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[6450-01-P]

DEPARTMENT OF ENERGY

10 CFR Parts 429 and 430

[Docket No. EERE-2014-BT-TP-0010]

RIN: 1904-AC80

Energy Conservation Program: Test Procedures for Dehumidifiers

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

ACTION: Final rule.

SUMMARY: On May 21, 2014, the U.S. Department of Energy (DOE) published a notice of proposed rulemaking (NOPR) to amend the test procedures for dehumidifiers. On February 4, 2015, DOE published a supplemental notice of proposed rulemaking (SNOPR) to amend the proposed test procedure for dehumidifiers. Those proposed rulemakings serve as the basis for this action. DOE is issuing a final rule to revise its test procedure for dehumidifiers established under the Energy Policy and Conservation Act, codified in Title 10 of the Code of Federal Regulations (CFR), part 430, subpart B, appendix X, and establish a new test procedure for dehumidifiers in a new appendix X1. The amendments to the test procedure in appendix X provide technical clarifications and repeatability improvements, and do not significantly modify the current test setup, conduct, or results. The new test procedure in appendix X1 includes: (1) separate provisions for testing whole-home dehumidifiers (both refrigerant-only and refrigerant-desiccant types) with a ducted test setup; (2) new dry-bulb temperature test conditions for both

portable and whole-home dehumidifiers; (3) an updated definition for off-cycle mode; and (4) additional clarifications and adjustments.

DATES: The effective date of this rule is **[INSERT DATE 30 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**.

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 www.regulations.gov. All documents in the docket are listed in the 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: http://www.regulations.gov/#!docketDetail;D=EERE-2014-BT-TP-0010. This webpage will contain a link to the docket for this notice on the www.regulations.gov site. The www.regulations.gov webpage will contain simple instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact Ms. Brenda Edwards at (202) 586-2945 or by email: Brenda.Edwards@ee.doe.gov.

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SUPPLEMENTARY INFORMATION:

This final rule incorporates by reference into part 430 the following industry standards:

(1) American National Standards Institute (ANSI)/American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) Standard 41.1-2013, Standard Method for Temperature Measurement, ASHRAE approved January 29, 2013, ANSI approved January 30, 2013.

Copies of ANSI/ASHRAE Standard 41.1-2013 can be obtained from the American National Standards Institute at 25 W 43rd Street 4th Floor, New York, NY 10036, or by going to http://webstore.ansi.org/RecordDetail.aspx?sku=ANSI%2FASHRAE+Standard+41.1-2013.

(2) ANSI/ASHRAE 51-07/ANSI/Air Movement and Control Association International, Inc. (AMCA) 210-07, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating, AMCA approved July 28, 2006, ANSI approved August 17, 2007, ASHRAE approved March 17, 2008.

Copies of ANSI/AMCA 210-07 can be obtained from the Air Movement and Control Association International, Inc. at 30 West University Drive, Arlington Heights, IL 60004, or by going to http://www.amca.org/store/item.aspx?ItemId=81.

See section IV.N for additional information on these industry standards.

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I. Authority and Background

Title III of the Energy Policy and Conservation Act of 1975 (42 U.S.C. 6291, et seq.; "EPCA" or "the Act") sets forth a variety of provisions designed to improve energy efficiency.[1] Part B of title III establishes the "Energy Conservation Program for Consumer Products Other Than Automobiles."[2] These consumer products include dehumidifiers, the subject of this rule. (42 U.S.C. 6295(cc))

[1] All references to EPCA refer to the statute as amended through the Energy Efficiency Improvement Act of 2015, Pub. L. 114-11 (Apr. 30, 2015).
[2] For editorial reasons, Part B was redesignated as Part A upon incorporation into the U.S. Code.

Under EPCA, the energy conservation program consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and enforcement procedures. 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, and (2) making representations about the efficiency of those products. Similarly, DOE must use these test procedures to determine whether the products comply with any relevant standards promulgated under EPCA.

A. General Test Procedure Rulemaking Process

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))

In addition, if DOE determines that a test procedure amendment is warranted, it must publish proposed test procedures and offer the public an opportunity to present oral and written comments on them. (42 U.S.C. 6293(b)(2)) Finally, in any rulemaking to amend a test procedure, DOE must determine to what extent, if any, the proposed test procedure would alter the measured energy efficiency of any covered product as determined under the existing test procedure. (42 U.S.C. 6293(e)(1))

B. Current Dehumidifier Test Procedure

The DOE test procedure for dehumidifiers is found at 10 CFR part 430, subpart B, appendix X. EPCA specifies that the dehumidifier test criteria used under the ENERGY STAR program in effect as of August 8, 2005,[3] must serve as the basis for the DOE test procedure for dehumidifiers, unless revised by DOE. (42 U.S.C. 6293(b)(13)) The ENERGY STAR test criteria, effective on August 8, 2005, required that ANSI/Association of Home Appliance Manufacturers (AHAM) Standard DH-1, "Dehumidifiers," be used to measure capacity while the Canadian Standards Association (CAN/CSA) standard CAN/CSA-C749-1994 (R2005), "Performance of Dehumidifiers," be used to calculate the energy factor (EF). The version of AHAM Standard DH-1 in use at the time the ENERGY STAR test criteria were adopted was AHAM Standard DH-1-1992. DOE adopted these test criteria, along with related definitions and tolerances, as its test procedure for dehumidifiers at 10 CFR part 430, subpart B, appendix X in 2006. 71 FR 71340, 71347, 71366–68 (Dec. 8, 2006).

On October 31, 2012, DOE published a final rule to establish a new test procedure for dehumidifiers that references ANSI/AHAM Standard DH-1-2008, "Dehumidifiers," (ANSI/AHAM DH-1-2008) for both energy use and capacity measurements. 77 FR 65941. The final rule also adopted standby and off mode provisions that satisfy the requirement in EPCA for DOE to include measures of standby mode and off mode energy consumption in its test procedures for residential products, if technically feasible. (42 U.S.C. 6295(gg)(2)(A)) This new DOE test procedure, codified at that time at 10 CFR part 430, subpart B, appendix X1 (appendix

[3] "Energy Star Program Requirements for Dehumidifiers," Version 1.0, U.S. Environmental Protection Agency (Available at: www.energystar.gov/products/specs/system/files/DehumProgReqV1.0.pdf).

X1), established a new metric, integrated energy factor (IEF), which incorporates measures of active, standby, and off mode energy use.

DOE subsequently removed the existing test procedures at appendix X and redesignated the test procedures at appendix X1 as appendix X. 79 FR 7366 (Feb. 7, 2014). Any representations of energy use, including standby mode or off mode energy consumption or efficiency of portable dehumidifiers must currently be made in accordance with the results of testing pursuant to the redesignated appendix X.

C. Current Dehumidifier Test Procedure Rulemaking

1. The May 2014 NOPR

On May 21, 2014, DOE published a NOPR (hereinafter referred to as the May 2014 NOPR) in which it proposed to revise its existing test procedure for dehumidifiers in redesignated appendix X by adding clarifications for equipment setup during testing and correcting the calculations of active mode energy use and IEF. The NOPR also proposed to establish a new appendix, appendix X1, that would require certain active mode testing at a lower ambient dry-bulb temperature, account for fan-only mode energy consumption in the IEF metric, and include testing methodology and measures of performance for whole-home dehumidifiers. DOE also proposed to amend 10 CFR parts 429 and 430 to add clarifying definitions of covered products, amend the certification requirements, add verification instructions for capacity measurement, and make certain editorial corrections. 79 FR 29271 (May 21, 2014). DOE held a public meeting on June 13, 2014, to request comment on the May 2014 NOPR, and accepted written comments, data, and information related to the proposal until August 4, 2014.

2. The February 2015 SNOPR

On February 4, 2015, DOE published an SNOPR (hereinafter referred to as the February 2015 SNOPR) proposing additions and clarifications to the dehumidifier test procedure previously proposed in the May 2014 NOPR. These proposals updated the whole-home dehumidifier test setup and conduct, introduced a method to determine whole-home dehumidifier case volume for product class differentiation, revised the off-cycle mode definition to incorporate the originally proposed fan-only mode, updated the combined low power mode energy use equations, provided a clarification to the relative humidity and capacity equations in ANSI/AHAM DH-1-2008, "Dehumidifiers" (ANSI/AHAM DH-1-2008) incorporated by reference, and included other additional technical corrections and clarifications. Other than the specific amendments newly proposed in the SNOPR, DOE continued to propose the test procedure amendments originally included in the May 2014 NOPR. 80 FR 5994 (Feb. 4, 2015).

II. Summary of the Final Rule

In this final rule, DOE establishes amendments to various sections in 10 CFR part 429 that are associated with certification, compliance, and enforcement for dehumidifiers. These amendments update 10 CFR 429.36 with requirements for determining capacity for a basic model and the certification reporting requirements. This final rule also updates 10 CFR 429.134 to include information about verification of capacity for enforcement purposes.

This final rule also establishes amendments to various sections in 10 CFR part 430. These amendments include: (1) revising the dehumidifier definitions and adding new definitions for various dehumidifier configurations (portable, refrigerant-desiccant, and whole-home) in 10 CFR 430.2; (2) incorporating by reference new materials necessary for testing whole-home and refrigerant-desiccant dehumidifiers in 10 CFR 430.3; (3) and identifying in 10 CFR 430.23 the sections in the test procedure appendices used to determine capacity and IEF.

This final rule also establishes specific clarifications and amendments to the dehumidifier test procedure codified in appendix X. These include: (1) new definitions for dehumidification mode and product capacity; (2) revisions to the test apparatus and general instructions section to provide guidance for the minimum number of psychrometers required when testing multiple units simultaneously; clarify psychrometer placement in relation to the unit with special instruction for those units with multiple air intake grilles; provide condensate collection setup with additional details for those units without gravity fed drains or pumps; specify required control settings for the dehumidification setting and fan speed; and include rounding requirements when calculating results; (3) revisions to the test measurement section to harmonize with the newly proposed dehumidification mode; and (4) updated equations and various editorial clarifications in the calculation of results section. The modifications to the test setup and test conduct in appendix X are intended to improve reproducibility and should not significantly impact test results.

Finally, this final rule establishes a new test procedure for dehumidifiers at appendix X1 to 10 CFR part 430. The test procedure at appendix X1: (1) incorporates provisions for representative test setup and test conduct for whole-home dehumidifiers; (2) reduces the test room ambient dry-bulb temperature for portable dehumidifiers to 65 degrees Fahrenheit (°F), and for whole-home dehumidifiers, to 73 °F; (3) modifies the definition for off-cycle mode to incorporate fan operation when the compressor has cycled off; (4) introduces a test procedure for off-cycle mode; (5) incorporates instructions for determining whole-home dehumidifier case volume; and (6) introduces various adjustments to further improve repeatability and reproducibility while minimizing test burden.

III. Discussion

A. Covered Products and Definitions

1. Dehumidifier Definition

EPCA defines a dehumidifier as a self-contained, electrically operated, and mechanically encased assembly consisting of –

a) a refrigerated surface (evaporator) that condenses moisture from the atmosphere;

b) a refrigerating system, including an electric motor;

c) an air-circulating fan; and

d) means for collecting or disposing of the condensate.

42 U.S.C. 6291(34).

In the May 2014 NOPR, DOE proposed to amend the dehumidifier definition codified at 10 CFR 430.2 to specifically exclude portable air conditioners and room air conditioners, two other products that may provide dehumidification functions. DOE explained that the primary function of an air conditioner is to provide cooling by removing both sensible and latent heat, while a dehumidifier is intended to remove only latent heat. 79 FR 29271, 29291 (May 21, 2014). DOE also proposed to correct the definition of dehumidifier currently codified at 10 CFR 430.2 to remove the term “refrigerated” between the terms “mechanically” and “encased” for consistency with the EPCA definition. Id.

In response to the May 2014 NOPR, Aprilaire noted that EPCA's definition of dehumidifier is too broad, and encompasses a wide range of products that also have a dehumidification mode, such as portable, room, and central air conditioners, as well as refrigerators for which dehumidification is not the intended use. Thus, Aprilaire stated that DOE should provide a clearer definition of what constitutes a dehumidifier. (Aprilaire, No. 5 at p. 2[4]) Aprilaire further contended that DOE's proposal would subject one method of whole-home humidity control to a test procedure for dehumidifiers, while air conditioners, also a method of whole-home dehumidification control, are subject to a different test procedure. (Aprilaire, Public Meeting Transcript, No. 10 at pp. 18–20[5])

DOE notes that it proposed a dehumidifier definition specifically excluding portable air conditioners and room air conditioners because the primary function of an air conditioner is to provide cooling by removing both sensible and latent heat, while a dehumidifier removes moisture (i.e., only latent heat). Moreover, Congress has already established energy conservation standards for consumer refrigerators, room air conditioners, and central air conditioners separately under EPCA (42 U.S.C. 6295(b), (c), and (d)), and DOE is currently considering new standards for portable air conditioners in a separate rulemaking.

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[4] A notation in the form "Aprilaire, Public Meeting Transcript, No. 10 at pp. 18–20" identifies an oral comment that DOE received during the June 13, 2014, NOPR public meeting, was recorded in the public meeting transcript in the docket for this test procedure rulemaking (Docket No. EERE-2014-BT-TP-0010), and is available for review at www.regulations.gov. This particular notation refers to a comment (1) made by Aprilaire, Inc. during the public meeting; (2) recorded in document number 10, which is the public meeting transcript that is filed in the docket of this test procedure rulemaking; and (3) which appears on pages 18–20 of document number 10.

[5] A notation in the form "Aprilaire, No. 5 at p. 2" identifies a written comment: (1) made by Aprilaire, Inc.; (2) recorded in document number 5 that is filed in the docket of this test procedure rulemaking (Docket No. EERE–2014– BT–TP–0010) and available for review at www.regulations.gov; and (3) which appears on page 2 of document number 5.

In the February 2015 SNOPR, DOE further proposed that packaged terminal air conditioners be excluded in the dehumidifier definition for similar reasons of clarification. 80 FR 5994, 6005 (Feb. 4, 2015). AHAM did not oppose the definition for dehumidifier proposed in the February 2015 SNOPR. (AHAM, No. 16 at p. 7)

Therma-Stor expressed concern that excluding classes of equipment based upon generic descriptions may exclude or eliminate certain new designs that may be more efficient for some applications than existing designs. Therma-Stor noted that traditional dehumidifier designs convert latent heat into sensible heat within a single process air stream. However, recent designs such as split-dehumidifiers and refrigerant-desiccant dehumidifiers may transfer sensible and/or latent heat between air streams within the conditioned space and outside the conditioned space. Therma-Stor is concerned that these non-traditional designs may be excluded or categorized in an equipment class inconsistent with their intent and performance, and recommended that the definition of "dehumidifier" include equipment whose primary function is to remove latent heat at the specified test condition. This would allow new and innovative products that transfer some sensible heat to be included as long as their primary function at the test condition is to remove latent heat. (Therma-Stor, No. 15 at pp. 3–4)

The definition for dehumidifier promulgated in EPCA (42 U.S.C. 6291(34)) does not establish coverage as a dehumidifier for products without a refrigeration-based system or for products that would not otherwise comply with that statutory definition, such as split dehumidifiers. This dehumidifier rulemaking focuses solely on products that provide the primary function of removing moisture from the conditioned space (i.e., latent heat removal). Therefore, DOE proposed to clarify the EPCA definition by excluding products that may provide condensate removal or latent heat removal as a secondary function. DOE notes that the definition does not exclude products that provide sensible heat removal in addition to the primary function of latent heat removal, including products that transfer sensible and/or latent heat between air streams within the conditioned space and outside the conditioned space such as refrigerant-desiccant whole-home dehumidifiers.

Therefore, in this final rule, DOE establishes the following definition for dehumidifier:

A product, other than a portable air conditioner, room air conditioner, or packaged terminal air conditioner, that is a self-contained, electrically operated, and mechanically encased assembly consisting of—

1) A refrigerated surface (evaporator) that condenses moisture from the atmosphere;
2) A refrigerating system, including an electric motor;
3) An air-circulating fan; and
4) A means for collecting or disposing of the condensate.

2. Product Capacity Definition

In the May 2014 NOPR, DOE proposed adjusting the definition for product capacity by further specifying that product capacity is the measure of moisture removed from the surrounding atmosphere measured in pints collected per 24 hours of operation under the specified ambient conditions. The added specificity of the ambient conditions was necessary due to the varying test conditions among different dehumidifier configurations. 79 FR 29271, 29281 (May 21, 2014).

Therma-Stor commented that DOE should modify the definition to add “of condensate” regarding the number of pints of moisture removed from the atmosphere and collected in 24 hour period. Therma-Stor suggested that this definition is necessary to clarify that the condensate should be in liquid form. (Therma-Stor, No. 6 at p. 2)

DOE recognizes that the majority of dehumidifiers covered by this test procedure collect the moisture in liquid form; however, refrigerant-desiccant dehumidifiers remove moisture from the conditioned space and discharge some of that moisture in vapor form outside the conditioned space instead of collecting or draining it as condensate. Because the primary function of a dehumidifier is to remove moisture from the air within a conditioned space rather than to collect condensate, and to ensure that the definition of product capacity properly represents all configurations of dehumidifiers, DOE elected in this final rule to maintain the definition for product capacity proposed in the May 2014 NOPR.

3. Configuration Definitions

In the May 2014 NOPR, DOE proposed to amend 10 CFR 430.2 to include definitions of portable, whole-home, and refrigerant-desiccant dehumidifiers. 79 FR 29271, 29275 (May 21, 2014).

AHAM agreed with the definition for a portable dehumidifier. (AHAM, No. 7 at p. 3) Aprilaire suggested that the whole-home dehumidifier definition should differentiate these units from portable dehumidifiers by intended use instead of installation. (Aprilaire, No. 5 at p. 2) Therma-Stor stated that the proposed definitions for whole-home and portable dehumidifiers should be revised to accurately define specific attributes of each product type, allowing dealers and consumers to make comparisons without confusion. (Therma-Stor, No. 6 at p. 1) Due to the many similarities between certain portable and whole-home dehumidifiers and the inability to determine their intended use through examination of the product, DOE determined that design features associated with installation, namely the attachment of ducts, are the most reliable method for differentiation.

Therefore, DOE is establishing in 10 CFR 430.2 definitions for portable and whole-home dehumidifiers, which are identical to those proposed in the May 2014 NOPR. According to the definitions, a portable dehumidifier is a dehumidifier without ducting, although it may include optional ducts attachments, and a whole-home dehumidifier is a unit that is installed with ducting to deliver air to one or more locations in the dehumidified space.

4. Convertible Products

As discussed in the May 2014 NOPR, DOE determined that some dehumidifiers on the market have optional ducting kits that allow the product to be used as either a portable or ducted (i.e., whole-home) dehumidifier. DOE proposed that these products would be tested under both the portable and whole-home test procedures and would be required to meet any applicable standards for each configuration. 79 FR 29271, 29300 (May 21, 2014).

Appliance Standards Awareness Project (ASAP), Alliance to Save Energy (ASE), American Council for an Energy-Efficient Economy (ACEEE), Consumers Union (CU), National Consumer Law Center (NCLC), and Natural Resources Defense Council (NRDC) (hereinafter the "Joint Commenters") and Pacific Gas and Electric Company (PG&E), Southern California Gas Company (SCG), San Diego Gas and Electric Company (SDG&E), and Southern California Edison (SCE) (hereinafter the "California Investor-Owned Utilities (IOUs)"), each agreed with the convertible product definition and DOE's proposal that if these products meet the definitions of both portable and whole-home dehumidifiers, they be tested under both configurations. These commenters indicated that it is important to capture performance of convertible products in both configurations to ensure good performance regardless of how the customer chooses to operate the unit. According to the commenters, testing in both configurations would also provide information to consumers about capacity and efficiency in each, as performance can vary significantly depending upon the presence of ducting and overall configuration. (Joint Commenters, No. 8 at p. 2; California IOUs, No. 9 at p. 1)

Aprilaire stated that the proposed definition for convertible products places a burden on whole-home dehumidifier manufacturers that have no control over distributors that could convert products from whole-home to portable configuration and vice versa. Aprilaire also stated that it is unclear if the manufacturer would have to test for conditions that could arise from the installation or modification of the product by a third party. (Aprilaire, No. 5 at p. 2)

As discussed in the May 20104 NOPR, convertible products are those dehumidifiers manufactured with optional ducting kits. 79 FR 29271, 29275 (May 21, 2014). Therefore, any product sold by a manufacturer that meets both the portable and whole-home dehumidifier definition would be considered convertible. However, if the manufacturer does not provide a ducting kit and the distributor or installer devises a ducting kit or modifies the unit, the dehumidifier would not be considered a convertible product.

Therma-Stor objected to the proposal for convertible products, and stated that the definitions for whole-home dehumidifier and portable dehumidifier should be revised to be mutually exclusive so that products would meet only one of these definitions. (Therma-Stor, No. 6 at p. 1) DOE notes that the test procedure and standards for products are intended to represent the typical usage in the field. If a product is designed to be installed and used in either of two configurations that would result in different performance, the test procedure should consider both of these configurations individually and ensure the product is compliant with any applicable energy conservation standards. Without further input on specific changes that would make the definitions mutually exclusive, DOE is maintaining the proposal from the May 2014 NOPR and establishing in appendix X1 that units that meet the definitions for both portable and whole-home dehumidifiers as produced by the manufacturer, exclusive of any third-party modifications, must be tested in both configurations and comply with any applicable energy conservations standards for each configuration.

