units per hour (Btu/h), and electrical power input, expressed in watts, for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition.

$Capacity_{83\_SS} = Capacity_{Full}$

$Capacity_{83\_SS\_CLF} = Capacity_{Full} \times 0.875$

$P_{83\_SS} = P_{Full}$

Where:

$Capacity_{83\_SS}$ = theoretical comparable single-speed portable air conditioner cooling capacity, in Btu/h, calculated for the 83 °F dry-bulb outdoor temperature operating condition.

$Capacity_{83\_SS\_CLF}$ = theoretical comparable single-speed portable air conditioner cooling capacity with cycling losses, in Btu/h, calculated for the 83 °F dry-bulb outdoor temperature operating condition.

$Capacity_{Full}$ = cooling capacity, in Btu/h, measured in section 4.1 of this appendix at Test Condition 1 in Table 1 of this appendix.

P_{83_SS} = theoretical comparable single-speed portable air conditioner electrical power input, in watts, calculated for the 83 °F dry-bulb outdoor temperature operating condition.

P_{Full} = electrical power input, in watts, measured in section 4.1 of this appendix at Test Condition 1 in Table 1 of this appendix.

0.875 = cycling loss factor for the 83 °F dry-bulb outdoor temperature operating condition.

5.5.2 *Duct Heat Transfer for a Theoretical Comparable Single-Speed Portable Air Conditioner at the Lower Outdoor Temperature Operating Condition.* Calculate the condenser exhaust duct heat transfer to the conditioned space for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, as follows:

$$Q_{duct\_83\_SS} = 3 \times A_{duct} \times (T_{duct\_Full} - T_{ei})$$

Where:

$Q_{duct\_83\_SS}$ = total heat transferred from the condenser exhaust duct to the indoor conditioned space in cooling mode, for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, in Btu/h.

3 = convection coefficient, in Btu/h per square foot per °F.

A_{duct} = surface area of the condenser exhaust duct, as calculated in section 4.1.1 of this appendix, in square feet.

T_{duct_Full} = average surface temperature for the condenser exhaust duct, as measured in section 4.1.1 of this appendix at Test Condition 1 in Table 1 of this appendix, in °F.

T_{ei} = average evaporator inlet air dry-bulb temperature, measured in section 4.1.1 of this appendix, in °F.

5.5.3 *Infiltration Air Heat Transfer for a Theoretical Comparable Single-Speed Portable Air Conditioner at the Lower Outdoor Temperature Operating Condition.* Calculate the heat contribution from infiltration air for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, as described in this section. Calculate the dry air mass flow rate of infiltration air according to the following equation:

$$\dot{m}_{83\_SS} = \frac{V_{co\_Full} \times \rho_{co\_Full}}{\left(1 + \omega_{co\_Full}\right)}$$

Where:

$\dot{m}_{83\_SS}$ = dry air mass flow rate of infiltration air for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, in lb/m.

V_{co_Full} = actual average volumetric flow rate of the condenser outlet air, as determined in section 4.1 of this appendix during cooling mode testing with the full compressor speed at Test Condition 1 in Table 1 of this appendix, in cfm.

ρ_{co_Full} = actual average density of the condenser outlet air, as determined in section 4.1 of this appendix during cooling mode at Test Condition 1 in Table 1 of this appendix, in lb_m/ft^3

ω_{co_Full}= average humidity ratio of condenser outlet air, as determined in section 4.1 of this appendix during cooling mode testing at Test Condition 1 in Table 1 of this appendix, in pounds mass of water vapor per pounds mass of dry air (lb_w/lb_{da}).

Calculate the sensible component of infiltration air heat contribution for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition as follows:

$Q_{s\_83\_SS} = \dot{m}_{83\_SS} \times 60 \times [(0.24 \times (T_{ia\_83} - 80)) + (0.444 \times (0.01086 \times T_{ia\_83} - 0.0112 \times 80))]$

Where:

$Q_{s\_83\_SS}$ = sensible heat added to the room by infiltration air for a theoretical comparable single-speed portable air conditioner, at the 83 °F dry-bulb outdoor temperature operating condition, in Btu/h.

0.24 $Btu/lb_m - °F$ = specific heat of dry air.

0.444 $Btu/lb_m - °F$ = specific heat of water vapor.

80 = indoor chamber dry-bulb temperature, in °F.

T_{ia_95} and T_{ia_83} = infiltration air dry-bulb temperatures for the 95 °F and the 83 °F dry-bulb outdoor temperature operating conditions, 95 °F and 83 °F, respectively.

0.01086 = ω_{ia_83} = humidity ratio of the infiltration air for the 83 °F dry-bulb outdoor temperature operating condition, in lb_w/lb_{da}.