5. Coverage of Whole-Home Dehumidifiers

The Joint Commenters supported the clarification in the May 2014 NOPR that whole-home dehumidifiers, including refrigerant-desiccant units, are covered products. Although whole-home dehumidifiers currently represent a small portion of the total dehumidifier market, the Joint Commenters believe that the market share of these products will grow as homes are being built more airtight, resulting in a need for mechanical ventilation, a shift in the mix of sensible and latent loads, and more moisture to be removed. (Joint Commenters, No. 8 at p. 2)

Aprilaire commented that whole-home dehumidifiers are a separate product category, and that instead of extending the portable dehumidifier test procedure to whole-home dehumidifiers, which are much more complex and have multiple ways of solving the solution, DOE should propose a separate standard for whole-home dehumidifiers. Aprilaire also suggested that DOE fund research currently ongoing at AHAM to better understand humidity control models. (Aprilaire, Public Meeting Transcript, No. 10 at pp. 20–22) Aprilaire further commented that portable and whole-home dehumidifiers are different classes of products in their construction, intended application, and function, and that combining these two classes of products under a single rule and test procedure is not practical. Therefore, Aprilaire indicated that it does not support the inclusion of whole-home dehumidifiers in this rulemaking. It recommended that DOE instead work with industry to better understand residential latent load requirements and methods of controlling it, and develop a test method that properly measures and compares different classes of products. (Aprilaire, No. 5 at pp. 1–2, 4) Aprilaire additionally stated that its testing indicates whole-home dehumidifiers may use less energy than portable dehumidifiers and that further investigation may show how much is related to larger air flows, control logic, control accuracy, fan cycling for sampling, and the ability to control the space's humidity. Aprilaire believes that implementing a test for whole-home dehumidifiers could limit innovation and prevent the development of products that perform adequately while reducing overall energy use. (Aprilaire, No. 5 at pp. 4–5)

DOE recognizes the differences between portable and whole-home dehumidifiers, but because these products both meet the definition for dehumidifier as established under EPCA and because they provide similar primary functions, DOE is addressing both products in the current test procedure rulemaking. DOE is establishing in this final rule test methodology specific to whole-home dehumidifiers that will measure energy use of these products under representative installation and operating conditions. DOE discusses its evaluation of test burden on manufacturers in section IV.B of this notice. DOE is also addressing energy conservations standards for portable and whole-home dehumidifiers in the concurrent dehumidifier standards rulemaking. In the energy conservation standards NOPR published on June 3, 2015, DOE proposed separating dehumidifiers into portable and whole-home dehumidifier product classes for the purposes of setting standards. 80 FR 31645, 31647.

6. Alternative Dehumidification Technologies

Because the EPCA definition for a dehumidifier specifies a refrigeration system, products that use solely a desiccant or technology other than vapor-compression refrigeration to remove a latent load would not be covered by statute. However, as discussed in the May 2014 NOPR, DOE is aware of a dehumidifier configuration that incorporates desiccant technology along with a refrigeration system, referred to as a “refrigerant-desiccant” dehumidifier. In the May 2014 NOPR, DOE defined a refrigerant-desiccant dehumidifiers as a whole-home dehumidifier that removes moisture from the process air via a desiccant material in addition to a refrigeration system. 79 FR 29271, 29275 (May 21, 2014).

Aprilaire noted that the dehumidifier configurations defined in the May 2014 NOPR do not include other methods of latent heat removal, such as desiccants. Aprilaire also stated that the current whole-home dehumidifier definition limits moisture removal to only "refrigeration means." (Aprilaire, No. 5 at p. 4)

Therma-Stor commented that because the EPCA definition for dehumidifier does not include mention of a desiccant and specifies that there is a "means for collecting or disposing of the condensate," the definition would not apply to a desiccant dehumidifier which removes water in vapor form. Therefore, Therma-Stor also believes that desiccant product types are outside the scope of the EPCA definition and should not be covered as a separate product type. However, it stated that dehumidifiers with desiccant (or other) components in addition to components included in the EPCA definition should be characterized as refrigerant dehumidifiers for testing and rating, rather than as a separate product type, or should be exempted from coverage. Therma-Stor added that DOE only considered one possible configuration that incorporates a desiccant component into a refrigerant dehumidifier and that other configurations exist in the market. The duct configurations, external static pressures (ESP), and volumetric flow rates may be different than for other whole-home dehumidifiers. Therma-Stor contends, therefore, that refrigerant-desiccant dehumidifiers are outside the scope of the EPCA definition. (Therma-Stor, No. 6 at pp. 2, 5)

DOE agrees that desiccant-only products do not meet the EPCA definition and are therefore not considered a covered product under this rulemaking. DOE further determines that the EPCA definition of dehumidifier, while specifying that the product contain a refrigerated surface that condenses moisture, does not require that this refrigeration system and cooled surface be the sole source of condensate removal. DOE therefore agrees that refrigerant-desiccant dehumidifiers should be covered and tested in a manner that would produce similarly representative results as their refrigerant-only counterparts, though DOE concludes that a unique test setup and determination of moisture removal is necessary to account for the multiple air streams. DOE also notes that it is only aware of one configuration for residential dehumidifiers, refrigerant-desiccant, that employs additional technologies to complement the refrigeration system latent heat removal.

Therefore, DOE is establishing in this final rule the definition of "refrigerant-desiccant dehumidifier" as proposed in the May 2014 NOPR.

7. Process Air Definition

In the May 2014 NOPR, DOE proposed to define process air as the air supplied to the dehumidifier from the dehumidified space and discharged to the dehumidified space after moisture has been removed. 79 FR 29271, 29275 (May 21, 2014).

AHAM agrees with this definition of process air. (AHAM, No. 7 at p. 3) Aprilaire commented that the process air may not always come from the dehumidified space, and that a portion of the air may be ventilation air. (Aprilaire, No. 5 at p. 4) DOE recognizes that some portion of the process air may comprise outside ventilation air for some units in certain installations. However, without further data on typical percentages of ventilation air in the process air stream, DOE maintains its approach to consider the process air to be supplied to the dehumidifier solely from the dehumidified space.

B. Dehumidification Mode

In the May 2014 NOPR, DOE proposed a definition of “dehumidification mode” to specify an active mode in which the dehumidifier has activated its main moisture removal function according to the humidistat or humidity sensor signal, and has activated either the refrigeration system or the fan or blower. DOE then proposed an updated version of this definition in the February 2015 SNOPR to include control settings as means for activating the main moisture removal function. 80 FR 5994, 6005 (Feb. 4, 2015).

AHAM agreed with the definition for dehumidification mode proposed in the February 2015 SNOPR. (AHAM, No. 16 at p. 7)

Aprilaire commented that the proposed dehumidification mode definition should only apply to operation related to actively removing moisture from the air, corresponding to when the dehumidifier has its air-movement device and latent-heat removal system operating. Aprilaire suggested that a whole-home dehumidifier may turn on its fan or blower to sample the air, and some products also simultaneously activate the heating, ventilation, and air conditioning (HVAC) system’s fan to ensure proper measurements and mixing. Aprilaire was unsure if the proposed definition refers to the dehumidifier's fan or the HVAC fan. According to Aprilaire, some whole-home dehumidifiers use the HVAC fan while it has been energized for other reasons, such as cooling, air cleaning, or ventilation, and this could penalize a whole-home dehumidifier when such operation actually may reduce overall energy use. (Aprilaire, No. 5 at pp. 2–3) In this rulemaking, dehumidification mode refers to active moisture removal achieved via operation of the covered product, including energization of internal air-handling and latent-heat removal systems. Thus, the fan or blower included in the dehumidification mode definition only refers to the fan or blower that is within the unit's case and not the separate HVAC fan. HVAC fans are subject to separate standards under 10 CFR 430.32(y).

Therma-Stor suggested that the dehumidification mode definition should include all combinations of operating and non-operating components engaged when the dehumidifier controller has activated a moisture removal operation. According to Therma-Stor, there are a number of different operational modes that may occur (based on the air and/or internal dehumidifier conditions) once a dehumidifier has been placed into moisture removal mode, and all should be considered when testing to determine capacity and efficiency ratings. (Therma-Stor, No. 6 at p. 2) DOE acknowledges that some units may employ varying approaches in dehumidification mode to optimize operation with variable speed compressors or blowers. The DOE test procedure uses a fixed dehumidification mode test condition in which the "main moisture removal function" is activated throughout testing to ensure repeatable and comparable results among units. A particular unit may activate different combinations of operating components throughout the test period, but as long as the main moisture removal function remains activated, the energy use of each of these components is captured in the dehumidification mode test.

1. Ambient Temperature – Portable Dehumidifiers

In the May 2014 NOPR, DOE proposed to require dehumidification mode testing in appendix X1 at nominal indoor ambient conditions of 65 °F dry-bulb temperature and 56.6 °F wet-bulb temperature, which corresponds to 60-percent relative humidity, for both portable and whole-home dehumidifiers. 79 FR 29271, 29279 (May 21, 2014). This proposal reduced the test conditions from those in ANSI/AHAM DH-1-2008, 80 °F dry-bulb temperature and 69.6 °F wet-bulb temperature, corresponding to 60-percent relative humidity.

The Joint Commenters, AHAM, NRDC, and ASAP agreed with the 65 °F dry-bulb temperature test condition proposed in the May 2014 NOPR. AHAM stated that its member test results at these conditions were consistent with DOE's findings. The Joint Commenters confirmed that the current 80 °F test condition is likely significantly higher than typical ambient conditions during dehumidifier use, and believe that the lower 65 °F test condition will provide better information to consumers regarding capacity and efficiency and will ensure savings in the field. (NRDC, Public Meeting Transcript, No. 10 at p. 45; ASAP, Public Meeting Transcript, No. 10 at p. 46; AHAM, No. 7 at p. 5; Joint Commenters, No. 8 at p. 3)

GE expressed concern that testing at 65 °F dry-bulb temperature with 60-percent relative humidity would reduce the amount of water in the air available to be removed by the dehumidifier than at 80 °F dry-bulb. GE indicated that at 80 °F, the dehumidifier system runs more consistently with no frost developing on the evaporator, and therefore the higher test condition is much easier to perform. (GE, Public Meeting Transcript, No. 10 at p. 43)

Aprilaire suggested that 65 °F dry-bulb temperature and 60-percent relative humidity may be an appropriate condition for testing, but that 65 °F would be cool for basement conditions and that room temperature tends to increase because heat is rejected to the room from the operating dehumidifier. Therefore, Aprilaire suggested a higher ambient test temperature of 68 °F, which is also the heating set point for a previous ENERGY STAR thermostat heat setting. (Aprilaire, No. 5 at p. 3) Therma-Stor also indicated that operating a refrigerant dehumidifier below grade or in a basement will increase the temperature of the space, because it converts the latent heat of the moisture and electrical energy consumed into sensible heat. Therefore, Therma-Stor believes that basements with dehumidifiers operating are a few degrees warmer than those without a dehumidifier. (Therma-Stor, No. 6 at p. 3)

DOE recognizes that there may be temperature variation among specific basement locations; however, based on DOE's analysis presented in the May 2014 NOPR, DOE expects that the average ground temperature during the dehumidification season to be close to 65 °F. In addition, although dehumidifiers add sensible heat to the room due to the conversion of the latent heat and the efficiencies of the electrical components, any temperature increase in the room will be a function of parameters including dehumidifier capacity in relation to basement size, slab and wall insulation, and air infiltration rates. Because of the uncertainty of such effects, DOE is not raising the test ambient temperature requirement above that determined from ground temperature analysis. Further, the 65 °F test condition for portable dehumidifiers is also representative of units installed in above-grade living spaces, based on climate data analysis. Therefore, without further field temperature data to support a higher test temperature, DOE adopts the 65 °F dry-bulb ambient temperature condition for testing portable dehumidifiers in dehumidification mode. DOE recognizes that dehumidifiers will extract less condensate at this dry-bulb temperature than at the current 80 °F, which will result in a lower measured capacity, but believes that the 65 °F condition is most representative of consumer usage of the product. If dehumidifiers defrost under 65 °F ambient temperatures, it is appropriate for the test procedure to capture this operation; however, DOE notes that most current products did not require defrosts under these test conditions, and manufacturers would likely design their models to avoid defrosts during testing.

In the May 2014 NOPR, DOE proposed and requested comment on an alternate approach of conducting dehumidification mode testing at both 65 °F and 80 °F ambient temperatures, with IEF and capacity calculated from the combined results of the two tests. DOE also proposed weighting factors for combining these two approaches (i.e., 79 percent for the 65 °F test condition and 21 percent for the 80 °F test condition) and requested feedback on alternate appropriate weighting factors. 79 FR 29271, 29279 (May 21, 2014).

The California IOUs commented that a test condition of 80 °F alone does not accurately measure dehumidifier efficiency in typical operating conditions. The California IOUs believe that moisture control is important both in basements where the average temperature is close to 65 °F, which is currently the industry standard low-temperature test point in ANSI/AHAM DH-1-2008, and in warmer conditions representative of the 80 °F test condition. Therefore, they believe that measurements at both 65 °F and 80 °F should be required, and that the standards should be determined by a weighted average of performance at each temperature to account for variation in actual field conditions across the country. The California IOUs also supported DOE's proposed weighting percentages. (California IOUs, No. 9 at p. 2)

The Joint Commenters encouraged DOE to require testing at a dry-bulb temperature lower than 65 °F, such as 55 °F, in addition to testing at 65 °F to capture performance under frost conditions that are likely encountered in the field. The Joint Commenters noted that Consumer Reports includes a "cool room performance" test which measures capacity and efficiency at 50 °F. Because testing at 55 °F in addition to 65 °F would likely capture defrost cycles, the Joint Commenters stated that this would encourage adoption of improved defrost methods and controls. If, as noted in the preliminary TSD, manufacturers are already testing their units at very low ambient temperatures, the Joint Commenters suggested that requiring testing at lower than 65 °F as well as at 65 °F may not represent a significant additional testing burden. (Joint Commenters, No. 8 at pp. 3–4) The California IOUs suggested that DOE also measure dehumidifier efficiency under conditions that lead to defrost mode operation. These commenters stated that defrost operation is necessary to remove frost that builds up on the evaporator coils at lower temperatures, reducing effectiveness of the dehumidifier and wasting energy. The California IOUs suggested that because different defrost methods may lead to a wide range in performance, defrost mode should be tested by adding an additional test point at a low ambient temperature where defrost is likely to occur. The California IOUs suggested that manufacturers should be required to report the results of the two temperature tests independently so that consumers can distinguish which units will function the most efficiently in a particular environment and application. (California IOUs, No. 9 at pp. 2–3)

AHAM and NRDC opposed the alternative proposal to test portable dehumidifiers at 80 °F and 65 °F due to the additional testing burden. AHAM added that the 65 °F test condition is sufficient, especially given DOE's extensive data and analysis supporting the proposal for 65 °F. (NRDC, Public Meeting Transcript, No. 10 at p. 45; AHAM, No. 7 at p. 6)

DOE recognizes the potential value of testing dehumidifiers at additional temperatures higher or lower than 65 °F to obtain a measure of performance under a broader range of real-world conditions, which could capture effects such as icing or the benefits of variable-speed operation. However, DOE's information does not suggest that the alternative temperatures recommended by commenters are representative of a significant number of operating hours in regions of typical dehumidifier usage. For example, as depicted in Figure III.1, a review of the climate data from 2012 indicates that, in regions comprising the majority of dehumidifier usage (based on U.S. Department of Energy: Energy Information Administration's, Residential Energy Consumption Survey (RECS) 2009 data), only 3 percent of time during the dehumidification season (between April and October) occurs when ambient conditions are greater than 80 °F and 60-percent relative humidity. Although more hours are attributed to periods when average ambient temperatures are lower than 55 °F and relative humidity is 60 percent or higher, DOE believes that during many of these hours, the conditioned space above-grade would be heated, thereby reducing the relative humidity. Similarly, few hours during the dehumidification season have soil temperatures below 55 °F and thus this lower temperature would not be a representative testing condition for dehumidifiers installed in basements.

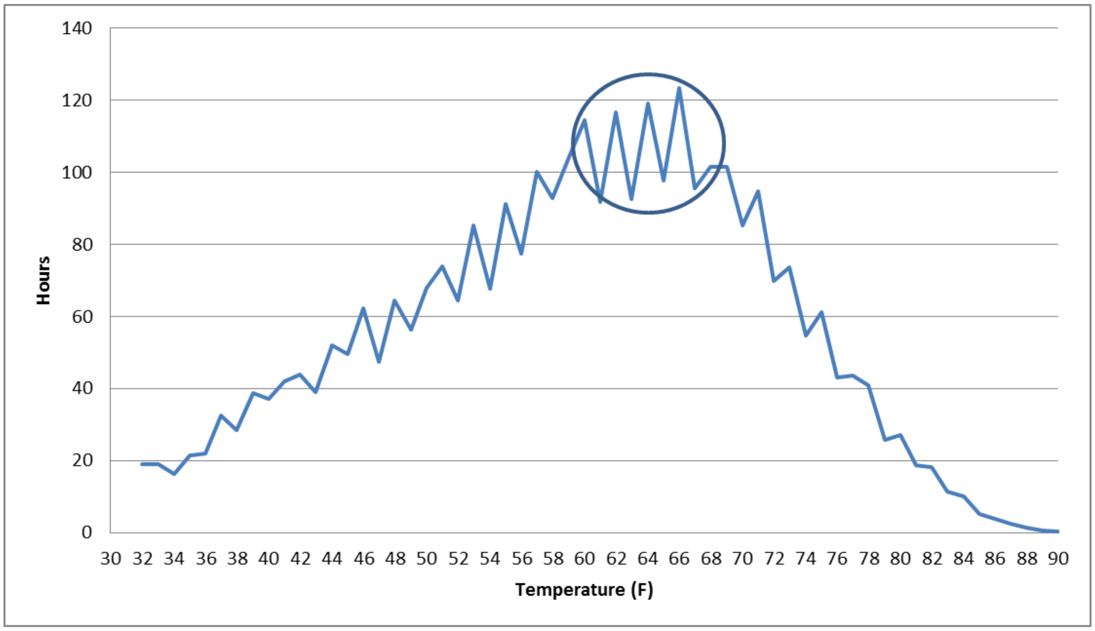

Figure III.1 Weighted-Average Dehumidification Season Hours at Specific Ambient Temperatures and a Relative Humidity of 60-Percent or Higher

Therefore, while DOE agrees that 80 °F or 55 °F are useful test conditions for determining performance under extremes of expected operation, DOE concludes that the minimal usage of dehumidifiers under these conditions would not warrant the burden of conducting additional dehumidification mode testing. Therefore, based on the analysis presented in the May 2014 NOPR, DOE concludes that the 65 °F dry-bulb temperature is representative of the majority of conditions during periods of dehumidifier use and is not adopting a requirement to measure and average dehumidifier performance over multiple ambient test temperatures.

Aprilaire suggested that DOE require two rating conditions but not combine them into the same metric. They believe this would allow manufacturers to design for specific uses (e.g., basement, living space, etc.) instead of combining them using a weighting factor. (Aprilaire, Public Meeting Transcript, No. 10 at p. 42) As discussed above, the minimal usage of dehumidifiers at extreme conditions of expected operation does not warrant additional test burden. Therefore, DOE is maintaining the proposed 65 °F dry-bulb test condition for portable dehumidifiers.

2. Part-Load Testing

In response to the May 2014 NOPR proposals, Aprilaire questioned how products with modulating or variable-speed capabilities that are on the market currently or will be on the market in the future would be considered. (Aprilaire, Public Meeting Transcript, No. 10 at p. 32) The Joint Commenters encouraged DOE to consider adding a part-load test, noting that the National Renewable Energy Laboratory (NREL) conducted part-load testing of four dehumidifiers and found, in a January 2014 technical report,[6] that efficiency can degrade significantly when there is a high rate of compressor cycling and continued fan operation after the compressor cycles off. The Joint Commenters also noted that NREL found that when the compressor stayed on for 3 to 6 minutes and the fan ran for 3 minutes after it shut off, 17 to 42-percent of the condensate was re-evaporated. The Joint Commenters suggested that a test procedure that captured part-load performance would discourage this type of fan control strategy that reduces efficiency in the field, and would instead encourage variable-speed compressors that would reduce compressor cycling not currently captured in the test procedure. The Joint Commenters further suggested that if DOE does not adopt a part-load test, DOE should consider an alternative approach to capture the impacts of re-evaporation on efficiency when the fan continues to operate following a compressor cycle. (Joint Commenters, No. 8 at p. 5) The California IOUs reiterated the Joint Commenters' suggestion, but further noted that variable-

[6] "Measured Performance of Residential Dehumidifiers Under Cyclic Operation," National Renewable Energy Laboratory. NREL/TP-5500-61076 (January 2014) (Available at http://apps1.eere.energy.gov/buildings/publications/pdfs/building_america/dehumidifiers_cyclic_operation.pdf).

speed compressors are uncommon for this product type and that cycling degrades equipment and may shorten the dehumidifier life. The California IOUs suggested that a part-load test would be conducted by supplying humidity to the test chamber at a low rate so that the dehumidifier cycles on and off, and the test variable could be the number of compressor cycles and energy consumption during the rating test period. The California IOUs referenced the NREL study that provides information on how existing test chamber could be modified to accommodate part-load testing and how the test results can be interpreted. (California IOUs, No. 9 at pp. 2–3)

In response to the February 2015 SNOPR, the Joint Commenters reiterated their suggestion that DOE include a test to capture performance under frost conditions and encouraged DOE to consider adding a part-load test in future rulemakings. They indicated that NREL's testing found when there is a high rate of compressor cycling, dehumidifier efficiency can degrade significantly. They believe that incorporating these two tests would encourage improved defrost methods and controls, as well as technologies such as variable-speed compressors and control strategies such as increasing the humidistat deadband that could improve efficiency by reducing compressor cycling. (Joint Commenters, No. 17 at p. 2)

DOE agrees that a part-load test could capture some effects of re-evaporation and other performance impacts. However, DOE is not establishing a part-load test for dehumidifiers at this time because of concerns with significantly increased test burden and reduced repeatability and reproducibility. Current environmental chambers are able to maintain steady-state conditions, but it would be difficult for test laboratories to modulate the humidity in the chamber accurately over the duration of a test, given the variability in compressor capacities and chamber configurations and equipment. This would potentially require upgraded facilities and require more complex calculations to account for the varying conditions throughout the test. Accordingly DOE is maintaining the current approach for testing dehumidifiers that implements steady-state temperature and humidity conditions.

3. Relative Humidity

In the May 2014 NOPR, DOE proposed that the ambient relative humidity level maintained throughout dehumidification mode testing shall remain at 60 percent, as specified in ANSI/AHAM DH-1-2008. 79 FR 29271, 29283 (May 21, 2014).

Aprilaire, Therma-Stor, GE, and AHAM agreed with DOE's proposal to maintain 60-percent relative humidity for testing dehumidification mode. Aprilaire further commented that 60-percent relative humidity is the manufacturer-recommended set point and where consumers will likely run the dehumidifier for comfort. Therma-Stor stated that 60-percent relative humidity would be representative of consumer use because it is at or near the upper limit of many recognized comfort zones used to define acceptable indoor conditions during the summer cooling season. (GE, Public Meeting Transcript, No. 10 at p. 51; AHAM, Public Meeting Transcript, No. 10 at pp. 51–52; Aprilaire, Public Meeting Transcript, No. 10 at p. 51; Aprilaire, No. 5 at p. 4; Therma-Stor, No. 6 at p. 4; AHAM, No. 7 at p. 7)

Nyle Systems commented that dehumidifiers and heat pump hot water heaters are both installed in similar locations (e.g., basements and furnace rooms) and should therefore be tested at the same test conditions, namely the ambient temperature and relative humidity settings for testing heat pump hot water heaters (68 °F and 50 percent, respectively). Nyle Systems also stated that the proposed dew point is too high and that the heat pump hot water heater test conditions would be a reasonable dew point. (Nyle Systems, No. 12 at p. 1) DOE notes that, despite potentially similar installation locations, the annual usage patterns and thus representative ambient conditions for dehumidifiers are different than those for water heaters. Therefore, DOE is not adopting the water heater test conditions as representative test conditions for dehumidifiers.

4. Whole-Home Dehumidifier Ducted Installation

In the May 2014 NOPR, DOE proposed modifications to the dehumidifier test setup to allow testing of whole-home dehumidifiers in a ducted configuration, including provisions regarding instrumentation, fresh air inlets, process air inlet and outlet ducts, test duct specifications, transition sections, and flow straighteners. 79 FR 29271, 29283–86 (May 21, 2014). DOE based these proposals on current industry practices for testing ducted air treatment devices and investigative testing under various testing configurations.

The Joint Commenters agreed that whole-home dehumidifiers should be tested with ducting because they are intended to be installed as part of a home's HVAC system, which imposes an external static pressure that reduces airflow and impacts capacity and efficiency. (Joint Commenters, No. 8 at p. 4)

Therma-Stor believes that the test procedures for all product types, including refrigerant-desiccant units, should utilize the same measurement methods. Therma-Stor is concerned that different test procedures, conditions, and standards for each product type would lead to different performance ratings and cause confusion among dealers and consumers. Therefore, Therma-Stor prefers an approach which rates portable and whole-home dehumidifiers on a comparable basis. (Therma-Stor, No. 6 at p. 5) Because DOE's test procedure must measure representative energy use of dehumidifiers, and because whole-home dehumidifiers are designed to be installed in a ducted configuration that results in performance different than when the unit is operated unducted, DOE is adopting a unique test setup and conduct for whole-home dehumidifiers in appendix X1 that specifies the use of ducts and other associated instrumentation.

The ducted installation requirements for whole-home dehumidifiers that DOE proposed in the May 2014 NOPR included: (1) duct configurations, including specifications for fresh air inlets, process air inlet and outlet ducts, test duct specifications, transition sections, flow straighteners; and (2) instrumentation for measuring dry-bulb temperature, relative humidity, ESP, and volumetric flow rate, as well as specifications for measurement frequency. DOE also proposed in the May 2014 NOPR a capacity measurement for refrigerant-desiccant dehumidifiers based on a vapor calculation method. 79 FR 29271, 29283–29289 (May 21, 2014).

In the February 2015 SNOPR, DOE revised its proposal to reduce the required minimum duct length for whole-home dehumidifiers from 10 duct diameters to 4.5 duct diameters, but otherwise maintained the ducted installation proposals from the May 2014 NOPR. 80 FR 5994, 5998 (Feb. 4, 2015). DOE received no comments in response to the proposed reduction in duct length for whole-home dehumidifiers and is adopting the February 2015 SNOPR duct length proposals to reduce test burden and improve reproducibility as discussed in the February 2015 SNOPR.

Furthermore, with the exception of the provisions discussed in the following sections on which DOE received comments, DOE is maintaining the remaining whole-home dehumidifier testing provisions that were proposed in the February 2015 SNOPR for the reasons described in that proposal and the May 2014 NOPR.

a. Inlet Temperature

In the February 2015 SNOPR, DOE proposed that whole-home dehumidifiers be tested with all ducted intake air at 73 °F dry-bulb temperature and 63.6 °F wet-bulb temperature to maintain a 60-percent relative humidity. DOE noted that the results for portable and whole-home dehumidifiers would not be directly comparable, but rather that the application, installation, and ambient conditions of the two product types are inherently different, and therefore it is reasonable that representative performance should also differ. 80 FR 5994, 5996–5997 (Feb. 4, 2015).

The Joint Commenters supported DOE's proposal to test whole-home dehumidifiers at an ambient temperature of 73 °F, noting that the field study referenced in the February 2015 SNOPR found that the average inlet dry-bulb temperature during compressor operation for the four units in the study was 73.2 °F. (Joint Commenters, No. 17 at p. 1)

Aprilaire did not support using the Burke Study[7] to conclude that 73 °F is an appropriate rating point for whole-home dehumidifiers. According to Aprilaire, the dates, times, and associated temperatures of the average of each location are not known; therefore, the meaning of "average by location" is not clear. In addition, Aprilaire stated that there is no way to know if these locations were "typical" in terms of installation, user habits, equipment set points, or weather. Additionally, Aprilaire noted that there were significant differences among the locations, climates, building types, and equipment at the sites in the study. Aprilaire expressed concern about whether a simple average of four test sites from two very different locations is a proper representation of the population of all homes in the United States. Based on the very limited data, Aprilaire recommended an ambient test temperature of 75 °F to 80 °F, or DOE's own recommendation for a cooling set point of 78 °F, which could be changed in the future if additional data were available. (Aprilaire, No. 14 at p. 2)

DOE notes that, although the climate study showed the average outdoor temperature to be close to 65 °F, data available from the limited field study indicated that 73 °F dry-bulb temperature is a more appropriate inlet condition for whole-home dehumidifiers. DOE did not receive additional data demonstrating that a different dry-bulb temperature was warranted; accordingly, DOE is maintaining the test conditions as proposed in the February 2015 SNOPR for whole-home dehumidifiers: 73 °F dry-bulb temperature and 63.6 °F wet-bulb temperature.

b. External Static Pressure

[7] T. Burke, et al., Whole-Home Dehumidifiers: Field-Monitoring Study, Lawrence Berkeley National Laboratory, Report No. LBNL-6777E (September 2014) (Available at https://isswprod.lbl.gov/library/view-docs/public/output/rpt83520.PDF).

In the February 2015 SNOPR, DOE concluded that its analysis supported testing whole-home dehumidifiers at an ESP higher than 0.2 inches of water column (in. w.c.) but substantially less than 0.5 in. w.c. Due to the limited data available to more precisely define this value, DOE proposed an ESP of 0.25 in. w.c. as the appropriate test condition for whole-home dehumidifiers. 80 FR 5994, 5998 (Feb. 4, 2015).

The Joint Commenters stated that DOE's proposal to specify an ESP of 0.25 in. w.c. for whole-home dehumidifiers is reasonable. (Joint Commenters, No. 17 at p. 1)

Therma-Stor agreed that whole home dehumidifiers typically experience an ESP in excess of portable dehumidifiers, but feel that the proposed test ESP of 0.25 in. w.c. is still too high. According to Therma-Stor, manufacturers recommend installation practices, but the ESP that a whole-home dehumidifier experiences in the field is determined by the field installation. Therma-Stor recommends installation practices for its whole-home dehumidifiers that result in a lower ESP and suggested that the test condition be revised to 0.2 in. w.c. ESP. (Therma-Stor, No. 15 at p. 1) Therma-Stor further suggested that the ESP of a furnace and duct system is not a good proxy for whole-home dehumidifiers, which typically process a much smaller volumetric flow rate of air than a furnace or air handler. Therma-Stor indicated that whole-home dehumidifiers are designed with duct connections intended to provide less than 0.15 in. w.c. ESP per 100 feet of duct. Therma-Stor stated that specifying 0.25 in. w.c. in the dehumidifier test procedure would force manufacturers to incorporate fans that require more power and make more noise than the fans currently in use without providing a real benefit. (Therma-Stor, No. 15 at pp. 1–2)

Aprilaire commented that the DOE test method would represent a “Return to Supply” installation configuration. In this installation, air is pulled from the return and then put into the supply, which requires the dehumidifier blower to overcome the system pressure losses caused by the HVAC blower. According to Aprilaire, manufacturers have stated that this is not a typical installation, and that due to the very limited size of the market, the varying applications and installation methods, and the lack of industry organizations, a true data set of installation methods cannot be obtained. Therefore, Aprilaire believes that a “Return to Return” or “Room to Return” installation is typical. In such installations, Aprilaire stated that the highest static pressure would be equivalent to two elbows and a few feet of duct work, which would not result in an ESP close to 0.25 in. w.c.; rather, it would be much closer to zero. Aprilaire does not agree with a higher static pressure as a recommended test condition. (Aprilaire, No. 14 at pp. 2–3)

Both the calculations and limited field data discussed in the February 2015 SNOPR resulted in representative ESPs of 0.2 and 0.23 in. w.c. for typical whole-home dehumidifier installations. DOE acknowledges that certain installations will have lower or higher ESPs, and agrees that its proposal to round the ESP to 0.25 in w.c. would result in a system static pressure on the high end of the estimated representative range. Thus, DOE concludes that 0.2 in. w.c. is a representative value that would best capture the effects of varying types of installations and duct configurations. In light of these results and feedback from commenters, DOE establishes in this notice that whole-home dehumidifier testing must be conducted with an ESP of 0.2 in. w.c.

c. Fresh Air Inlet

In the May 2014 NOPR, DOE tentatively determined, based on investigative test data, that the slight positive impact of using the fresh air inlet on a whole-home dehumidifier is not significant enough to warrant the added test burden of providing separate fresh air inlet flow; therefore, DOE proposed that any fresh air inlet on a whole-home dehumidifier be capped and sealed during testing. 79 FR 29271, 29285 (May 21, 2014).

Aprilaire agreed with the proposal to seal ventilation ducts and fresh air ducts because the inlet air would have similar conditions either way, and the ventilation air is part of the inlet air. (Aprilaire, Public Meeting Transcript, No. 10 at pp. 60–61)

Therma-Stor objected to sealing the fresh air inlet because it would reduce capacity and efficiency, leading to an unfair bias against whole-home dehumidifiers with fresh air inlets as compared to whole-home units which do not incorporate a separate fresh air inlet. (Therma-Stor, No. 6 at p. 4) As mentioned above and in the May 2014 NOPR, DOE's investigative testing indicated that sealing the fresh air inlets would produce a 5-percent or smaller reduction in capacity and EF. Additionally, DOE lacks information about consumer use of fresh air inlet ducts for these products. Therefore, the test procedure requires that any fresh air inlets be covered and sealed during testing due to the relatively small impact on test results and the added test burden if they were to be ducted separately.

5. Relative Humidity Instrumentation

In the February 2015 SNOPR, DOE proposed that refrigerant-desiccant whole-home dehumidifier testing be conducted with a relative humidity sensor accurate to within ±1 percent relative humidity. DOE maintained the original proposal from the May 2014 NOPR to use an aspirating psychrometer to measure inlet air relative humidity for portable and refrigerant-only whole-home dehumidifiers. 80 FR 5994, 5999 (Feb. 4, 2015).

Therma-Stor noted that it has used both aspirating psychrometers and relative humidity sensors for dehumidifier testing and has found both instruments capable of providing accurate and precise measurements. Therma-Stor recommended that DOE allow both aspirating psychrometers and relative humidity sensors (with specified precision and accuracy) to be used for testing all types of dehumidifiers. Therma-Stor asserted that allowing a testing laboratory to use either instrument would minimize instrument costs and the time required to set up and conduct tests on different types of dehumidifiers. (Therma-Stor, No. 15 at p. 2)

Aprilaire disagreed with the requirement for an aspirating psychrometer and recommended humidity sensors, or at a minimum a choice between the two methods. Aprilaire commented that humidity sensors are more reliable than, and not as sensitive to setup, calibration, and error during use, as aspirating psychrometers. Aprilaire also noted that U.S. Environmental Protection Agency (EPA) -certified testing facilities have confirmed that errors have been attributed to the setup, calibration, and use of an aspirating psychrometer, and that the facilities would prefer using humidity sensors. (Aprilaire, No. 14 at p. 3)

DOE notes that the February 2015 SNOPR proposal to incorporate relative humidity sensors into testing was intended only for refrigerant-desiccant whole-home dehumidifiers that require ducting. This proposal was based on extensive testing and common practice with measuring relative humidity conditions in a duct. Although DOE's test procedure for portable dehumidifiers and refrigerant-only whole-home dehumidifiers does not require ducts with relative humidity instrumentation, DOE received feedback that relative humidity sensors are more reliable, accurate, and repeatable than aspirating psychrometers. Commenters suggested that relative humidity sensors should also be permitted for use when testing portable dehumidifiers and refrigerant-only whole home dehumidifiers. Based on discussions with manufacturers regarding in-house and third-party testing that they conduct, DOE also believes that the majority of testing laboratories already implement these relative humidity sensors in conducting a wide range of tests for various products. Additionally, DOE conducted market research that supported commenters assertions regarding the accuracy of relative humidity sensors. Therefore, in light of this information and widespread industry support, DOE adopts in this final rule provisions that would allow either aspirating psychrometers or relative humidity sensors to be used for testing portable and refrigerant-only whole-home dehumidifiers. The accuracy for both types of instrumentation must be within 0.1 °F dry-bulb temperature, and either 0.1 °F wet-bulb temperature (for aspirating psychrometers) or 1 percent relative humidity (for relative humidity sensors). DOE notes that the allowable accuracy for relative humidity sensors approximates the current allowable accuracy for wet-bulb temperature as measured using an aspirating psychrometer at dry-bulb temperatures close to the nominal values of either 65 °F or 73 °F.

DOE further notes that ANSI/AHAM DH-1-2008 provides allowable dry-bulb and wet-bulb temperature ranges throughout the test period. According to ANSI/AHAM DH-1-2008, wet-bulb temperatures must be within 1 °F of the nominal wet-bulb specification for individual readings, and within 0.3 °F of the specified value for the arithmetical average over the test period. Because relative humidity sensors monitor relative humidity rather than wet-bulb temperature, DOE is establishing that all individual relative humidity readings be within 5 percent of the relative humidity setpoint, and the average relative humidity over the test period be within 2 percent of the relative humidity setpoint. These values approximately correspond to the current allowable wet-bulb temperature ranges for aspirating psychrometers.

6. Compressor Run-in Period

In the February 2015 SNOPR, DOE maintained the proposal from the May 2014 NOPR that the 24 hour run-in period need not be conducted in the test chamber. However, DOE proposed to clarify in appendix X1 that the run-in period must contain 24 hours of continuous compressor operation. This may be achieved by running the test unit outside of the test chamber with the control setpoint below the ambient relative humidity. 80 FR 5994, 6004 (Feb. 4, 2015).

AHAM believes that the unit must be run-in in a test chamber to ensure standardization and reduce variation in the testing process, and does not expect that DOE's proposal would minimize test burden. According to AHAM, a laboratory would have no choice but to run the unit in the test chamber or a chamber of similar environment to ensure 24 hours of continuous compressor operation. Accordingly, AHAM stated that test burden concerns should not preclude DOE requiring the run-in to occur in the test chamber. (AHAM, No. 16 at p. 7) DOE recognizes AHAM's concern with maintaining continuous compressor operation for 24 hours, but is still sensitive to the reduced burden that would be associated with conducting run-in outside of a test chamber. Further, even when operating in a test chamber at fixed ambient conditions, the compressor may periodically cycle off for reasons such as defrosting. The intent of run-in is to operate the compressor for a number of cumulative hours, and it is not necessary that those hours occur continuously. Therefore, DOE is clarifying in this final rule that the compressor need not operate for 24 continuous hours, but there must be a minimum of 24 hours of compressor operation in total. The compressor may periodically cycle off during this period as long as the cumulative compressor runtime is at least 24 hours.

7. Psychrometer Requirements

In the May 2014 NOPR, DOE proposed that portable dehumidifiers with multiple intake grilles be tested with a separate sampling tree placed 1 foot away in a perpendicular direction from the center of each air inlet. DOE also proposed to clarify that for portable dehumidifiers with only one intake grille, the psychrometer or sampling tree be placed 1 foot away in a perpendicular direction from the center of the air inlet. DOE proposed to add clarifying text that would allow no more than one portable dehumidifier connected to a single psychrometer during testing. DOE explained that these proposals would ensure consistency among test facilities and improve test result accuracy. 79 FR 29271, 29289–90 (May 21, 2014).

AHAM agreed with DOE's proposal to require multiple sampling trees for multiple intake grilles. AHAM also agreed that no more than one portable dehumidifier should be connected to a single psychrometer during testing; otherwise, the measurement will be the average wet-bulb and dry-bulb temperature for all units connected to it. AHAM also proposed that DOE require sampling trees for testing all dehumidifiers, regardless of air intakes, for consistency and repeatability. AHAM's round robin testing revealed a clear difference between using a sampling tree and placing a psychrometer box one foot from the air intake. (AHAM, No. 7 at p. 7) DOE reviewed the AHAM round robin test results provided in its comment, and notes that the data do not identify the individual laboratory test setups, nor did the submitted data quantify the impacts of individual test configurations or specific testing conditions. Although the AHAM data showed that one laboratory had a larger absolute z-score[8] for its capacity and EF results than the other laboratories, there is insufficient data for DOE to determine the cause of this larger z-score or to attribute it to one single test setup component. The round robin did not evaluate changes to the test procedure conditions individually. Therefore, at this time, DOE is unable to conclude which approach, sampling tree or psychrometer-only, is most repeatable and provides the best results. DOE thus maintains the proposal from the May 2014 NOPR that testing for units with a single air intake be monitored with a psychrometer placed perpendicular to, and 1 foot in front of, the center of the intake grille. Units with multiple air intakes must have a separate sampling tree placed perpendicular to, and 1 foot in front of, the center of each intake grille, with the samples combined and connected to a single psychrometer using a minimal length of insulated ducting. This approach will minimize test burden for units with a single air intake, and limit the requirement for a sampling tree to those cases in which average inlet conditions must be determined from multiple locations.

For units with multiple air intake grilles, if a relative humidity sensor is used instead of an aspirating psychrometer, separate sensors for measuring relative humidity and temperature

[8] The "z-score" is a measure of how much a single data point within a set of data varies from the mean of the data. Z-score is defined as the difference between the data point (in this case, a single laboratory's capacity or EF) and the mean of the set of corresponding data points (either capacity or EF), divided by the standard deviation of the data set. A larger magnitude for the z-score corresponds to a greater variation (either positive or negative) from the mean.

must be placed 1 foot in front of the center of each intake grille. The relative humidity and temperature measurements from each sensor is then averaged to determine the overall inlet air conditions, and the overall air conditions must fall within the test procedure tolerances.

Therma-Stor suggested that DOE clarify how to determine when more than one psychrometer is needed, because multiple intake grills could be very close to each other or far apart on different faces of the dehumidifier. (Therma-Stor, No. 6 at p. 2) DOE's research showed that units with multiple air intakes were typically configured with the intakes on different faces of the unit. Because DOE does not specify the maximum size for an air intake, as long as an air intake is contiguous and along the same surface of the unit (i.e., perpendicular to the air stream), the test procedure requires only one psychrometer or relative humidity sensor.

AHAM suggested that DOE define a standard psychrometer box and sampling tree in the test procedure, and recommended that DOE speak to third-party laboratories to develop such a specification. AHAM also proposed that DOE require a 90-degree elbow between the psychrometer fan and the dry and wet-bulb temperature sensors. AHAM believes that, depending on the location of the fan, there may be residual heat from the fan motor that is likely to affect the temperature readings. AHAM also indicated that air velocity in the psychrometer box has a direct effect on the wet-bulb temperature measurement and thus the overall temperature accuracy. Therefore, AHAM suggested that the acceptable air velocity range be changed from 700–1000 feet/minute to 900–1000 feet/minute. ASHRAE 41.1, Standard Method for Temperature Measurement, as referenced by ANSI/AHAM DH-1-2008 for psychrometer box design, recommends an air velocity of 1000 feet/minute. (AHAM, No. 7 at pp. 7–8, 11) Based on the AHAM-provided round robin data, DOE is unable to determine whether any repeatability improvements are associated with adjusting the fan location in relation to the dry-bulb and wet-bulb temperature sensors or with tightening the air velocity requirements because information about such test equipment configurations was not available. Also, DOE does not have sufficient data to quantify the burdens associated with reducing the allowable range from 700–1000 feet/minute to 900–1000 feet/minute, so it is maintaining the industry-accepted requirements as specified in ANSI/AHAM DH-1-2008 at this time. DOE is, however, committed to working with AHAM to further investigate this issue to confirm whether AHAM’s proposals would yield improvements in repeatability, and DOE does not expect such changes would impact the measured efficiency values.

Therma-Stor suggested that DOE consider the accuracy and precision of instrumentation for measuring test chamber conditions if multiple psychrometers are required. Otherwise, Therma-Stor believes that maintaining air conditions within a tight tolerance at two or more measurement points within the test chamber may become burdensome. (Therma-Stor, No. 6 at p. 2) DOE notes that a manufacturer need not test multiple dehumidifiers at the same time. For a unit with multiple air intakes, only one psychrometer is required and can be implemented with multiple sampling trees placed in front of each intake grille. Therefore, testing can be conducted while maintaining only one set of measured air conditions.