0.0112 = humidity ratio of the indoor chamber air at Test Condition 1 in Table 1 of this appendix, in lb_w/lb_{da}.

60 = conversion factor from minutes to hours.

$\dot{m}_{83\_SS}$ as previously calculated in this section.

Calculate the latent component of infiltration air heat contribution for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition as follows:

$$Q_{l\_83\_SS} = \dot{m}_{83\_SS} \times 63660 \times (\omega_{ia\_83} - 0.0112)$$

Where:

$Q_{l\_83\_SS}$ = latent heat added to the room by infiltration air for a theoretical comparable single-speed portable air conditioner, at the 83 °F dry-bulb outdoor temperature operating condition, in Btu/h.

63660 Btu−m/lb_m–h = latent heat of vaporization for water vapor, 1060 Btu/lb_m, multiplied by the conversion factor from minutes to hours, 60 m/h.

0.0112 lb_w/lb_{da} = humidity ratio of the indoor chamber air.

$\dot{m}_{83\_SS}$ and ω_{ia_83} as previously calculated and defined, respectively, in this section.

Calculate the total heat contribution of the infiltration air for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition according to the following equation:

$$Q_{infiltration\_83\_SS} = Q_{s\_83\_SS} + Q_{l\_83\_SS}$$

Where:

$Q_{infiltration\_83\_SS}$ = total infiltration air heat in cooling mode for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, in Btu/h.

$Q_{s\_83\_SS}$, $Q_{l\_83\_SS}$ as previously calculated in this section

5.5.4 *Adjusted Cooling Capacity for a Theoretical Comparable Single-Speed Portable Air Conditioner at the Lower Outdoor Temperature Operating Condition.* Calculate the adjusted cooling capacity for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition without cycling losses, ACC_{83_SS}, and with cycling losses, $ACC_{83\_SS\_CLF}$, in Btu/h, according to the following equations:

$$ACC_{83\_SS} = Capacity_{83\_SS} - Q_{duct\_83\_SS} - Q_{infiltration\_83\_SS}$$

$$ACC_{83\_SS\_CLF} = Capacity_{83\_SS\_CLF} - Q_{duct\_83\_SS} - Q_{infiltration\_83\_SS}$$

Where:

ACC_{83_SS} and $ACC_{83\_SS\_CLF}$ = adjusted cooling capacity for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition without and with cycling losses, respectively, in Btu/h.

$Capacity_{83\_SS}$ and $Capacity_{83\_SS\_CLF}$ = theoretical comparable single-speed portable air conditioner cooling capacity without and with cycling losses, respectively, in Btu/h, at the 83 °F dry-bulb outdoor temperature operating condition, calculated in section 5.5.1 of this appendix.

$Q_{duct\_83\_SS}$ = total heat transferred from the ducts to the indoor conditioned space in cooling mode for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, in Btu/h, calculated in section 5.5.2 of this appendix.

$Q_{infiltration\_83\_SS}$ = total infiltration air heat in cooling mode for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, in Btu/h, calculated in section 5.5.3 of this appendix.

5.5.5 *Annual Energy Consumption in Cooling Mode for a Theoretical Comparable Single-Speed Portable Air Conditioner at the Lower Outdoor Temperature Operating Condition.* Calculate the annual energy consumption in cooling mode for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition, in kWh/year, according to the following equation:

$$AEC_{83\_SS} = P_{83\_SS} \times 750 \times 0.001$$

Where:

AEC_{83_SS} = annual energy consumption for a theoretical comparable single-speed portable air conditioner in cooling mode at the 83 °F dry-bulb outdoor temperature operating condition, in kWh/year.

P_{83_SS} = electrical power input for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition as calculated in section 5.5.1 of this appendix, in watts.

750 = number of cooling mode hours per year, as defined in section 5.3 of this appendix.

0.001 kWh/Wh = conversion factor from watt-hours to kilowatt-hours.

5.5.6 *Combined Energy Efficiency Ratio for a Theoretical Comparable Single-Speed Portable Air Conditioner.* Calculate the combined energy efficiency ratio for a theoretical comparable single-speed portable air conditioner without cycling losses, $CEER_{SS}$, and with cycling losses, $CEER_{SS\_CLF}$, in Btu/Wh, according to the following equations:

$$CEER_{SS} = \left[\frac{ACC_{95}}{\left(\frac{AEC_{Full} + AEC_{T}}{750 \times 0.001}\right)}\right] \times 0.2 + \left[\frac{ACC_{83\_SS}}{\left(\frac{AEC_{83\_SS} + AEC_{T}}{750 \times 0.001}\right)}\right] \times 0.8$$

$$CEER_{SS\_CLF} = \left[\frac{ACC_{95}}{\left(\frac{AEC_{Full} + AEC_{T}}{750 \times 0.001}\right)}\right] \times 0.2 + \left[\frac{ACC_{83\_SS\_CLF}}{\left(\frac{AEC_{83\_SS} + AEC_{T}}{750 \times 0.001}\right)}\right] \times 0.8$$

Where:

$CEER_{SS}$ and $CEER_{SS\_CLF}$ = combined energy efficiency ratio for a theoretical comparable single-speed portable air conditioner without and with cycling losses considered, respectively, in Btu/Wh.