Aprilaire suggested that it is easier to control the conditions in the room overall than at the inlet. According to Aprilaire, its test chamber is designed so that, with the unit running, the room conditions are mixed and thus the same as the inlet conditions. (Aprilaire, Public Meeting

Transcript, No. 10 at pp. 68–69) Because testing is conducted at many different test chambers, it is important to ensure that the air around and entering the unit is consistent from test to test and laboratory to laboratory. Therefore, DOE maintains in this final rule that the test chamber conditions must be measured at the inlet of the test unit.

8. Condensate Collection

In the May 2014 NOPR, DOE investigated the test procedure condensate collection method to ensure that the amount of condensate measured during the dehumidification mode test for portable dehumidifiers and refrigerant-only whole-home dehumidifiers is representative of the amount of moisture removed from the air during the 6-hour test. DOE proposed that if means are provided on the dehumidifier for draining condensate away from the cabinet, the condensate would be collected in a substantially closed vessel which would be placed on the weight-measuring instrument. DOE further proposed that if no means for draining condensate away from the cabinet are provided, any automatic shutoff of dehumidification mode operation that would be activated when the collection container is full would be disabled to allow overflow. Any overflow would be collected in a pan that is completely covered to prevent re-evaporation and is placed beneath the dehumidifier. The collection pan would be sized to ensure that all water that overflows from the full internal collection container during the rating test period would be captured and covered by the collection pan. Both the pan and dehumidifier would be placed on the weight-measuring instrument for direct reading of the condensate weight during the test. Finally, DOE proposed that any internal pump would not be used to drain the condensate into a substantially closed vessel unless such pump is provided for use by default in dehumidification mode. 79 FR 29271, 29290 (May 21, 2014).

Aprilaire and AHAM agreed with DOE's proposals regarding condensate collection. (Aprilaire, Public Meeting Transcript, No. 10 at p. 30; Aprilaire, No. 5 at p. 3; AHAM, No. 7 at p. 8)

Therma-Stor suggested that both the dehumidifier and condensate vessel should be placed on a scale for a true measure of condensate collected. (Therma-Stor, No. 6 at p. 2) DOE notes that many condensate collection methods were investigated in its testing. DOE found that the simplest and most reproducible condensate collection approach is the gravity fed drain, where available. However, DOE recognized the direct scale measurement approach as the next most reproducible and maintains the proposal that the scale approach be used when no gravity drain option is available, as included in the May 2014 NOPR and the February 2015 SNOPR.

9. Control Settings

In the May 2014 NOPR, DOE proposed that for units with a "continuous on" feature, that control setting be selected for dehumidification mode testing. For units without a feature for continuous operation, the fan would be set at the maximum speed if the fan speed is user adjustable, and the relative humidity controls would be set to the lowest available value during dehumidification mode testing. 79 FR 29271, 29290 (May 21, 2014).

AHAM, GE, and Therma-Stor agreed with DOE's proposals for control settings, including the relative humidity setpoint and fan speed setting. (AHAM, Public Meeting Transcript, No. 10 at p. 34; GE, Public Meeting Transcript, No. 10 at p. 34; Therma-Stor, No. 6 at p. 3, AHAM, No. 7 at p. 8)

Aprilaire suggested that testing should be performed at settings that initiate latent heat removal at rated capacities. For units with multiple settings, Aprilaire suggested that manufacturers should be allowed to rate at multiple settings if it chooses to list the product that way. (Aprilaire, No. 5 at p. 3) DOE notes that the proposed test procedure only specifies performance under one test condition and control setting, and has maintained this requirement for this final rule. However, manufacturers may provide additional documentation to consumers regarding performance under alternate control settings (e.g., energy saver).

Therma-Stor stated that some whole-home dehumidifiers do not include integrated controls and are intended to operate with external controls of varying types. Therma-Stor suggested that these dehumidifiers should be manually set to dehumidification mode without the use of external controls if possible. (Therma-Stor, No. 6 at p. 3) DOE notes that all products in its test sample shipped with controls that could be used for conducting testing according to the test procedure proposed in the May 2014 NOPR. DOE recognizes that there may be units that are designed to be set via external controls, and therefore do not have integrated controls. Such units should be set manually to the conditions being specified in this final rule, without the use of external controls.

10. Ambient Condition Tolerances

In response to the May 2014 NOPR, AHAM proposed that DOE reduce the dry-bulb temperature tolerance from ± 2 °F to ±1 °F and the wet-bulb temperature tolerance from ± 1 °F to ± 0.5 °F. AHAM asserted that doing so would reduce test result variation without increasing testing burden because, as AHAM observed during round robin testing, laboratories are already capable of these more stringent tolerances. (AHAM, No. 7 at p. 10)

In addition to temperature measurement accuracy, AHAM proposed that DOE reduce the voltage tolerance from 2 percent to 1 percent because it would reduce variation, and AHAM believes test facilities already have the ability to maintain the more stringent tolerance based on observations during its round robin testing. AHAM also proposed that DOE change the condensate mass tolerance from 0.5 percent to +/-0.02 pounds because it would maintain the same degree of accuracy when testing dehumidifiers with a range of capacities. AHAM based the suggested tolerance number on the amount of condensate that is collected by typical small-capacity dehumidifiers. AHAM also noted it is open to other balance accuracy requirements. (AHAM, No. 7 at p. 11) DOE notes that during investigative testing, there was no indication that the ambient condition tolerances, voltage tolerance, or condensate collection tolerance reduced test repeatability and accuracy. Without specific data from the AHAM round robin testing that would allow DOE to evaluate the impact of these reduced tolerances, DOE does not have sufficient data to adjust the tolerances and is maintaining the proposals included in the May 2014 NOPR and the February 2015 SNOPR.

11. Measurement Frequency

In the May 2014 NOPR, DOE proposed that the measurement frequency for whole-home dehumidifiers must be greater than for portable dehumidifiers. DOE found that the measurement interval of 10 minutes or less in appendix X was sufficient for the steady-state operation of a portable dehumidifier in the test chamber, but that the conditions of the air flowing through ducts for whole-home dehumidifiers may vary on time scales that are shorter than 10 minutes. Therefore, DOE proposed that whole-home dehumidifiers be tested with measurement acquisition rates for dry-bulb temperature, velocity pressure, and relative humidity equal to or more frequently than once per minute. 79 FR 29271, 29289 (May 21, 2014).

Aprilaire agreed with DOE's proposal to measure data at least every minute, but stated that it was not clear why data recording frequency should be higher for whole-home dehumidifiers than for portable dehumidifiers. (Aprilaire, Public Meeting Transcript, No. 10 at p. 78; Aprilaire, No. 5 at p. 4) AHAM proposed that dehumidifiers be tested with an acquisition rate of at least once per minute, and that weight measurements be included in the data to be recorded at each interval. AHAM believes that test facilities already have the necessary data acquisition equipment, so there should be no added test burden. AHAM noted that these requirements are also consistent with other DOE test procedure requirements, such as the refrigerator/freezer test procedure. (AHAM, No. 7 at p. 12) As explained previously, DOE believes that the conditions of air flowing through ducts may vary on time scales shorter than 10 minutes, and thus whole-home dehumidifiers would warrant a minimum of one reading per minute. DOE notes that its portable dehumidifier investigative testing recorded ambient conditions and weight data at a higher sampling rate than the requirements in appendix X, and did not find significant variation in the test conditions for portable dehumidifiers. Therefore, DOE does not believe that it is necessary to reduce the interval between measurements for portable dehumidifiers, though DOE notes that this requirement is a minimum and that testing may be conducted with more frequent measurements if the laboratory chooses.

12. Test Period

In the May 2014 NOPR, DOE did not propose modifying the current 6-hour test period in appendix X. Therma-Stor commented that at the proposed ambient test temperature for portable dehumidifiers of 65 °F dry-bulb, the variability of the test may increase as some models move from steady-state to cyclic operation due to the formation of ice and frost on the evaporator coils. Therma-Stor suggested that the test period and methodology may need to be revised to account for cyclic operation. Therma-Stor believes that a fixed test period may not provide repeatable results for cyclic operation because the condensate removal rate may increase and decrease during cycles, and capacity and efficiency may vary based on the portion(s) of the operating cycle when data are collected. (Therma-Stor, No. 6 at p. 3) While conducting the dehumidifier test procedure and standards rulemaking, DOE tested two separate groups of portable dehumidifiers. Both sets of units were selected from among various manufacturers and covered the full range of available capacities to act as a representative sample of units available on the market at the time. The sample units were tested at the ambient conditions proposed in the May 2014 NOPR and February 2015 SNOPR (65°F dry-bulb temperature and 60-percent relative humidity). Of the first 14 units tested, 5 units cycled the compressor during the dehumidification mode test. Of the 13 units tested in the next round of testing, 2 cycled the compressor during dehumidification mode testing. All of the others operated the compressor continuously. DOE notes that the second round of testing was performed on units manufactured after October 2012, and thus the units had been certified as compliant with the current energy conservation standards that had taken effect that month. Therefore, these units were likely to represent the most current designs and typical operation at the test conditions. In response to Therma-Stor's comment, DOE's testing confirmed that the test procedure methodology and test period captured the cyclic nature of the dehumidifier models tested as part of DOE's investigation that are currently on the market. Because cyclic operation typically yields lower IEF values due to the inclusion of defrost energy, DOE expects that manufacturers will engineer updated models that will avoid defrost cycling at the new 65 °F and 60-percent relative humidity test conditions. In addition, DOE believes that Therma-Stor's comment likely also addresses whole-home dehumidifiers, which will be tested at 73 °F rather than 65 °F. Because cycling typically occurs less frequently at higher temperatures, DOE expects cyclic operation to be less of an issue for whole-home dehumidifiers, thereby alleviating Therma-Stor's concern.

As discussed in the February 2015 SNOPR, DOE tested a limited sample of whole-home dehumidifiers at the proposed 73 °F ambient condition and did not find that any of these test units cycled for defrost purposes. Because the test sample included units from a range of manufacturers, DOE does not believe that cycling for defrosts would be an issue for testing current whole-home dehumidifiers at the proposed 73 °F test condition.

C. Whole-Home Dehumidifier Case Volume Measurement

In the February 2015 SNOPR, DOE proposed that whole-home dehumidifier case volume be determined based on the maximum length of each dimension of the whole-home dehumidifier case, exclusive of any duct collar attachments or other external components. 80 FR 5994, 6000 (Feb. 4, 2015). DOE received no comments in response to the whole-home dehumidifier case volume measurements and calculations, and therefore, DOE maintains the case volume equation proposed in the February 2015 SNOPR.

D. Off-Cycle Mode

In the May 2014 NOPR, DOE proposed a definition for off-cycle mode that would preclude fan operation. However, DOE indicated that certain dehumidifier models maintain blower operation without activation of the compressor after the humidity setpoint has been reached. Such fan-only mode operation may be intended to draw air over the humidistat to monitor ambient conditions, or may occur immediately following a period of dehumidification mode to defrost and dry the evaporator coil to prevent the humidistat from prematurely sensing a humidity level high enough to reactivate the compressor. In these cases, the blower may operate continuously in fan-only mode, or may cycle on and off intermittently. DOE proposed provisions for accounting for the energy consumption for dehumidifiers that either enter off-cycle or fan-only mode. 79 FR 29271, 29290 (May 21, 2014).

Therma-Stor and the Joint Commenters agreed with DOE's proposal to measure fan-only mode energy use. Additionally, Therma-Stor and GE suggested that if there is a control option that allows the user to manually engage the fan without dehumidification, either continuously or in an energy saver mode, that such a mode should be excluded from the overall energy use measurement. (Joint Commenters, No. 8 at p. 5; Therma-Stor, No. 6 at p. 5; GE, Public Meeting Transcript, No. 10 at pp. 86–89)

GE suggested that if a unit does not have a fan-only mode it should not be measured or accounted for in the EF. (GE, Public Meeting Transcript, No. 10 at p. 85) DOE notes that the fan-only mode definition and proposed test procedure supplement the off-cycle mode provisions in appendix X. Therefore, if a unit does not have fan-only mode, as defined in the May 2014

NOPR, that unit would instead have off-cycle mode and the existing approach for testing and considering off-cycle mode would apply.

Aprilaire recommended that only fan energy used during dehumidification mode be included. According to Aprilaire, the effects of fan operation outside of dehumidification mode and its effects on controlling humidity in the room, reducing cycling of the dehumidifier, and reducing energy use are not clearly understood at this time. (Aprilaire, No. 5 at pp. 4–5)

Aprilaire commented that whole-home dehumidifier fans are activated for multiple reasons, including ensuring proper air circulation throughout the home or delivering other indoor air quality and temperature averaging properties. Aprilaire requested that DOE clarify whether fan mode refers to operation of the fan inside the unit or the HVAC fan. According to Aprilaire, certain whole-home dehumidifiers use the fan inside the unit to sample air but will use the HVAC fan when it's running to perform that sampling to minimize energy consumption. (Aprilaire, Public Meeting Transcript, No. 10 at pp. 24–25, 89) As discussed above regarding dehumidification mode, DOE clarifies that fan-only mode is only referring to the fan or blower that operates within the dehumidifier’s case and not the home’s HVAC fan.

In the February 2015 SNOPR, DOE proposed that off-cycle mode testing be conducted over a duration representative of the typical off-cycle duration. Based on the metered off-cycle duration, DOE proposed an off-cycle mode test beginning immediately after completion of the dehumidification mode test and ending after a period of 2 hours. The average power measurement for the 2-hour period would then be applied to the 1,850 annual hours associated with off-cycle mode in the final IEF calculation. 80 FR 5994, 6001 (Feb. 4, 2015).

AHAM asserted that DOE's proposed definition of off-cycle mode in the February 2015 SNOPR conflicts with the proposed dehumidification mode definition. AHAM stated that the dehumidification mode definition describes the fan or blower as being active without the activation of the refrigeration system, and that this definition is similar to the off-cycle mode definition, which provides that the dehumidifier may or may not operate its fan or blower. AHAM believes this may be a conflict, and therefore proposed alternate definitions for dehumidification mode and off-cycle mode:

> Dehumidification mode: an active mode in which a dehumidifier has activated the main moisture removal function according to the humidistat or humidity sensor signal and the ambient relative humidity is equal to or higher than the relative humidity setpoint.
>
> Off-cycle mode: a mode in which the dehumidifier has cycled off its main moisture removal function by humidistat or humidity sensor and the ambient relative humidity has fallen below the relative humidity setpoint. (AHAM, No. 16 at p. 2)

DOE notes that the dehumidification mode definition proposed in the February 2015 SNOPR requires first that the main moisture removal function be active, and then the second part of the definition, quoted by AHAM, clarifies that this may include operation of the refrigeration system or operation of the fan without operation of the refrigeration system. The off-cycle mode definition requires that the main moisture removal function has been cycled off, which would mean the unit is not in dehumidification mode; therefore, there is no conflict between the dehumidification mode and off-cycle mode definition. DOE also notes that the definitions cannot relate ambient relative humidity to the control setpoint because temperature sensors and thermostats vary in their sensitivity and each manufacturer may program their controls to react to changes in relative humidity differently. For example, one unit may cycle off the main moisture removal function when the sensor indicates the ambient humidity has dropped below the setpoint by at least 1-percent relative humidity, while other may choose a different deadband. Therefore, DOE is maintaining the definitions as proposed in the February 2015 SNOPR.

The California IOUs support the proposed definition for off-cycle mode, and believe that the proposed energy use measurement while the product is in off-cycle mode would effectively capture the energy use of fan-only mode as well as standby mode. However, the California IOUs recommended that DOE consider amending the proposed off-cycle mode test procedure initiation process to initiate the transition from active mode to off-cycle mode by means of a change in ambient relative humidity rather than manually adjusting the dehumidifier setpoint to a level that places the dehumidifier into off-cycle mode while holding the ambient relative humidity of the test chamber constant. The California IOUs stated that this would assess how well the humidistat and setpoint controls work together to respond to changes in ambient conditions. (California IOUs, No. 18 at p. 2) Although the approach suggested by the California IOUs would represent varying ambient conditions as are seen in the field, DOE expects that the additional complexity necessary for the testing would increase test burden and decrease repeatability and reproducibility. This type of test would require testing only one unit at a time within a chamber because each unit may initiate off-cycle mode at a different relative humidity. Additionally, the rate of change of the relative humidity in the chamber would depend on the overall size of the chamber in relation to the capacity of the test unit. DOE notes that it would also be difficult to maintain other test conditions, such as temperature, within the chamber as relative humidity changes. DOE believes this additional test burden would not be warranted and expects its approach to test off-cycle mode for a fixed duration to provide repeatable and sufficiently representative results.

AHAM agreed with DOE's proposed off-cycle mode instrumentation requirements and also agreed that the off-cycle mode measurement should begin immediately after the compressor operation for the dehumidification mode, as proposed in the February 2015 SNOPR. However, AHAM asked DOE to clarify if the transition from dehumidification mode to off-cycle mode is instantaneous. If so, AHAM believes the compressor function needs to be monitored to ensure it has ended before recording measurements for off-cycle mode. AHAM proposed to add an extension of 10 minutes before the switch to the off-cycle mode measurements to ensure the compressor has cycled off. (AHAM, No. 16 at p. 3) DOE notes that based on the definitions proposed in the February 2015 SNOPR, the switch from dehumidification mode to off-cycle mode is signified by the cycling off of the main moisture removal function. This is initiated by adjusting the dehumidifier's relative humidity setting and is confirmed by observing the compressor or main moisture removal function cycling off. DOE notes that all test units immediately cycled off the compressor in response to the relative humidity setpoint adjustment. Therefore, DOE proposed in the February 2015 SNOPR that the off-cycle rating period shall begin when the compressor has cycled off due to the change in relative humidity setpoint, immediately following dehumidification mode. As explained in the February 2015 SNOPR, conducting the off-cycle mode test immediately following the dehumidification mode test would capture all energy use of the dehumidifier under conditions that meet the newly proposed off-cycle mode definition, including fan operation intended to dry the evaporator coil, sample the air, or circulate the air. DOE also notes that a 10-minute delay in the start of the off-cycle mode test period may exclude any energy consumed to dry off the evaporator coils. Therefore, DOE is not adopting a 10-minute delay between the end of the dehumidification mode test and the start of the off-cycle test.

The California IOUs believe that under the same ambient conditions, two dehumidifiers may spend different amounts of time in off-cycle mode. According to the California IOUs the amount of time that each unit spends in off-cycle mode is a function of both humidistat accuracy and automatic setpoint control, as well as effective management of fan-only mode. Therefore, the California IOUs recommended that DOE consider modifying the test procedure to standardize a method for measuring off-cycle duration by using the test chamber to simulate field conditions. One method that the California IOUs suggested would be to define the rate of humidification in the test chamber such that the dehumidifier under test is capable of achieving its setpoint humidity. The test procedure would then require observing and measuring the operation of the unit as it enters off-cycle mode and then again as it reengages active mode once ambient humidity increases above the setpoint. The time that the device spends in off-cycle mode, as well as the ambient humidity levels at which the device entered and exited off-cycle mode, would be a reported test result that could be used as a variable for calculating annual energy use. (California IOUs, No. 18 at p. 3) DOE notes that this approach proposed by the California IOUs would increase test complexity similar to the method described above for initiating off mode. In addition to the concerns described for that approach, this suggested methodology would require a fixed humidification rate into the test chamber, and would only provide representative conditions for one room size. Dehumidifiers are sold in various capacities that are targeted for different room sizes and applications. Therefore, it would not be representative to test all dehumidifiers according to one humidification rate. DOE further notes that extensive testing would be necessary to determine an appropriate humidification rate and there would be a significant increase in test burden to maintain and ensure a consistent humidification rate before and during the off-cycle mode rating test period. Due to the burdens and complexity associated with the suggested method, DOE establishes that off-cycle mode testing be initiated by changing the control setpoint of the test unit rather than by allowing ambient conditions to vary in the test chamber.

AHAM requested the data DOE used to determine the average off-cycle duration of 2 hours. (AHAM, No. 16 at p. 3) During the 2012 and 2013 humidity seasons, DOE conducted a field metering study for portable dehumidifiers to monitor the cycling patterns of various modes during typical operation (hereinafter the 2013 Willem study).[9] The study determined the average off-cycle duration for all test units, while excluding long duration off-cycle periods likely caused by a full condensate container or periods of time where the ambient relative humidity was considerably lower than the set point. The 2013 Willem study shows that, when excluding off-cycle durations longer than 12 hours and repeating the analysis to exclude off-cycle duration

[9] "Using Field-Metered Data to Quantify Annual Energy Use of Residential Portable Unit Dehumidifiers," Lawrence Berkeley National Laboratory. Berkeley, CA. Report No. LBNL-6469E Rev. (2013) (Available at: https://publications.lbl.gov/).

longer than one day, the average off-cycle durations were 64 minutes and 169 minutes, respectively. DOE believes that these values reflect typical off-cycle durations, while excluding time the dehumidifier spends with a full internal condensate collection container, during which dehumidification mode operation is suspended until the container is emptied. DOE selected an approximate midpoint between these two values, 2 hours, as a representative off-cycle mode test period.

The California IOUs and Joint Commenters supported DOE's intent to capture all energy use in off-cycle mode, but noted that the energy use impact of fan operation after the compressor cycles off would not be fully captured. In particular, they noted that while the proposed off-cycle mode test would fully capture fan power consumption, it would not capture the efficiency impact of re-evaporation of moisture still on the evaporator coils. They noted that humidification of the space during off-cycle mode would decrease the overall dehumidifier efficiency, causing the ambient relative humidity to rise and leading to active mode operation reengaging sooner than otherwise would have been necessary. They asserted that, through this process, a device that does not properly manage its fan-only mode will consume more energy over time. The Joint Commenters noted in comments on the May 2014 NOPR that NREL's test of two portable dehumidifier units that continue to operate the fan after the compressor cycles off demonstrated that with compressor run times ranging from 3 to 6 minutes, 17 to 42 percent of the removed moisture was returned to the space, meaning that 17 to 42 percent of the energy consumed in dehumidification mode was wasted. The California IOUs proposed that DOE consider an adjustment factor or other test procedure provisions to account for this issue. (Joint Commenters, No. 17 at p. 2; California IOUs, No. 18 at p. 2)

The NREL study referenced by the Joint Commenters and the California IOUs determined a relationship between cyclic compressor run time and the percent of moisture returned to the room when the compressor cycles off. This relationship was developed based on part-load test data from two portable dehumidifiers for which the compressor run times were set as test parameters and did not represent the default dehumidifier control schemes responding to changing ambient conditions. Compressor run times in the field likely vary significantly depending on local ambient conditions, resulting in runtimes which may be substantially longer than the 3 to 6-minute range where re-evaporation is a significant issue. For example, the 2013 Willem study found that the average compressor runtime was 50 minutes based on the most conservative estimate of eliminating all compressor on-cycles with durations longer than 4 hours. DOE notes that Figure 11 in the NREL report indicates that as compressor runtime increases, the percent of returned moisture quickly falls below 5 percent of the total removed condensate for compressor runtimes of 50 minutes. Because dehumidifier compressor operating time is both dependent on the local ambient conditions and the specific manufacturer control scheme, and because metering and test data indicate that re-evaporation would likely have a minimal effect, DOE is not incorporating provisions to quantify the effects of moisture returned to the conditioned space during off-cycle mode for the dehumidifier test procedure.

E. Technical Corrections and Clarifications

1. Average Relative Humidity

In the February 2015 SNOPR, DOE proposed modified versions of Table II in ANSI/AHAM DH-1-2008 to cover the range of dry-bulb and wet-bulb temperatures that would be necessary to determine relative humidity at the proposed ambient test conditions within the test tolerances for portable and whole-home dehumidifiers. 80 FR 5994, 6001–02 (Feb. 4, 2015).

AHAM and Therma-Stor noted that the proposed Table III.2, "Percent Relative Humidity Determination for Portable Dehumidifiers" included in the February 2015 SNOPR, appeared to provide an incorrect range for both the dry-bulb and wet-bulb temperatures. The proposed Table III.2 lists a range of 72.5 °F to 73.5 °F dry-bulb temperature and 63.3 °F to 63.9 °F wet-bulb temperature. These commenters noted that these ranges do not match the proposed temperatures for portable dehumidifiers. (AHAM, No. 16 at p. 4; Therma-Stor, No. 15 at p. 3)

In the February 2015 SNOPR, the discussion section inadvertently presented two tables that each listed the range of dry-bulb and wet-bulb temperatures proposed for whole-home dehumidifier testing, but not those that satisfied the proposed portable dehumidifier test conditions. However, Section 4.1.1 in the regulatory text section of the February 2015 SNOPR included correct temperature specifications for both whole-home dehumidifiers and portable dehumidifiers. DOE is maintaining the correct temperature tables as included in the proposed regulatory text in the February 2015 SNOPR.

2. Corrected Capacity and Corrected Relative Humidity Equations

In the February 2015 SNOPR, DOE proposed substitute coefficients for the corrected capacity and corrected relative humidity equations in Section 7.1.7 of ANSI/AHAM DH-1-2008. DOE developed these proposed coefficients by analyzing the psychrometric properties within the tolerances of the portable and whole-home dehumidifier ambient test conditions. 80 FR 5994, 6003 (Feb. 4, 2015).

AHAM agreed with DOE's methodology for determining the correction for capacity and relative humidity, but requested details of DOE's data analysis and specific methodology used to develop the corrections. (AHAM, No. 16 at pp. 4–5)

As explained in the February 2015 SNOPR, DOE calculated the percent change in humidity ratio from the standard rating conditions of 65 °F dry-bulb (for portable dehumidifiers) or 73 °F dry-bulb (for whole-home dehumidifiers) and 60-percent relative humidity for small perturbations in either dry-bulb temperature or relative humidity. For the temperature adjustment coefficient, the dry-bulb temperature was varied within test tolerance while holding the relative humidity fixed. For the relative humidity adjustment coefficient, the wet-bulb temperature was varied within test tolerance while holding the dry-bulb temperature fixed, and the resulting variation in relative humidity was calculated. The coefficients themselves were calculated from linear curve fits of the changes in humidity ratio for the given temperature tolerance range. DOE used a similar approach to determine the appropriate coefficients for the corrected relative humidity equation based on small perturbations in barometric pressure. DOE also incorporated a clarification that the capacity used as an input to the corrected capacity equation would be the measured capacity for portable and refrigerant-only whole-home dehumidifiers and the calculated capacity during testing for refrigerant-desiccant whole-home dehumidifiers.

3. Integrated Energy Factor Calculation

In the May 2014 NOPR, DOE proposed to modify the existing IEF equation in section 5.2 of appendix X to incorporate the annual combined low-power mode energy consumption, E_{TLP}, in kWh per year, the fan-only mode energy consumption, E_{FM}, in kWh per year, and the dehumidification mode energy consumption, E_{DM}, in kWh, as measured during the dehumidification mode test. The proposed IEF equation used the measured condensate collected during the dehumidification mode test, with no adjustments for variations in the ambient test conditions. 79 FR 29271, 29291–92 (May 21, 2014). As discussed above, in the February 2015 SNOPR DOE proposed to remove fan-only mode and to define off-cycle mode to include any fan operation when the compressor has cycled off, thereby removing separate fan-only mode energy use from the IEF equation. 80 FR 5994, 6000 (Feb. 4, 2015).

AHAM opposed DOE's accompanying proposal to allocate the 1,840.5 annual hours currently attributed to off-cycle mode to fan-only mode because of a lack of supporting data. AHAM believes the hours must be based on consumer use data and DOE assumed that the fan is continuously on, which may not always be the case. AHAM commented that DOE should study the amount of time dehumidifiers typically stay in fan-only mode in consumers' homes. (AHAM, No. 7 at p. 4) DOE notes that with the updated proposal in the February 2015 SNOPR, no specific duration of fan operation is assumed. Instead, the proposed methodology, which is adopted in this final rule, allocates the annual hours to off-cycle mode, which would include any fan operation after the compressor has cycled off.

GE stated that drawing air over the humidistat, defrosting the evaporator, and circulating air are not primary functions, and was concerned that if these are included in the energy factor, the reported energy use would greatly increase. GE stated that because these are optional functions, they would likely no longer be included if they are to be considered as part of the IEF. GE further commented that for a similar product, ENERGY STAR allows for an "energy saver mode," in which the fan turns off when the compressor does, except that some air sampling is allowed and the fan may run for a certain period of time after the unit is shut off. For dehumidifiers, GE supports maintaining air sampling and defrosting functions. Therefore, GE requested that these functions be removed from the measured energy use. (GE, Public Meeting Transcript, No. 10 at pp. 85–86) The February 2015 SNOPR proposed that the two hours of dehumidifier operation following a compressor cycle be measured and considered off-cycle mode. This off-cycle mode energy consumption is monitored and included in the IEF metric to ensure that any energy consumption in continuous fan operation is addressed in the overall performance metric. During investigative testing, DOE found that fan operation following a compressor cycle can result in significant energy consumption, especially if it occurs following every compressor cycle, and believes that it is important to include a measure of such energy use to properly measure the representative energy consumption of the dehumidifier. DOE notes that short periods of fan operation for sampling air or other necessary functions over the course of the 2-hour test duration would impact the calculated IEF to a much lower extent than continuous fan operation.

AHAM and Therma-Stor observed that the proposed IEF equation does not convert the corrected capacity, C_t, in pints per day, to liters per day, and instead yields a result of pounds of water per kWh. Therma-Stor recommended that the equation should be adjusted to yield a result in liters of water per kWh. AHAM further requested that DOE apply a multiplication factor of

0.473 to the corrected capacity to convert from pints per day to liters per day. The numerator would then be divided by a factor of 24 hours to get the appropriate units of liters and multiplied by six to get the capacity within the test period. AHAM also requested that DOE clarify if this equation applies to both appendix X and appendix X1, and if so, DOE must ensure that it does not change measured energy in appendix X. (AHAM, No. 16 at pp. 5–6; Therma-Stor, No. 15 at pp. 3–4)

DOE agrees that the IEF equation proposed for appendix X1 in the February 2015 SNOPR inadvertently results in units of pounds of water per kWh and not the intended units of liters of water per kWh. DOE maintains its approach to convert the corrected capacity, and not the measured capacity as proposed by AHAM. Therefore, DOE adds a conversion factor to convert from pounds of water to liters of water to correct the proposed IEF equation in appendix X1. DOE estimated that the water condensed on the evaporator and collected in the condensate collection container would be similar to the evaporator temperature. Therefore, DOE concluded that the typical specific weight of water collected is 8.345 pounds per gallon at 40 °F. Using the conversion of 3.785 liters per gallon, DOE determined a conversion factor of 0.454 liters per pound of water. DOE removes reference to the measured water removed during the 6-hour test and only includes the corrected capacity in the list of variables for the IEF equation. In sum, DOE establishes the appendix X1 IEF equation in this final rule as follows:

$$IEF = \frac{\left(C_r \times \frac{t \times 1.04}{24}\right) \times 0.454}{\left[E_{DM} + \left(\left(\frac{E_{TLP}}{1095}\right) \times 6\right)\right]}$$

Where:

C_r is the corrected product capacity in pints per day;

t is the test duration in hours;

E_{DM} is the energy consumption during the 6-hour dehumidification mode test in kWh;

E_{TLP} is the annual combined low-power mode energy consumption in kWh per year;

1,095 is the dehumidification mode annual hours, used to convert E_{TLP} to combined low-power mode energy consumption per hour of dehumidification mode;

6 is the hours per dehumidification mode test, used to convert annual combined low-power mode energy consumption per hour of dehumidification mode for integration with dehumidification mode energy consumption;

1.04 is the density of water in pounds per pint;

0.454 is the liters of water per pound of water; and

24 is the number of hours per day.

4. Definition of "Inactive Mode"

In the February 2015 SNOPR, DOE proposed to specifically exclude the humidistat and humidity sensor from the internal sensor mentioned in the inactive mode definition, initially proposed in the May 2014 NOPR. 80 FR 5994, 6005 (Feb. 4, 2015). AHAM agreed with DOE's proposed modification to the inactive mode definition. (AHAM, No. 16 at p. 7) Accordingly, DOE has maintained in this final rule the definition of inactive mode as proposed in the February 2015 SNOPR.

5. Codified Energy Conservation Standards

Energy conservation standards for all dehumidifiers manufactured on or after October 1, 2012, are codified in 10 CFR 430.32(v)(2) as shown in Table III.1.

Table III.1: Current Dehumidifier Energy Conservation Standards Codified in the CFR

Product capacity (pints/day)	Minimum energy factor (liters/kWh)
Up to 35.00	1.35
35.01-45.00	1.50
45.01-54.00	1.60
54.01-75.00	1.70
75.00 or more	2.5

DOE notes that the current minimum energy factor table places a dehumidifier with a capacity of 75.00 in two product classes, and that the largest capacity product class does not correctly reflect the product class definitions set forth in Part B of Title III of EPCA (42 U.S.C. 6295(cc)), DOE is therefore amending 10 CFR 430.32(v)(2) to specify that the largest product class includes dehumidifiers with product capacity of 75.01 or more, in accordance with EPCA.

F. Certification and Verification

In the May 2014 NOPR, DOE proposed various requirements for dehumidifier certification reports. DOE proposed to require that for a given test sample size of a basic model, the average of the measured capacities be used for certification purposes. DOE also proposed to clarify which sections of the test procedure in appendix X and X1 should be used to measure capacity. DOE proposed to include rounding instructions in appendix X and X1 to clarify that the measurement of capacity and calculated IEF should be rounded to two decimal places. 79 FR 29271, 29292 (May 21, 2014).

AHAM agreed with the proposal that the average of the capacities measured for a given sample be used for certification purposes. AHAM also supported the proposal to round the capacity measurement to 2 decimal places. However, AHAM asked whether DOE would permit conservative ratings of capacity. (AHAM, Public Meeting Transcript, No. 10 at p. 96; AHAM, No. 7 at p. 10) As discussed in the May 2014 NOPR, DOE proposed that dehumidifier capacity be rated and certified based on the average of the capacities measured for a given basic model sample size. Therefore, DOE does not allow for variations from the average of the measured capacities for rating purposes. DOE notes that manufacturers may conservatively rate IEF under the proposed certification requirements.

AHAM also asked whether the certified capacity would be the exact average of each sample or a rounded value, and whether individual capacity measurements should be rounded before the final average is rounded. (AHAM, Public Meeting Transcript, No. 10 at pp. 94–95; AHAM, No. 7 at p. 10) As proposed in the May 2014 NOPR, the capacity for each sample must be determined based on the specified sections of appendix X or X1 and rounded to two decimal places. Therefore, the certified capacity would be the average of the rounded capacity for each unit in the test sample. DOE maintains these requirements in this final rule.

For verification purposes, DOE proposed that the test facility measurement of capacity must be within 5 percent of the rated capacity, or 1.00 pints/day, whichever is greater. DOE also proposed that if a rated capacity is not within 5 percent of the measured capacity, or 1.00 pints/day, whichever is greater, the capacity measured by the test facility would be used to determine the energy conservation standard applicable to the tested model. 79 FR 29271, 29292 (May 21, 2014).

AHAM agrees that enforcement provisions should require a test laboratory measurement of capacity to be within 5 percent of the rated value, or 1.00 pint/day, whichever is greater, and if this tolerance is not met, the laboratory value should be used to determine the product class. This approach is consistent with AHAM's verification program. (AHAM, No. 7 at p. 10) Thus, DOE maintains these provisions in this final rule.

G. Compliance Dates of Amended Test Procedures

In the May 2014 NOPR, DOE proposed that manufacturers would be required to use the revised appendix X for representations 180 days after the publication of any final amended test procedures in the Federal Register. DOE also proposed that, alternatively, manufacturers may certify compliance with any amended energy conservation standards prior to the compliance date of those amended energy conservation standards by testing in accordance with appendix X1. However, DOE proposed that manufacturers would be required to use the new appendix X1 for determining compliance with any amended standards adopted in the ongoing energy conservation standards rulemaking. 79 FR 29271, 29292 (May 21, 2014).

Therma-Stor suggested that if the test procedure is significantly revised, DOE should allow a reasonable grace period between publication of the final rule and the compliance date to allow small manufacturers to make necessary revisions to their products, literature materials, test facilities, and test instrumentation. (Therma-Stor, No. 6 at p. 6; Therma-Stor, No. 15 at p. 4)

DOE notes that in the energy conservation standards NOPR for dehumidifiers, DOE proposed a compliance date of 3 years after publication of any amended standards to provide manufacturers sufficient time to comply with the new test procedures and standards. 80 FR 31645 (June 3, 2015).

AHAM opposed the open-ended early compliance date for testing, noting that it supported such an approach for residential refrigerators/freezers and clothes washers for the limited purpose of easing the burden associated with manufacturers transitioning their full product lines to comply with amended standards on one date. (AHAM, No. 7 at p. 2)

AHAM supported DOE's guidance permitting early use of a new or amended test procedure as long as the products are certified to the applicable new or amended standards. However, AHAM requested that DOE remove the following phrase from DOE's guidance document "if a new or amended standard has not yet been established, manufacturers should ensure that their products or equipment satisfy the existing standard." AHAM believes this is contrary to EPCA's intent and policy to provide consumers with accurate, credible, and comparative energy information, especially if ENERGY STAR requires the use of a revised test procedure in advance of DOE compliance. AHAM suggested that this guidance would also allow manufacturers to pick and choose a test procedure that would result in more advantageous performance measurements. AHAM further suggested that the guidance would present challenges for verification because third parties could also test with either test procedure and, because a translation equation is an approximation, may not achieve the same results when using a different procedure. Accordingly, AHAM proposed that DOE revise its introductory notes to ensure that only one test procedure is in use at a given time to comply with a standard. (AHAM, No. 7 at pp. 2–3; AHAM, No. 16 at pp. 7–8)

AHAM further stated that early test procedure compliance must be connected to compliance with the amended standard. AHAM noted that, given the dramatic changes to capacity and IEF due to changes in ambient conditions and the inclusion of fan-only mode, early use of the test procedure will likely be needed for a brief time to ease the transition to the new standard, but the transition period must be limited. AHAM believes that DOE should clearly state a "start date" for early use of the test procedure, which AHAM requests should be no earlier than 9 months before the compliance date of standards. (AHAM, No. 7 at p. 3)

Where DOE has determined the amended test procedure will impact the measured efficiency and compliance with standards, DOE provides the opportunity for manufacturers to certify compliance using the new test procedure after the issuance of amended energy conservation standards. This approach is consistent with the guidance document issued in June 2012 and revised in August 2014, in which DOE provides discussion and details regarding early compliance.[10] Further, DOE does not believe it is appropriate to place a limit on the allowable period for early compliance. After the issuance date of a final rule to establish amended energy conservation standards, manufacturers may test according to appendix X1 to certify compliance with the amended standards. As established in this notice, appendix X and appendix X1 each contain introductory notes explaining when manufacturers may test and certify according to each version of the test procedure.

[10] Guidance document is available at: http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/tp_earlyuse_faq_2014-8-25.pdf

IV. Procedural Issues and Regulatory Review

A. Review Under Executive Order 12866

The Office of Management and Budget (OMB) has determined that test procedure rulemakings do not constitute "significant regulatory actions" under section 3(f) of Executive Order 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 the OMB.

B. Review under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 et seq., as amended by the Small Business Regulatory Fairness Act of 1996) requires preparation of an initial regulatory flexibility analysis (IRFA) for any rule that by law must be proposed for public comment and a final regulatory flexibility analysis (FRFA) for any such rule that an agency adopts as a final rule, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. A regulatory flexibility analysis examines the impact of the rule on small entities and considers alternative ways of reducing negative effects. As required by Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (Aug. 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 final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE has concluded that the rule would not have a significant impact on a substantial number of small entities. The factual basis for this certification is as follows:

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). The threshold number for NAICS classification code 335211, "Electric Housewares and Household Fan Manufacturing," is 750 employees; this classification specifically includes manufacturers of dehumidifiers.

DOE surveyed the AHAM member directory to identify manufacturers of residential dehumidifiers. DOE then consulted 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 estimates that there are five small businesses that manufacture dehumidifiers.

This final rule amends the current test procedure in appendix X and establishes a new test procedure for dehumidifiers at appendix X1 that revises ambient temperature for active mode testing and requires that whole-home dehumidifiers be tested in active mode with ducting in place. The lower temperature test that DOE is establishing for portable dehumidifiers in dehumidification mode requires ambient temperature and humidity levels identical to those contained in section 8.2, Low Temperature Test, of ANSI/AHAM DH-1-2008, which some manufacturers already may be using. The test room ambient temperatures for whole-home dehumidifiers are higher than those for portable dehumidifiers, and would therefore be no more difficult or costly to achieve than the 65 °F test condition. In addition, product specifications for dehumidifiers from each of the small businesses indicate that they produce dehumidifiers rated for operation at ambient temperatures of 65 °F or below, suggesting that these manufacturers have conducted lower temperature testing already.

Friedrich commented that testing portable dehumidifiers at 65 °F would force a redesign of its product line because that ambient temperature would require larger coils, thus increasing unit cost. (Friedrich, Public Meeting Transcript, No. 10 at pp. 96–97) DOE notes that product redesigns would likely be in response to potential amended energy conservation standards for dehumidifiers rather than the establishment of a new test procedure. Products currently available on the market can be tested according to the newly established test procedure, and any cost impacts associated with design changes necessary to achieve potential amended energy conservation standards would be considered in the concurrent dehumidifier standards rulemaking.

In response to the proposed alternate approach in the May 2014 NOPR to combine results of two test points, Aprilaire commented that combining test points could limit innovation and force manufacturers to design products to meet test requirements rather than achieve optimal performance of its intended application. Aprilaire recommended that DOE consider rating points based on manufacturers' recommended uses. (Aprilaire, No. 5 at p. 3) For the reasons discussed in section III.B.1 of this notice, the proposal to include two test points and combine results from both to produce the final performance metric was not adopted in this final rule, and instead only one test condition is required for testing. This single test condition, 65 °F for portable dehumidifiers and 73 °F for whole-home dehumidifiers, is the basis for ratings and certifications.

In assessing the burden from the new test procedure, DOE also considered the cost of additional ducting, associated components, and instrumentation that would be required for whole-home dehumidifier testing. Based on its research of retail prices for components required to construct the instrumented inlet and outlet ducts, as well as estimate for the purchase of a complete instrumented duct assembly from a third-party laboratory, DOE determined that the cost of each non-instrumented duct would be approximately $1,500, and that the cost of an instrumented, calibrated duct would not exceed $2,700. Therefore, the equipment cost for testing a refrigeration-only whole-home dehumidifier with no inlet duct and a non-instrumented outlet duct would be approximately $1,500 or $3,000 for whole-home dehumidifiers with two outlets. For refrigerant-desiccant dehumidifiers, which would require instrumented ducts at the inlet and outlet of the process airstream and at the inlet of the reactivation air stream, the total equipment cost would be approximately $8,100. DOE also concludes that some whole-home dehumidifier manufacturers may already test their products in chambers that can accommodate comparably-sized ducting because product literature indicates that performance has been measured at non-zero ESP.