ACC_{95} = adjusted cooling capacity for the sample unit, as calculated in section 5.1 of this appendix, when tested at Test Condition 1 in Table 1 of this appendix that is representative of operation at the 95 °F dry-bulb outdoor temperature operating condition, in Btu/h.

ACC_{83_SS} and $ACC_{83\_SS\_CLF}$ = adjusted cooling capacity for a theoretical comparable single-speed portable air conditioner at the 83 °F dry-bulb outdoor temperature operating condition without and with cycling losses, respectively, as calculated in section 5.5.4 of this appendix, in Btu/h.

AEC_{Full} = annual energy consumption for the sample unit, as calculated in section 5.3 of this appendix, for cooling mode operation at Test Condition 1 in Table 1 of this appendix that represents operation at a 95 °F dry-bulb outdoor temperature operating condition, in kWh/year.

AEC_{83_SS} = annual energy consumption for a theoretical comparable single-speed portable air conditioner in cooling mode at the 83 °F dry-bulb outdoor temperature operating condition, calculated in section 5.5.5 of this appendix, in kWh/year.

AEC_T = total annual energy consumption attributed to all operating modes except cooling for the sample unit, calculated in section 5.3 of this appendix, in kWh/year.

750 and 0.001 as defined previously in this section.

0.2 = weighting factor for the 95 °F dry-bulb outdoor temperature operating condition.

0.8 = weighting factor for the 83 °F dry-bulb outdoor temperature operating condition.

5.5.7 *Single-Duct Variable-Speed Portable Air Conditioner Performance Adjustment Factor*. Calculate the sample unit's performance adjustment factor, F_p, according to the following equation:

$$F_p = \frac{(CEER_{SS} - CEER_{SS\_CLF})}{CEER_{SS\_CLF}}$$

Where:

$CEER_{SS}$ and $CEER_{SS\_CLF}$ = combined energy efficiency ratio for a theoretical comparable single-speed portable air conditioner without and with cycling losses considered, respectively, calculated in section 5.5.6 of this appendix, in Btu/Wh.

5.5.8 *Single-Duct Variable-Speed Portable Air Conditioner Combined Energy Efficiency Ratio.* Calculate the sample unit's final combined energy efficiency ratio, CEER, in Btu/Wh, according to the following equation:

$$CEER = CEER_{UA} \times (1 + F_p)$$

Where:

CEER = combined energy efficiency ratio for the sample unit, in Btu/Wh.

$CEER_{UA}$ = unadjusted combined energy efficiency ratio for the sample unit, calculated in section 5.4 of this appendix, in Btu/Wh.

F_p = sample unit's performance adjustment factor, determined in section 5.5.7 of this appendix."

(3) *Representations*. LG may not make representations about the efficiency of any basic model listed in paragraph (1) of this Order for any purpose, including compliance and marketing, unless the basic model has been tested in accordance with the provisions set forth above and such representations fairly disclose the results of such testing..

(4) This waiver shall remain in effect according to the provisions of 10 CFR 430.27.

(5) DOE issues this waiver on the condition that the statements, representations, and information provided by LG are valid. If LG makes any modifications to the controls or configurations of a

basic model subject to this waiver, such modifications will render the waiver invalid with respect to that basic model, and LG will either be required to use the current Federal test procedure or submit a new application for a test procedure waiver. DOE may rescind or modify this waiver at any time if it determines the factual basis underlying the petition for waiver is incorrect, or the results from the alternate test procedure are unrepresentative of a basic model's true energy consumption characteristics. 10 CFR 430.27(k)(1). Likewise, LG may request that DOE rescind or modify the waiver if LG discovers an error in the information provided to DOE as part of its petition, determines that the waiver is no longer needed, or for other appropriate reasons. 10 CFR 430.27(k)(2).

(6) LG remains obligated to fulfill the certification requirements set forth at 10 CFR part 429.

Signed in Washington, DC, on May 8, 2020.

Alexander N. Fitzsimmons,
Deputy Assistant Secretary,
for Energy Efficiency
Energy Efficiency and Renewable Energy.

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