Aprilaire does not support DOE regulating the whole-home dehumidifier industry at this time. Aprilaire commented that in this relatively new industry, innovative products are being developed every year to help control whole-home latent conditions, and that little data is available regarding how products are designed, applied, and used. Aprilaire does not see the potential financial or energy savings benefit to regulation at this time and instead believes that regulations have a much higher probability of limiting innovation, growth, and energy savings because designs and applications are not fully understood today and are rapidly changing. Instead, Aprilaire encouraged DOE to work alongside manufacturers and organizations, such as ASHRAE, to establish representative testing methods prior to energy conservation standards. (Aprilaire, No. 5 at p. 2; Aprilaire, No. 14 at p. 1)

Therma-Stor commented that the secondary costs to test whole-home dehumidifiers, including substantially larger psychrometric chambers, upgraded data acquisition systems, and additional cost to prepare and perform the test, would be orders of magnitude higher than DOE estimates for primary costs. Therma-Stor also stated that it has limited engineering design, manufacturing, and marketing resources because it is a small manufacturer. According to Therma-Stor, it typically maintains and manufactures a model for several years, and a substantial test procedure change might require it to reengineer current designs and revise related literature. Therma-Stor noted that, due to its small size and limited resources, reengineering may require more time for Therma-Stor and other small manufacturers than larger entities with larger resource pools. (Therma-Stor, No. 6 at pp. 5–6; Therma-Stor, No. 15 at p. 4)

DOE is sensitive to the constraints under which small entities design, produce, and market new products. Over the course of this rulemaking, DOE has sought and considered carefully inputs received from interested parties regarding the testing burdens and associated impacts on manufacturers of dehumidifiers of a new test procedure for whole-home dehumidifiers. Because DOE has determined that whole-home dehumidifiers meet the statutory definition of a dehumidifier and are thus covered products for the purposes of EPCA, DOE is fulfilling the statutory obligation promulgated under EPCA to establish test procedures that measure representative energy use of whole-home dehumidifiers. This final rule is being issued in advance of any amended energy conservation standards for dehumidifiers. Analysis related to changing product designs to improve efficiencies and determining potential energy savings associated with amended standards and the impacts of such standards on manufacturers would be conducted as part of the concurrent energy conservation standards rulemaking for dehumidifiers. DOE notes that it conducts manufacturer interviews as part of the standards rulemaking, during which manufacturers may provide confidential feedback on all issues, including test procedures.

In the February 2015 SNOPR, DOE estimated the costs for a new or expanded environmental chamber to be $30,000, based on manufacturer feedback. DOE has also adopted a reduced duct length for whole-home dehumidifier testing to limit the need for updated environmental chambers. DOE expects that those manufacturers that conduct the DOE dehumidifier test in-house will likely be able to conduct testing on a majority of units within existing test chambers. For any unit too large for the manufacturer’s existing test chamber, DOE believes that manufacturers will likely test at a third-party laboratory as needed, rather than invest in a larger environmental chamber. DOE expects whole-home dehumidifier testing at a third-party laboratory to cost approximately $7,000 per test. Additionally, DOE believes that many manufacturers likely already conduct certification testing at third-party laboratories, so there would be little or no increased cost associated with the third-party laboratory testing.

Therma-Stor expressed concern that changes to testing and rating may lead to confusion in the marketplace, as consumers are accustomed to the current rating scheme. According to Therma-Stor, it will be necessary to educate dealers and consumers about the substantial changes to the capacity and efficiency rating of each dehumidifier model. Therma-Stor is also concerned about divergence of the test procedure from that used for the ENERGY STAR program, noting that additional testing to determine multiple product ratings may place a larger burden on small manufacturers. Therma-Stor requested that DOE work with ENERGY STAR to harmonize test procedures to minimize cost, time, and complexity of compliance for manufacturers. (Therma-Stor, No. 6 at p. 6; Therma-Stor, No. 15 at p. 4) For covered products such as dehumidifiers, the ENERGY STAR program uses the Federal method of test as required by law. DOE will work with EPA to ensure the specification gets revised to reflect the updates in this final rule and the associated compliance timelines."

DOE notes that although the International Electrotechnical Commission (IEC) Standard 62301, titled “Household electrical appliances–Measurement of standby power,” Publication 62301 (Edition 2.0 2011-01) test method would not be applicable for any fan operation during off-cycle mode, the power meter accuracy specified in IEC Standard 62301 would still be necessary to accurately measure power consumption during periods of off-cycle mode with no fan operation. DOE is requiring that the power metering instrumentation for testing dehumidification mode and off-cycle mode comply with the requirements of both ANSI/AHAM DH-1-2008 and IEC Standard 63201. DOE is aware that power meters meeting the accuracy requirements of both test standards are readily available and currently in use in certain test laboratories. Therefore, DOE does not believe that these requirements would significantly increase the testing burden associated with instrumentation.

Test facilities that use a single psychrometer box to test multiple units simultaneously that do not already own additional psychrometer boxes would need to purchase an additional psychrometer box for each additional unit that would be tested concurrently. Based on DOE research and input from test laboratories, DOE estimates that test facilities may purchase and calibrate the required equipment for approximately $1,000 each.

Additionally, test laboratories with only one sampling tree for each psychrometer box may be required to purchase additional sampling trees to account for units with multiple air inlets. In this final rule, DOE establishes that a sampling tree be placed in front of each air inlet on a test unit. DOE expects laboratories may purchase additional sampling trees at an estimated cost of $300 each to comply with the proposed test requirements.

DOE estimates that the cost of a relative humidity sensor is approximately $1,000, which is comparable to that of an aspirating psychrometer and its associated calibration costs. Therefore, DOE does not expect that the option to test any dehumidifier configurations with a relative humidity sensor or an aspirating psychrometer would increase test burden. Based on feedback from interested parties and its own research, DOE also expects the optional use of a relative humidity sensor would decrease test burden because it confirmed that most laboratories already use these types of sensors for other testing and because they are less labor-intensive to operate and maintain compared to aspirating psychrometers.

After estimating the potential impacts of the new test procedure provisions and considering feedback from interested parties regarding test burdens, DOE has determined that the rule would not have a significant impact on a substantial number of small entities.

C. Review Under the Paperwork Reduction Act of 1995

Manufacturers of dehumidifiers must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for dehumidifiers, 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 dehumidifiers. 76 FR 12422 (March 7, 2011); 80 FR 5099 (Jan. 30, 2015). 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 30 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

In this final rule, DOE amends its test procedure for dehumidifiers. DOE has determined that this rule falls into a class of actions that are categorically excluded from review under the National Environmental Policy Act of 1969 (42 U.S.C. 4321 et seq.) and DOE's implementing regulations at 10 CFR part 1021. Specifically, this rule amends an existing rule without affecting the amount, quality or distribution of energy usage, and, therefore, will not result in any environmental impacts. Thus, this rulemaking is covered by Categorical Exclusion A5 under 10 CFR part 1021, subpart D, which applies to any rulemaking that interprets or amends an existing rule without changing the environmental effect of that rule. Accordingly, neither an environmental assessment nor an environmental impact statement is required.

E. Review Under Executive Order 13132

Executive Order 13132, "Federalism," 64 FR 43255 (Aug. 10, 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. Pub. L. No. 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 (This policy is 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. Accordingly, no further assessment or analysis is required under UMRA.

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

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any rule that may affect family well-being. This 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). 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 promulgates or is expected to lead to promulgation of a final rule, and that: (1) is a significant regulatory action under Executive Order 12866, or any successor order; and (2) is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (3) is designated by the Administrator of OIRA as a significant energy action. For any proposed significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use 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 (Pub. L. 95–91; 42 U.S.C. 7101 et seq.), DOE must comply with section 32 of the Federal Energy Administration Act of 1974 (Pub. L. 93-275), as amended by the Federal Energy Administration Authorization Act of 1977 (Pub. L. 95-70). (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.

This final rule establishes testing methods contained in the following commercial standards: ANSI/ASHRAE Standard 41.1-2013, Standard Method for Temperature Measurement; and ANSI/ASHRAE 51-2007/ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating. While the newly established test procedure at appendix X1 is not exclusively based on these standards, one component of the test procedure, namely ducted installation requirements for testing whole-home dehumidifiers, adopts provisions from these standards without amendment. DOE has evaluated these standards and is unable to conclude whether they fully comply with the requirements of section 32(b) of the FEAA, (i.e., that they were developed in a manner that fully provides for public participation, comment, and review). DOE has consulted with the Attorney General and the Chairman of the FTC concerning the impact on competition of requiring manufacturers to use the test methods contained in these standards, and neither recommended against incorporation of these standards.

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. Materials Incorporated by Reference

In this final rule, DOE incorporates by reference the ANSI and ASHRAE test standard, titled “Standard Method for Temperature Measurement,” ANSI/ASHRAE Standard 41.1-2013. ANSI/ASHRAE Standard 41.2013 is an industry-accepted standard that describes temperature measurement methods intended for use in heating, refrigerating, and air conditioning equipment and components. The test procedure established in this final rule references a section of ANSI/ASHRAE 41.1-2013 to determine the number and locations of temperature sensors within the ducts for refrigerant-desiccant whole-home dehumidifiers. ANSI/ASHRAE 41.1-2103 is available on ANSI’s website at http://webstore.ansi.org/RecordDetail.aspx?sku=ANSI%2FASHRAE+Standard+41.1-2013.

In this final rule, DOE also incorporates by reference the ANSI and AMCA test standard, titled “Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating,” ANSI/AMCA 210-07. ANSI/AMCA 210-07 is an industry-accepted test procedure that defines uniform methods for conducting laboratory tests on housed fans to determine airflow rate, pressure, power and efficiency at a given speed of rotation. The test procedure established in this final rule references sections of ANSI/AMCA 210-07 to describe required instrumentation and measurements of external static pressure, pressure losses, and velocity pressures for refrigerant-desiccant whole-home dehumidifiers testing. ANSI/AMCA 210-07 is available on AMCA’s website at http://www.amca.org/store/item.aspx?ItemId=81.

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, Buildings and facilities, Business and industry, Energy conservation, Grant programs-energy, Housing, Reporting and recordkeeping requirements, Technical assistance.

10 CFR Part 430

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

Issued in Washington, DC, on June 26, 2015.

Kathleen B. Hogan
Deputy Assistant Secretary for Energy Efficiency
Energy Efficiency and Renewable Energy

For the reasons stated in the preamble, DOE amends part 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.

2. Section 429.36 is amended by adding paragraphs (a)(3), (a)(4), and (b)(2) as follows:

§429.36 Dehumidifiers.

(a) * * *

(3) The capacity of a basic model is the mean of the measured capacities for each tested unit of the basic model. Round the mean capacity value to two decimal places.

(4) For whole-home dehumidifiers, the case volume of a basic model is the mean of the measured case volumes for each tested unit of the basic model. Round the mean case volume value to one decimal place.

(b) * * *

(2) Pursuant to §429.12(b)(13), a certification report must include the following public product-specific information: The energy factor in liters per kilowatt hour (liters/kWh), capacity in pints per day, and for whole-home dehumidifiers, case volume in cubic feet.

* * * *

3. Section 429.134 is amended by reserving paragraph (e) and adding paragraph (f) to read as follows:

§429.134 Product-specific enforcement provisions.

* * * * *

(e) [Reserved]

(f) Dehumidifiers.

(1) Verification of capacity. The capacity will be measured pursuant to the test requirements of part 430 for each unit tested. The results of the measurement(s) will be averaged and compared to the value of capacity certified by the manufacturer for the basic model. The certified capacity will be considered valid only if the measurement is within five percent, or 1.00 pint per day, whichever is greater, of the certified capacity.

(i) If the certified capacity is found to be valid, the certified capacity will be used as the basis for determining the minimum energy factor allowed for the basic model.

(ii) If the certified capacity is found to be invalid, the average measured capacity of the units in the sample will be used as the basis for determining the minimum energy factor allowed for the basic model.

(2) Verification of whole-home dehumidifier case volume. The case volume will be measured pursuant to the test requirements of part 430 for each unit tested. The results of the measurement(s) will be averaged and compared to the value of case volume certified by the manufacturer for the basic model. The certified case volume will be considered valid only if the measurement is within two percent, or 0.2 cubic feet, whichever is greater, of the certified case volume.

(i) If the certified case volume is found to be valid, the certified case volume will be used as the basis for determining the minimum energy factor allowed for the basic model.

(ii) If the certified case volume is found to be invalid, the average measured case volume of the units in the sample will be used as the basis for determining the minimum energy factor allowed for the basic model.

PART 430 -- ENERGY CONSERVATION PROGRAM FOR CONSUMER PRODUCTS

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

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

5. Section 430.2 is amended by revising the definition of “Dehumidifier” and adding the definitions for “Portable dehumidifier”, “Refrigerant-desiccant dehumidifier”, and “Whole-home dehumidifier” in alphabetical order to read as follows:

§ 430.2 Definitions.

*   *   *   *   *

Dehumidifier means a product, other than a portable air conditioner, room air conditioner, or packaged terminal air conditioner, that is a self-contained, electrically operated, and mechanically encased assembly consisting of—

1) A refrigerated surface (evaporator) that condenses moisture from the atmosphere;
2) A refrigerating system, including an electric motor;
3) An air-circulating fan; and
4) A means for collecting or disposing of the condensate.

*   *   *   *   *

Portable dehumidifier means a dehumidifier designed to operate within the dehumidified space without the attachment of additional ducting, although means may be provided for optional duct attachment.

*   *   *   *   *

Refrigerant-desiccant dehumidifier means a whole-home dehumidifier that removes moisture from the process air by means of a desiccant material in addition to a refrigeration system.

*   *   *   *   *

Whole-home dehumidifier means a dehumidifier designed to be installed with ducting to deliver return process air to its inlet and to supply dehumidified process air from its outlet to one or more locations in the dehumidified space.

6. Section 430.3 is amended by:

a. Revising paragraph (f)(4);

b. Redesignating paragraphs (f)(6) through (f)(9) and (f)(10) through (f)(13) as paragraphs (f)(7) through (f)(10) and (f)(12) through (f)(15), respectively; and

c. Adding new paragraphs (f)(6) and (f)(11) and revising paragraphs (i)(1) and (r)(4).

The additions and revisions read as follows:

§ 430.3 Materials Incorporated by reference.

* * * * *

(f) * * *

* * * * *

(6) ANSI/ASHRAE Standard 41.1-2013, Standard Method for Temperature Measurement, ASHRAE approved January 29, 2013, ANSI approved January 30, 2013, IBR approved for appendix X1 to subpart B.

* * * * *

(11) ANSI/ASHRAE 51-07/ANSI/AMCA 210-07, Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating, AMCA approved July 28, 2006, ANSI approved August 17, 2007, ASHRAE approved March 17, 2008, IBR approved for appendix X1 to subpart B.

* * * * *

(i) * * *

(1) ANSI/AHAM DH-1-2008 (“ANSI/AHAM DH-1”), Dehumidifiers, ANSI approved May 9, 2008, IBR approved for appendices X and X1 to subpart B.

* * * * *

(r) * * *

* * * * *

(4) IEC 62301 ("IEC 62301"), Household electrical appliances-Measurement of standby power, (Edition 2.0, 2011-01), IBR approved for appendices C1, D1, D2, G, H, I, J2, N, O, P, X, and X1 to subpart B.

7. Section 430.23 is amended by revising paragraph (z) to read as follows:

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

*** * * * ***

(z) Dehumidifiers. When using appendix X, determine the capacity, expressed in pints per day (pints/day), and the energy factor, expressed in liters per kilowatt hour (L/kWh), in accordance with section 4.1 of appendix X of this subpart. When using appendix X1, determine the capacity, expressed in pints/day, according to section 5.2 of appendix X1 to this subpart; determine the integrated energy factor, expressed in L/kWh, according to section 5.4 of appendix X1 to this subpart; and determine the case volume, expressed in cubic feet, for whole-home dehumidifiers in accordance with section 5.7 of appendix X1 of this subpart.

*** * * * ***

8. Section 430.32 is amended by revising paragraph (v)(2) to read as follows:

§ 430.32 Energy and water conservation standards and their compliance dates.

* * * * *

(v) * * *

(2) Dehumidifiers manufactured on or after October 1, 2012, shall have an energy factor that meets or exceeds the following values:

Product capacity (pints/day)	**Minimum energy factor (liters/kWh)**
Up to 35.00	1.35
35.01-45.00	1.50
45.01-54.00	1.60
54.01-75.00	1.70
75.01 or more	2.5

*** * * * ***

Appendix X to Subpart B of Part 430—[Amended]

9. Appendix X to subpart B of part 430 is amended:

a. By revising the note after the heading;

b. In section 2, Definitions, by revising section 2.3, redesignating sections 2.4 through 2.10 as sections 2.5 through 2.11, adding new section 2.4, and revising newly redesignated sections 2.7 and 2.10;

c. In section 3, Test Apparatus and General Instructions, by revising section 3.1 and adding new sections 3.1.1 through 3.1.4;

d. In section 4, Test Measurement, by revising sections 4.1, 4.2.1, and 4.2.2; and

e. In section 5, Calculation of Derived Results From Test Measurements, by revising sections 5.1 and 5.2;

The additions and revisions read as follows:

APPENDIX X TO SUBPART B OF PART 430–UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF DEHUMIDIFIERS

Note: 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 portable dehumidifiers must be made in accordance with the results of testing pursuant to this appendix. Until **[INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**, manufacturers must either test portable dehumidifiers in accordance with this appendix, or the previous version of this appendix as it appeared in the Code of Federal Regulations on January 1, 2015. DOE notes that, because testing under this appendix X must be completed as of **[INSERT DATE 180 DAYS AFTER DATE OF PUBLICATION IN THE FEDERAL REGISTER]**, manufacturers may wish to begin using this test procedure immediately. Alternatively, manufacturers may certify compliance with any amended energy conservation standards for portable dehumidifiers prior to the compliance date of those amended energy conservation standards by testing in accordance with appendix X1. Any representations made with respect to the energy use or efficiency of such portable dehumidifiers must be in accordance with whichever version is selected.

Any representations made with respect to the energy use or efficiency of whole-home dehumidifiers made on or after the compliance date for new standards must be made in accordance with the results of testing pursuant to appendix X1.

*　　　*　　　*　　　*　　　*

2. Definitions

*　　　*　　　*　　　*　　　*

2.3 Combined low-power mode means the aggregate of available modes other than dehumidification mode.

2.4 Dehumidification mode means an active mode in which a dehumidifier:

(1) Has activated the main moisture removal function according to the humidistat, humidity sensor signal, or control setting; and

(2) Has either activated the refrigeration system or activated the fan or blower without activation of the refrigeration system.

*　　　*　　　*　　　*　　　*

2.7 Inactive mode means a standby mode that facilitates the activation of active mode by remote switch (including remote control), internal sensor other than humidistat or humidity sensor, or timer, or that provides continuous status display.

*　　　*　　　*　　　*　　　*

2.10 Product capacity for dehumidifiers means a measure of the ability of the dehumidifier to remove moisture from its surrounding atmosphere, measured in pints collected per 24 hours of operation under the specified ambient conditions.

*　　　*　　　*　　　*　　　*

3. Test Apparatus and General Instructions

3.1 Active mode. The test apparatus and instructions for testing dehumidifiers in dehumidification mode shall conform to the requirements specified in Section 3, "Definitions," Section 4, “Instrumentation,” and Section 5, “Test Procedure,” of ANSI/AHAM DH-1 (incorporated by reference, see § 430.3), with the following exceptions.

3.1.1 Psychrometer placement. Place the psychrometer perpendicular to, and 1 ft. in front of, the center of the intake grille. For dehumidifiers with multiple intake grilles, place a separate sampling tree perpendicular to, and 1 ft. in front of, the center of each intake grille, with the samples combined and connected to a single psychrometer using a minimal length of insulated ducting. The psychrometer shall be used to monitor inlet conditions of one test unit only.

3.1.2 Condensate collection. If means are provided on the dehumidifier for draining condensate away from the cabinet, collect the condensate in a substantially closed vessel to prevent re-evaporation, and place the collection vessel on the weight-measuring instrument. If no means for draining condensate away from the cabinet are provided, disable any automatic shutoff of dehumidification mode operation that is activated when the collection container is full, and collect any overflow in a pan. The pan must be covered as much as possible to prevent re-evaporation without impeding the collection of overflow water. Place both the dehumidifier and the overflow pan on the weight-measuring instrument for direct reading of the condensate weight during the test. Do not use any internal pump to drain the condensate unless such pump operation is provided for by default in dehumidification mode.

3.1.3 Control settings. If the dehumidifier has a control setting for continuous operation in dehumidification mode, select that setting. Otherwise, set the controls to the lowest available relative humidity level and, if the dehumidifier has a user-adjustable fan speed, select the maximum fan speed setting.

3.1.4 Recording and rounding. Record measurements at the resolution of the test instrumentation. Round calculated values to the same number of significant digits as the previous step. Round the final capacity, energy factor and integrated energy factor values to two decimal places.

* * * * *

4. Test Measurement

4.1 Active mode. Measure the energy consumption in dehumidification mode, E_{DM}, expressed in kilowatt-hours (kWh), the energy factor, expressed in liters per kilowatt-hour (L/kWh), and product capacity, expressed in pints per day (pints/day), in accordance with the test requirements specified in Section 7, "Capacity Test and Energy Consumption Test," of ANSI/AHAM DH-1 (incorporated by reference, see § 430.3).

* * * * *

4.2.1 If the dehumidifier has an inactive mode, as defined in section 2.7 of this appendix, but not an off mode, as defined in section 2.8 of this appendix, measure and record the average inactive mode power of the dehumidifier, P_{IA}, in watts. Otherwise, if the dehumidifier has an off mode, as defined in section 2.8 of this appendix, measure and record the average off mode power of the dehumidifier, P_{OM}, in watts.

4.2.2 If the dehumidifier has an off-cycle mode, as defined in section 2.9 of this appendix, measure and record the average off-cycle mode power of the dehumidifier, P_{OC}, in watts.

5. Calculation of Derived Results From Test Measurements

5.1 Annual combined low-power mode energy consumption. Calculate the annual combined low-power mode energy consumption for dehumidifiers, E_{TLP}, expressed in kilowatt-hours per year, according to the following:

$E_{TLP} = [(P_{IO} \times S_{IO}) + (P_{OC} \times S_{OC})] \times K$

Where:

$P_{IO} = P_{IA}$, dehumidifier inactive mode power, or P_{OM}, dehumidifier off mode power in watts, as measured in section 4.2.1 of this appendix.

P_{OC} = dehumidifier off-cycle mode power in watts, as measured in section 4.2.2 of this appendix.

S_{IO} = 1,840.5 dehumidifier inactive mode or off mode annual hours.

S_{OC} = 1,840.5 dehumidifier off-cycle mode annual hours.

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

5.2 Integrated energy factor. Calculate the integrated energy factor, IEF, expressed in liters per kilowatt-hour, rounded to two decimal places, according to the following:

$IEF = L_W / [E_{DM} + ((E_{TLP} / 1095) \times 6)]$

Where:

L_W = water removed from the air during the 6-hour dehumidification mode test in liters, as measured in section 4.1 of this appendix.

E_{DM} = energy consumption during the 6-hour dehumidification mode test in kilowatt-hours, as measured in section 4.1 of this appendix.

E_{TLP} = annual combined low-power mode energy consumption in kilowatt-hours per year, as calculated in section 5.1 of this appendix.

1,095 = dehumidification mode annual hours, used to convert E_{TLP} to combined low-power mode energy consumption per hour of dehumidification mode.

6 = hours per dehumidification mode test, used to convert combined low-power mode energy consumption per hour of dehumidification mode for integration with dehumidification mode energy consumption.

Appendix X1 to Subpart B of Part 430

10. Appendix X1 is added to subpart B of part 430 to read as follows:

APPENDIX X1 TO SUBPART B OF PART 430–UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF DEHUMIDIFIERS

Note: Manufacturers may certify compliance with any amended energy conservation standards for portable dehumidifiers prior to the compliance date of those amended energy conservation standards by testing in accordance with this appendix. Any representations made with respect to the energy use or efficiency of such portable dehumidifiers must be in accordance with either appendix X or this appendix, whichever version is selected for testing and compliance with standards.

Any representations made on or after the compliance date of any amended energy conservation standards, with respect to the energy use or efficiency of whole-home dehumidifiers, must be made in accordance with the results of testing pursuant to this appendix.

1. Scope

This appendix covers the test requirements used to measure the energy performance of dehumidifiers.

2. Definitions

2.1 ANSI/AHAM DH-1 means the test standard published by the American National Standards Institute and the Association of Home Appliance Manufacturers, titled "Dehumidifiers," ANSI/AHAM DH-1-2008 (incorporated by reference; see § 430.3).

2.2 ANSI/AMCA 210 means the test standard published by ANSI, the American Society of Heating, Refrigeration and Air-Conditioning Engineers, and the Air Movement and Control Association International, Inc., titled "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating," ANSI/ASHRAE 51-07/ANSI/AMCA 210-07 (incorporated by reference; see § 430.3).

2.3 ANSI/ASHRAE 41.1 means the test standard published by ANSI and ASHRAE, titled "Standard Method for Temperature Measurement," ANSI/ASHRAE 41.1-2013 (incorporated by reference; see § 430.3).

2.4 Active mode means a mode in which a dehumidifier is connected to a mains power source, has been activated, and is performing the main functions of removing moisture from air by drawing moist air over a refrigerated coil using a fan or circulating air through activation of the fan without activation of the refrigeration system.

2.5 Combined low-power mode means the aggregate of available modes other than dehumidification mode.

2.6 Dehumidification mode means an active mode in which a dehumidifier:

(1) Has activated the main moisture removal function according to the humidistat, humidity sensor signal, or control setting; and

(2) Has either activated the refrigeration system or activated the fan or blower without activation of the refrigeration system.

2.7 Energy factor for dehumidifiers means a measure of energy efficiency of a dehumidifier calculated by dividing the water removed from the air by the energy consumed, measured in liters per kilowatt-hour (L/kWh).

2.8 External static pressure (ESP) means the process air outlet static pressure minus the process air inlet static pressure, measured in inches of water column (in. w.c.).

2.9 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).

2.10 Inactive mode means a standby mode that facilitates the activation of active mode by remote switch (including remote control), internal sensor other than humidistat or humidity sensor, or timer, or that provides continuous status display.

2.11 Off mode means a mode in which the dehumidifier is connected to a mains power source and is not providing any active mode or standby mode function, and where the mode may persist for an indefinite time. An indicator that only shows the user that the dehumidifier is in the off position is included within the classification of an off mode.

2.12 Off-cycle mode means a mode in which the dehumidifier:

(1) Has cycled off its main moisture removal function by humidistat or humidity sensor;

(2) May or may not operate its fan or blower; and

(3) Will reactivate the main moisture removal function according to the humidistat or humidity sensor signal.

2.13 Process air means the air supplied to the dehumidifier from the dehumidified space and discharged to the dehumidified space after some of the moisture has been removed by means of the refrigeration system.

2.14 Product capacity for dehumidifiers means a measure of the ability of the dehumidifier to remove moisture from its surrounding atmosphere, measured in pints collected per 24 hours of operation under the specified ambient conditions.

2.15 Product case volume for whole-home dehumidifiers means a measure of the rectangular volume that the product case occupies, exclusive of any duct attachment collars or other external components.

2.16 Reactivation air means the air drawn from unconditioned space to remove moisture from the desiccant wheel of a refrigerant-desiccant dehumidifier and discharged to unconditioned space.

2.17 Standby mode means any modes where the dehumidifier 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:

(1) To facilitate the activation of other modes (including activation or deactivation of active mode) by remote switch (including remote control), internal sensor, or timer;

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

3. Test Apparatus and General Instructions

3.1 Active mode.

3.1.1 Portable dehumidifiers and whole-home dehumidifiers other than refrigerant-desiccant dehumidifiers. The test apparatus and instructions for testing in dehumidification mode and off-cycle mode must conform to the requirements specified in Section 3, “Definitions,” Section 4, “Instrumentation,” and Section 5, “Test Procedure,” of ANSI/AHAM DH-1 (incorporated by reference, see § 430.3), with the following exceptions. Note that if a product is able to operate as both a portable and whole-home dehumidifier by means of installation or removal of an optional ducting kit, it must be tested and rated for both configurations.

3.1.1.1 Testing configuration for whole-home dehumidifiers other than refrigerant-desiccant dehumidifiers. Test dehumidifiers, other than refrigerant-desiccant dehumidifiers, with ducting attached to the process air outlet port. The duct configuration and component placement must conform to the requirements specified in section 3.1.3 of this appendix and Figure 1 or Figure 3, except that the flow straightener and dry-bulb temperature and relative humidity instruments are not required. Maintain the external static pressure in the process air flow and measure the external static pressure as specified in section 3.1.2.2.3.1 of this appendix.

3.1.1.2 Relative humidity instrumentation. A relative humidity sensor with an accuracy within 1 percent relative humidity may be used in place of an aspirating psychrometer. When using a relative humidity sensor for testing, disregard the wet-bulb test tolerances in Table 1 of AHAM DH-1-2008, the average relative humidity over the test period must be within 2 percent of the relative humidity setpoint, and all individual relative humidity readings must be within 5 percent of the relative humidity setpoint. When using a relative humidity sensor instead of an aspirating psychrometer, use a dry-bulb temperature sensor that meets the accuracy as required in section 4.1 of AHAM DH-1-2008.

3.1.1.3 Instrumentation placement. Place the aspirating psychrometer or relative humidity and dry-bulb temperature sensors perpendicular to, and 1 ft. in front of, the center of the process air intake grille. When using an aspirating psychrometer, for dehumidifiers with multiple process air intake grilles, place a separate sampling tree perpendicular to, and 1 ft. in front of, the center of each process air intake grille, with the samples combined and connected to a single psychrometer using a minimal length of insulated ducting. The psychrometer shall be used to monitor inlet conditions of one test unit only. When using relative humidity and dry-bulb temperature sensors, for dehumidifiers with multiple process air intake grilles, place a relative humidity sensor and dry-bulb temperature sensor perpendicular to, and 1 ft. in front of, the center of each process air intake grille.

3.1.1.4 Condensate collection. If means are provided on the dehumidifier for draining condensate away from the cabinet, collect the condensate in a substantially closed vessel to prevent re-evaporation and place the vessel on the weight-measuring instrument. If no means for draining condensate away from the cabinet are provided, disable any automatic shutoff of dehumidification mode operation that is activated when the collection container is full and collect any overflow in a pan. Select a collection pan large enough to ensure that all water that overflows from the full internal collection container during the rating test period is captured by the collection pan. Cover the pan as much as possible to prevent re-evaporation without impeding the collection of overflow water. Place both the dehumidifier and the overflow pan on the weight-measuring instrument for direct reading of the condensate weight collected during the rating test. Do not use any internal pump to drain the condensate into a substantially closed vessel unless such pump operation is provided for by default in dehumidification mode.

3.1.1.5 Control settings. If the dehumidifier has a control setting for continuous operation in dehumidification mode, select that control setting. Otherwise, set the controls to the lowest available relative humidity level, and if the dehumidifier has a user-adjustable fan speed, select the maximum fan speed setting. Do not use any external controls for the dehumidifier settings.

3.1.1.6 Run-in period. Perform a single run-in period during which the compressor operates for a cumulative total of at least 24 hours prior to dehumidification mode testing.

3.1.2 Refrigerant-desiccant dehumidifiers. The test apparatus and instructions for testing refrigerant-desiccant dehumidifiers in dehumidification mode must conform to the requirements specified in Section 3, “Definitions,” Section 4, “Instrumentation,” and Section 5, “Test Procedure,” of ANSI/AHAM DH-1 (incorporated by reference, see § 430.3), except as follows.

3.1.2.1 Testing configuration. Test refrigerant-desiccant dehumidifiers with ducting attached to the process air inlet and outlet ports and the reactivation air inlet port. The duct configuration and components must conform to the requirements specified in section 3.1.3 of this appendix and Figure 1 through Figure 3. Install a cell-type airflow straightener that conforms to the specifications in Section 5.2.1.6, “Airflow straightener”, and Figure 6A, “Flow Straightener – Cell Type”, of ANSI/AMCA 210 (incorporated by reference, see § 430.3) in each duct consistent with Figure 1 through Figure 3.

3.1.2.2 Instrumentation.

3.1.2.2.1 Temperature. Install dry-bulb temperature sensors in a grid centered in the duct, with the plane of the grid perpendicular to the axis of the duct. Determine the number and locations of the sensors within the grid according to Section 5.3.5, “Centers of Segments—Grids,” of ANSI/ASHRAE Standard 41.1 (incorporated by reference, see § 430.3).

3.1.2.2.2 Relative humidity. Measure relative humidity with a duct-mounted, relative humidity sensor with an accuracy within ±1 percent relative humidity. Place the relative humidity sensor at the duct centerline within 1 inch of the dry-bulb temperature grid plane.

3.1.2.2.3 Pressure. The pressure instruments used to measure the external static pressure and velocity pressures must have an accuracy within ±0.01 in. w.c. and a resolution of no more than 0.01 in. w.c.

3.1.2.2.3.1 External static pressure. Measure static pressures in each duct using pitot-static tube traverses that conform with the specifications in Section 4.3.1, "Pitot Traverse," of ANSI/AMCA 210 (incorporated by reference, see § 430.3), with pitot-static tubes that conform with the specifications in Section 4.2.2, "Pitot-Static Tube," of ANSI/AMCA 210 (incorporated by reference, see § 430.3), except that only two intersecting and perpendicular rows of pitot-static tube traverses shall be used. Record the static pressure within the test duct as measured at the pressure tap in the manifold of the traverses that averages the individual static pressures at each pitot-static tube. Calculate duct pressure losses between the unit under test and the plane of each static pressure measurement in accordance with section 7.5.2, "Pressure Losses," of ANSI/AMCA 210 (incorporated by reference, see § 430.3). The external static pressure is the difference between the measured inlet and outlet static pressure measurements, minus the sum of the inlet and outlet duct pressure losses. For any port with no duct attached, use a static pressure of 0.00 in. w.c. with no duct pressure loss in the calculation of external static pressure. During dehumidification mode testing, the external static pressure must equal 0.20 in. w.c. ± 0.02 in. w.c.

3.1.2.2.3.2 Velocity pressure. Measure velocity pressures using the same pitot traverses as used for measuring external static pressure, and which are specified in section 3.1.2.2.3.1 of this appendix. Determine velocity pressures at each pitot-static tube in a traverse as the difference between the pressure at the impact pressure tap and the pressure at the static pressure tap. Calculate volumetric flow rates in each duct in accordance with Section 7.3.1, “Velocity Traverse,” of ANSI/AMCA 210 (incorporated by reference, see § 430.3).

3.1.2.2.4 Weight. No weight-measuring instruments are required.

3.1.2.3 Control settings. If the dehumidifier has a control setting for continuous operation in dehumidification mode, select that control setting. Otherwise, set the controls to the lowest available relative humidity level, and if the dehumidifier has a user-adjustable fan speed, select the maximum fan speed setting. Do not use any external controls for the dehumidifier settings.

3.1.2.4 Run-in period. Perform a single run-in period during which the compressor operates for a cumulative total of at least 24 hours prior to dehumidification mode testing.

3.1.3 Ducting for whole-home dehumidifiers. Cover and seal with tape any port designed for intake of air from outside or unconditioned space, other than for supplying reactivation air for refrigerant-desiccant dehumidifiers. Use only ducting constructed of galvanized mild steel and with a 10-inch diameter. Position inlet and outlet ducts either horizontally or vertically to accommodate the default dehumidifier port orientation. Install all ducts with the axis of the section interfacing with the dehumidifier perpendicular to plane of the collar to which each is attached. If manufacturer-recommended collars do not measure 10 inches in diameter, use transitional pieces to connect the ducts to the collars. The transitional pieces must not contain any converging element that forms an angle with the duct axis greater than 7.5 degrees or a diverging element that forms an angle with the duct axis greater than 3.5 degrees. Install mechanical throttling devices in each outlet duct consistent with Figure 1 and Figure 3 to adjust the external static pressure and in the inlet reactivation air duct for a refrigerant-desiccant dehumidifier. Cover the ducts with thermal insulation having a minimum R value of 6 h-ft^2-

°F/Btu (1.1 m^2-K/W). Seal seams and edges with tape.

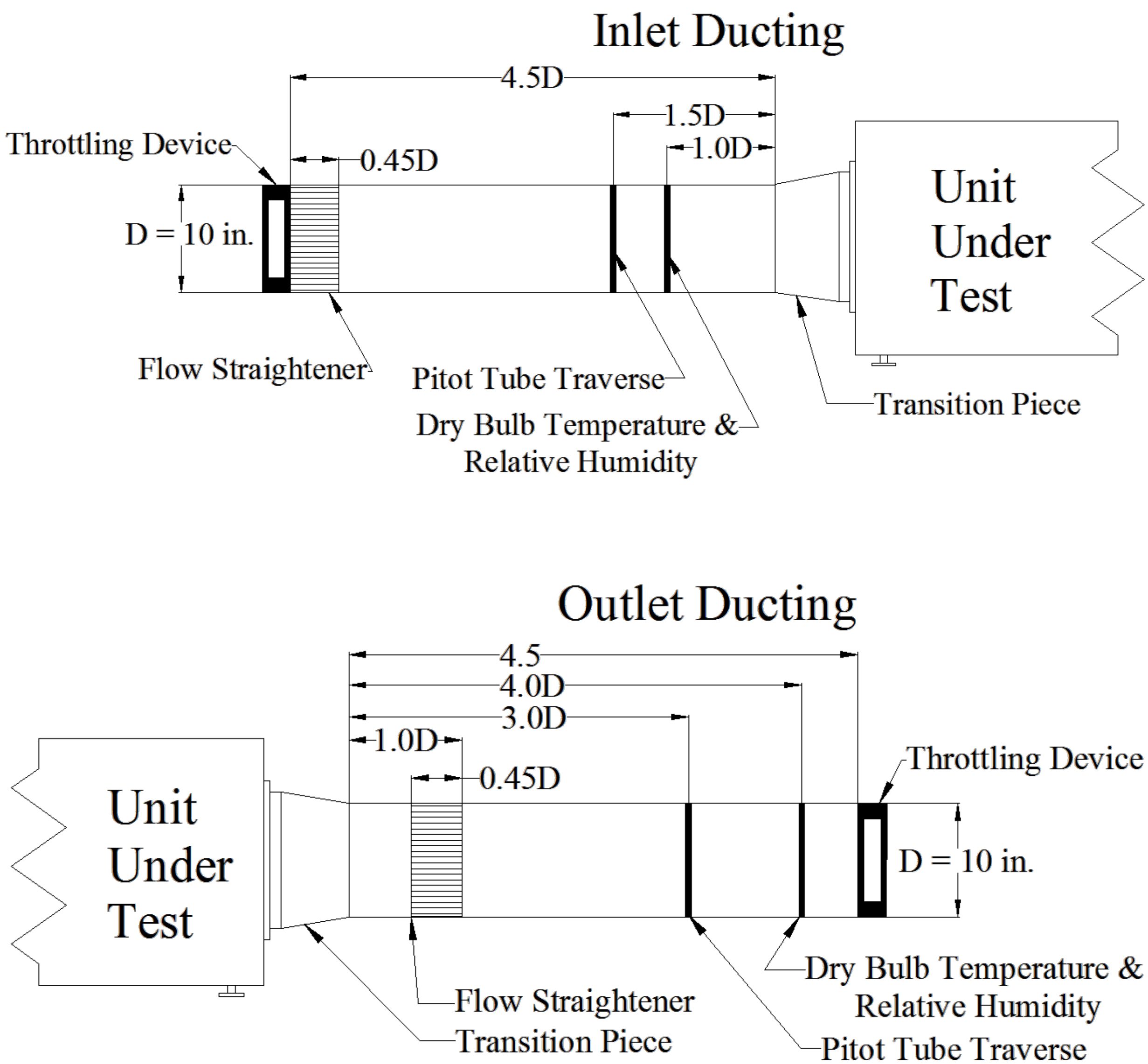

Figure 1. Inlet and Outlet Horizontal Duct Configurations and Instrumentation Placement

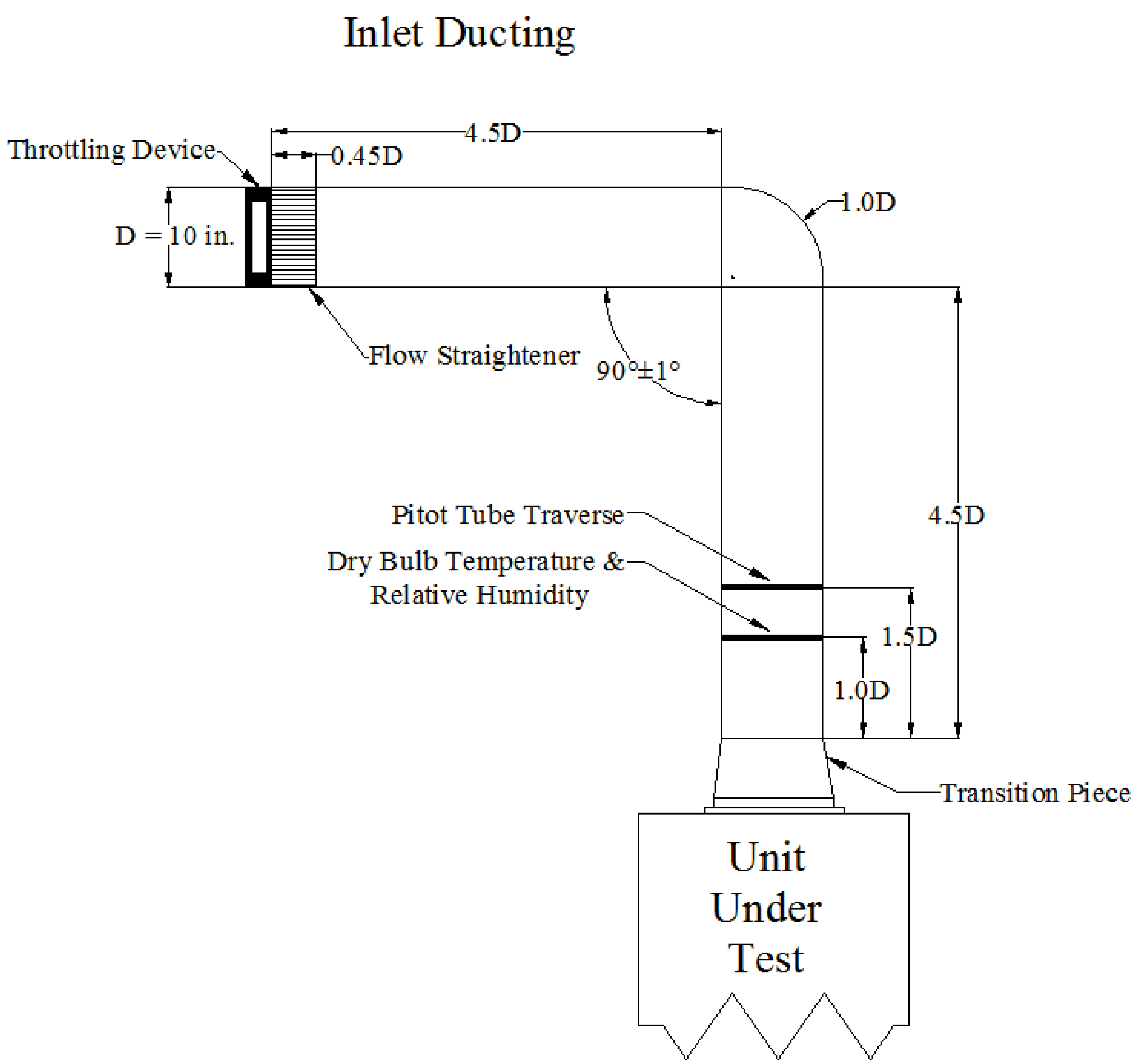

Figure 2: Inlet Vertical Duct Configuration and Instrumentation Placement

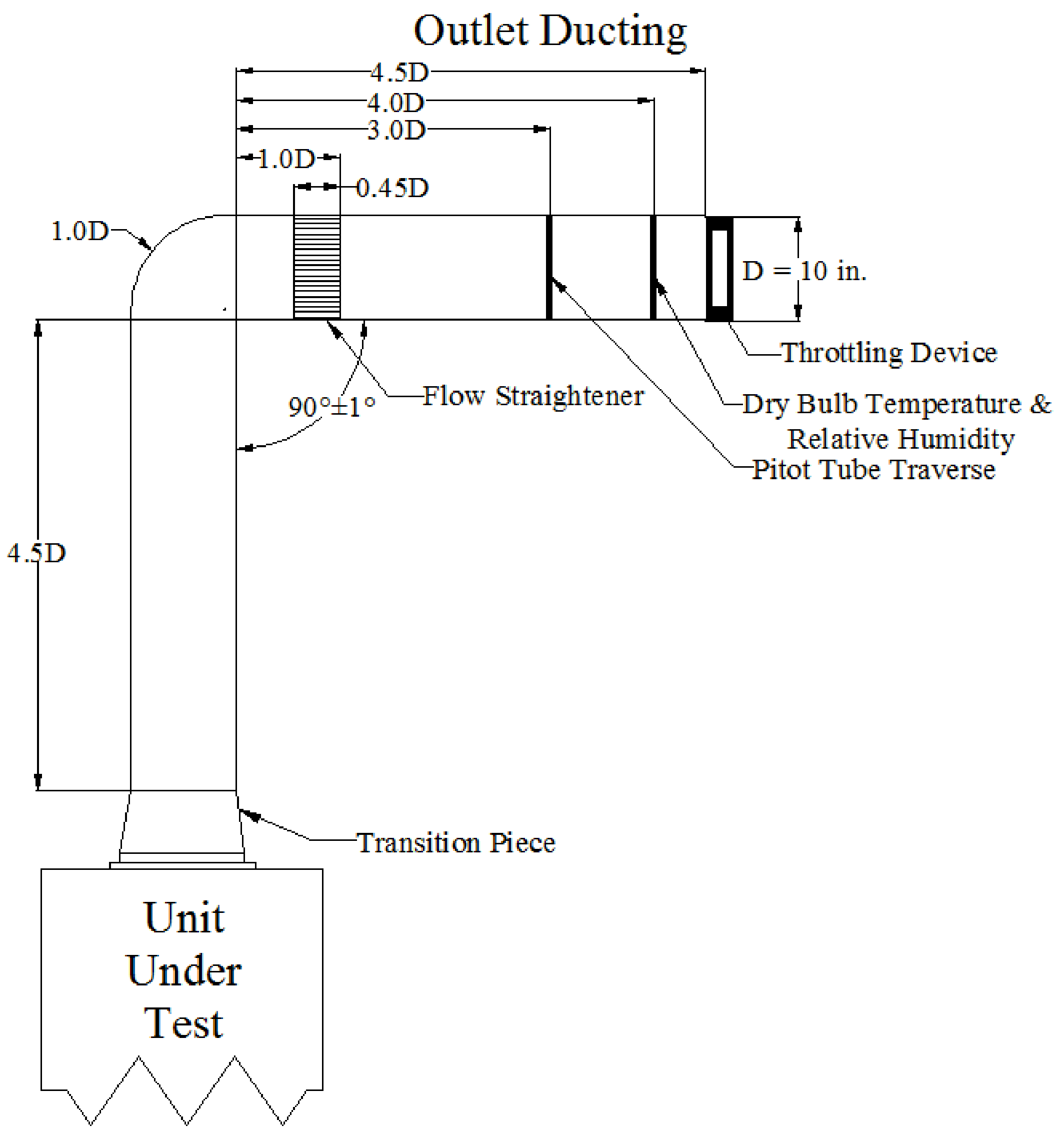

Figure 3: Outlet Vertical Duct Configurations and Instrumentation Placement

3.1.4 Recording and rounding. When testing either a portable dehumidifier or a whole-home dehumidifier, record measurements at the resolution of the test instrumentation. Record measurements for portable dehumidifiers and whole-home dehumidifiers other than refrigerant-desiccant dehumidifiers at intervals no greater than 10 minutes. Record measurements for refrigerant-desiccant dehumidifiers at intervals no greater than 1 minute. Round off calculations to the same number of significant digits as the previous step. Round the final product capacity, energy factor and integrated energy factor values to two decimal places, and for whole-home dehumidifiers, round the final product case volume to one decimal place.

3.2 Inactive mode and off mode.

3.2.1 Installation requirements. For the inactive mode and off mode testing, install the dehumidifier in accordance with Section 5, Paragraph 5.2 of IEC 62301 (incorporated by reference, see § 430.3), disregarding the provisions regarding batteries and the determination, classification, and testing of relevant modes.

3.2.2 Electrical energy supply.

3.2.2.1 Electrical supply. For the inactive mode and off mode testing, maintain the electrical supply voltage and frequency indicated in Section 7.1.3, “Standard Test Voltage,” of ANSI/AHAM DH-1 (incorporated by reference, see § 430.3). The electrical supply frequency shall be maintained ±1 percent.

3.2.2.2 Supply voltage waveform. For the inactive mode and off mode testing, maintain the electrical supply voltage waveform indicated in Section 4, Paragraph 4.3.2 of IEC 62301 (incorporated by reference, see § 430.3).

3.2.3 Inactive mode, off mode, and off-cycle mode wattmeter. The wattmeter used to measure inactive mode, off mode, and off-cycle mode power consumption must meet the requirements specified in Section 4, Paragraph 4.4 of IEC 62301 (incorporated by reference, see § 430.3).

3.2.4 Inactive mode and off mode ambient temperature. For inactive mode and off mode testing, maintain room ambient air temperature conditions as specified in Section 4, Paragraph 4.2 of IEC 62301 (incorporated by reference, see § 430.3).

3.3 Case dimensions for whole-home dehumidifiers. Measure case dimensions using equipment with a resolution of no more than 0.1 in.

4. Test Measurement

4.1 Dehumidification mode.

4.1.1 Portable dehumidifiers and whole-home dehumidifiers other than refrigerant-desiccant dehumidifiers. Measure the energy consumption in dehumidification mode, E_{DM}, expressed in kilowatt-hours (kWh), the average relative humidity, H_t, either as measured using a relative humidity sensor or using the tables provided below when using an aspirating psychrometer, and the product capacity, C_t, expressed in pints per day (pints/day), in accordance with the test requirements specified in Section 7, "Capacity Test and Energy Consumption Test," of ANSI/AHAM DH-1 (incorporated by reference, see § 430.3), except that the standard test conditions for portable dehumidifiers must be maintained at 65 °F ± 2.0 °F dry-bulb temperature and 56.6 °F ± 1.0 °F wet-bulb temperature, when recording conditions with an aspirating psychrometer, or 60 percent ± 2 percent relative humidity, when recording conditions with a relative humidity sensor. For whole-home dehumidifiers, conditions must be maintained at 73 °F ± 2.0 °F dry-bulb temperature and 63.6 °F ± 1.0 °F wet-bulb temperature, when recording conditions with an aspirating psychrometer, or 60 percent ± 2 percent relative humidity, when recording conditions with a relative humidity sensor. When using relative humidity and dry-bulb temperature sensors, for dehumidifiers with multiple process air intake grilles, average the measured relative humidities and average the measured dry-bulb temperatures to determine the overall intake air conditions.

Wet-Bulb	Dry-Bulb Temperatures (°F)										
Temperature (°F)	64.5	64.6	64.7	64.8	64.9	65.0	65.1	65.2	65.3	65.4	65.5
56.3	60.32	59.94	59.57	59.17	58.80	58.42	58.04	57.67	57.30	56.93	56.56
56.4	60.77	60.38	60.00	59.62	59.24	58.86	58.48	58.11	57.73	57.36	56.99
56.5	61.22	60.83	60.44	60.06	59.68	59.30	58.92	58.54	58.17	57.80	57.43
56.6	61.66	61.27	60.89	60.50	60.12	59.74	59.36	58.98	58.60	58.23	57.86
56.7	62.40	61.72	61.33	60.95	60.56	60.18	59.80	59.42	59.04	58.67	58.29
56.8	62.56	62.17	61.78	61.39	61.00	60.62	60.24	59.86	59.48	59.10	58.73
56.9	63.01	62.62	62.23	61.84	61.45	61.06	60.68	60.30	59.92	59.54	59.16

Table 1: Relative Humidity as a Function of Dry-Bulb and Wet-Bulb Temperatures for Portable Dehumidifiers

Wet-Bulb	Dry-Bulb Temperatures (°F)										
Temperature (°F)	72.5	72.6	72.7	72.8	72.9	73.0	73.1	73.2	73.3	73.4	73.5
63.3	60.59	60.26	59.92	59.59	59.26	58.92	58.60	58.27	57.94	57.62	57.30
63.4	60.98	60.64	60.31	59.75	59.64	59.31	58.98	58.65	58.32	58.00	57.67
63.5	61.37	61.03	60.70	60.36	60.02	59.69	59.36	59.03	58.70	58.38	58.05
63.6	61.76	61.42	61.08	60.75	60.41	60.08	59.74	59.41	59.08	58.76	58.43
63.7	62.16	61.81	61.47	61.13	60.80	60.46	60.13	59.80	59.47	59.14	58.81
63.8	62.55	62.20	61.86	61.52	61.18	60.85	60.51	60.18	59.85	59.52	59.19
63.9	62.94	62.60	62.25	61.91	61.57	61.23	60.90	60.56	60.23	59.90	59.57

Table 2: Relative Humidity as a Function of Dry-Bulb and Wet-Bulb Temperatures for Whole-Home Dehumidifiers

4.1.2 Refrigerant-desiccant dehumidifiers. Establish the testing conditions set forth in section 3.1.2 of this appendix. Measure the energy consumption, E_{DM}, expressed in kWh, in accordance with the test requirements specified in Section 7, "Capacity Test and Energy Consumption Test," of ANSI/AHAM DH-1 (incorporated by reference, see § 430.3), except that: (1) individual readings of the standard test conditions at the air entering the process air inlet duct and the reactivation air inlet must be maintained within 73 °F ± 2.0 °F dry-bulb temperature and 60 percent ± 5 percent relative humidity and the arithmetic average of the inlet test conditions over the test period shall be maintained within 73 °F ± 0.5 °F dry-bulb temperature and 60 percent ± 2 percent relative humidity; (2) the instructions for psychrometer placement do not apply; (3) the data recorded must include dry-bulb temperatures, relative humidities, static pressures, velocity pressures in each duct, volumetric air flow rates, and the number of samples in the test period; (4) the condensate collected during the test need not be weighed; and (5) the calculations in Section 7.2.2, “Energy Factor Calculation,” of ANSI/AHAM DH-1 need not be performed. To perform the calculations in Section 7.1.7, “Calculation of Test Results,” of ANSI/AHAM DH-1: (1) replace “Condensate collected (lb)” and “m_{lb}”, with the weight of condensate removed, W, as calculated in section 5.6 of this appendix; and (2) use the recorded relative humidities rather than the tables in section 4.1.1 of this appendix to determine average relative humidity.

4.2 Off-cycle mode. Establish the test conditions specified in section 3.1.1 or 3.1.2 of this appendix, but use the wattmeter specified in section 3.2.3 of this appendix. Begin the off-cycle mode test period immediately following the dehumidification mode test period. Adjust the setpoint higher than the ambient relative humidity to ensure the product will not enter dehumidification mode and begin the test when the compressor cycles off due to the change in setpoint. The off-cycle mode test period shall be 2 hours in duration, during which the power consumption is recorded at the same intervals as recorded for dehumidification mode testing. Measure and record the average off-cycle mode power of the dehumidifier, P_{OC}, in watts.

4.3 Inactive and off mode. Establish the testing conditions set forth in section 3.2 of this appendix, ensuring that the dehumidifier does not enter active mode during the test. For dehumidifiers that take some time to enter a stable state from a higher power state, as discussed in Section 5, Paragraph 5.1, Note 1 of IEC 62301 (incorporated by reference; see § 430.3), allow sufficient time for the dehumidifier to reach the lower power state before proceeding with the test measurement. Follow the test procedure specified in Section 5, Paragraph 5.3.2 of IEC 62301 for testing in each possible mode as described in sections 4.3.1 and 4.3.2 of this appendix.

4.3.1 If the dehumidifier has an inactive mode, as defined in section 2.10 of this appendix, but not an off mode, as defined in section 2.11 of this appendix, measure and record the average inactive mode power of the dehumidifier, P_{IA}, in watts.

4.3.2 If the dehumidifier has an off mode, as defined in section 2.11 of this appendix, measure and record the average off mode power of the dehumidifier, P_{OM}, in watts.

4.4 Product case volume for whole-home dehumidifiers. Measure the maximum case length, D_L, in inches, the maximum case width, D_W, in inches, and the maximum height, D_H, in inches, exclusive of any duct collar attachments or other external components.

5. Calculation of Derived Results From Test Measurements

5.1 Corrected relative humidity. Calculate the average relative humidity, for portable and whole-home dehumidifiers, corrected for barometric pressure variations as:

$$H_{c,p} = H_t \times [1 + 0.0083 \times (29.921 - B)]$$

$$H_{c,wh} = H_t \times [1 + 0.0072 \times (29.921 - B)]$$

Where:

$H_{c,p}$ = portable dehumidifier average relative humidity from the test data in percent, corrected to the standard barometric pressure of 29.921 in. mercury (Hg);

$H_{c,wh}$ = whole-home dehumidifier average relative humidity from the test data in percent, corrected to the standard barometric pressure of 29.921 in. Hg;

H_t = average relative humidity from the test data in percent; and

B = average barometric pressure during the test period in in. Hg.

5.2 Corrected product capacity. Calculate the product capacity, for portable and whole-home dehumidifiers, corrected for variations in temperature and relative humidity as:

$$C_{r,p} = C_t + 0.0352 \times C_t \times (65 - T_t) + 0.0169 \times C_t \times \left(60 - H_{C,p}\right)$$

$$C_{r,wh} = C_t + 0.0344 \times C_t \times (73 - T_t) + 0.017 \times C_t \times \left(60 - H_{C,wh}\right)$$

Where:

$C_{r,p}$ = portable dehumidifiers product capacity in pints/day, corrected to standard rating conditions of 65 °F dry-bulb temperature and 60 percent relative humidity;

$C_{r,wh}$ = whole-home dehumidifier product capacity in pints/day, corrected to standard rating conditions of 73 °F dry-bulb temperature and 60 percent relative humidity;

C_t = product capacity determined from test data in pints/day, as measured in section 4.1.1 of this appendix for portable and refrigerant-only whole-home dehumidifiers or calculated in section 5.6 of this appendix for refrigerant-desiccant whole-home dehumidifiers;

T_t = average dry-bulb temperature during the test period in °F;

$H_{C,p}$ = portable dehumidifier corrected relative humidity in percent, as determined in section 5.1 of this appendix; and

$H_{C,wh}$ = whole-home dehumidifier corrected relative humidity in percent, as determined in section 5.1 of this appendix.

5.3 Annual combined low-power mode energy consumption. Calculate the annual combined low-power mode energy consumption for dehumidifiers, E_{TLP}, expressed in kWh per year:

$$E_{TLP} = [(P_{IO} \times S_{IO}) + (P_{OC} \times S_{OC})] \times K$$

Where:

$P_{IO} = P_{IA}$, dehumidifier inactive mode power, or P_{OM}, dehumidifier off mode power in watts, as measured in section 4.3 of this appendix;

P_{OC} = dehumidifier off-cycle mode power in watts, as measured in section 4.2 of this appendix;

S_{IO} = 1,840.5 dehumidifier inactive mode or off mode annual hours;

S_{OC} = 1,840.5 dehumidifier off-cycle mode annual hours; and

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

5.4 Integrated energy factor. Calculate the integrated energy factor, IEF, expressed in L/kWh, rounded to two decimal places, according to the following:

$$IEF = \frac{\left(C_r \times \frac{t \times 1.04}{24}\right) \times 0.454}{\left[E_{DM} + \left(\left(\frac{E_{TLP}}{1095}\right) \times 6\right)\right]}$$

Where:

C_r = corrected product capacity in pints per day, as determined in section 5.2 of this appendix;

t = test duration in hours;

E_{DM} = energy consumption during the 6-hour dehumidification mode test in kWh, as measured in section 4.1 of this appendix;

E_{TLP} = annual combined low-power mode energy consumption in kWh per year, as calculated in section 5.3 of this appendix;

1,095 = dehumidification mode annual hours, used to convert E_{TLP} to combined low-power mode energy consumption per hour of dehumidification mode;

6 = hours per dehumidification mode test, used to convert annual combined low-power mode energy consumption per hour of dehumidification mode for integration with dehumidification mode energy consumption;

1.04 = the density of water in pounds per pint;

0.454 = the liters of water per pound of water; and

24 = the number of hours per day.

5.5 Absolute humidity for refrigerant-desiccant dehumidifiers. Calculate the absolute humidity of the air entering and leaving the refrigerant-desiccant dehumidifier in the process air stream, expressed in pounds of water per cubic foot of air, according to the following set of equations.

5.5.1 Temperature in Kelvin. The air dry-bulb temperature, in Kelvin, is:

$$T_K = \left(\frac{5}{9}(T_F - 32)\right) - 273.15$$

Where:

T_F = the measured dry-bulb temperature of the air in °F.

5.5.2 Water saturation pressure. The water saturation pressure, expressed in kilopascals (kPa), is:

$$P_{ws} = e^{\left(-\left(\frac{5.8\times10^3}{T_K}\right)-5.516-\left(4.864\times10^{-2}T_K\right)+\left(4.176\times10^{-5}{T_K}^2\right)-\left(1.445\times10^{-8}{T_K}^3\right)+6.546\,ln(T_K)\right)}$$

Where:

T_K = the calculated dry-bulb temperature of the air in K, calculated in section 5.5.1 of this appendix.

5.5.3 Vapor pressure. The water vapor pressure, expressed in kilopascals (kPa), is:

$$P_w = \frac{RH \times P_{ws}}{100}$$

Where:

RH = percent relative humidity during the rating test period; and

P_{ws} = water vapor saturation pressure in kPa, calculated in section 5.5.2 of this appendix.

5.5.4 Mixing humidity ratio. The mixing humidity ratio, the mass of water per mass of dry air, is:

$$HR = \frac{0.62198 \times P_w}{(P \times 3.386) - P_w}$$

Where:

P_w = water vapor pressure in kPa, calculated in section 5.5.3 of this appendix;

P = measured ambient barometric pressure in in. Hg;

3.386 = the conversion factor from in. Hg to kPa; and

0.62198 = the ratio of the molecular weight of water to the molecular weight of dry air.

5.5.5 Specific volume. The specific volume, expressed in feet cubed per pounds of dry air, is:

$$\nu = \left(\frac{0.287055 \times T_K}{(P \times 3.386) - P_w}\right) \times 16.016$$

Where:

T_K = dry-bulb temperature of the air in K, as calculated in section 5.5.1 of this appendix;

P = measured ambient barometric pressure in in. Hg;

P_w = water vapor pressure in kPa, calculated in section 5.5.3 of this appendix;

0.287055 = the specific gas constant for dry air in kPa times cubic meter per kg per K;

3.386 = the conversion factor from in. Hg to kPa; and

16.016 = the conversion factor from cubic meters per kilogram to cubic feet per pound.

5.5.6 Absolute humidity. The absolute humidity, expressed in pounds of water per cubic foot of air, is:

$$AH = \frac{HR}{\nu}$$

Where:

HR = the mixing humidity ratio, the mass of water per mass of dry air, as calculated in section 5.5.4 of this appendix; and

ν = the specific volume in cubic feet per pound of dry air, as calculated in section 5.5.5 of this appendix.

5.6 Product capacity for refrigerant-desiccant dehumidifiers. The weight of water removed during the test period, W, expressed in pounds is:

$$W=\sum_{i=1}^{n}\left(\left(AH_{I,i}\times X_{I,i}\right)-\left(AH_{O,i}\times X_{O,i}\right)\right)\times\frac{t}{60}$$

Where:

n = number of samples during the test period in section 4.1.1.2 of this appendix;

$AH_{I,i}$ = absolute humidity of the process air on the inlet side of the unit in pounds of water per cubic foot of dry air, as calculated for sample i in section 5.5.6 of this appendix;

$X_{I,i}$ = volumetric flow rate of the process air on the inlet side of the unit in cubic feet per minute, measured for sample i in section 4.1.1.2 of this appendix. Calculate the volumetric flow rate in accordance with Section 7.3, "Fan airflow rate at test conditions," of ANSI/AMCA 210 (incorporated by reference, see § 430.3);

$AH_{O,i}$ = absolute humidity of the process air on the outlet side of the unit in pounds of water per cubic foot of dry air, as calculated for sample i in section 5.5.6 of this appendix;

$X_{O,i}$ = volumetric flow rate of the process air on the outlet side of the unit in cubic feet per minute, measured for sample i in section 4.1.1.2 of this appendix. Calculate the volumetric flow rate in accordance with Section 7.3, "Fan airflow rate at test conditions," of ANSI/AMCA 210 (incorporated by reference, see § 430.3);

t = time interval in seconds between samples, with a maximum of 60; and

60 = conversion from minutes to seconds.

The capacity, C_t, expressed in pints/day, is:

$$C_t = \frac{W \times 24}{1.04 \times T}$$

Where:

24 = number of hours per day;

1.04 = density of water in pounds per pint; and

T = total test period time in hours.

Then correct the product capacity, $C_{r,wh}$, according to section 5.2 of this appendix.

5.7 Product case volume for whole-home dehumidifiers. The product case volume, V, in cubic feet, is:

$$V = \frac{D_L \times D_W \times D_H}{1728}$$

Where:

D_L = product case length in inches, measured in section 4.4 of this appendix;

D_W = product case width in inches, measured in section 4.4 of this appendix;

D_H = product case height in inches, measured in section 4.4 of this appendix; and

1,728 = conversion from cubic inches to cubic feet.