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[6450-01-P]

DEPARTMENT OF ENERGY

Office of Energy Efficiency and Renewable 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: Supplemental notice of proposed rulemaking.

SUMMARY: The U.S. Department of Energy (DOE) proposes to amend the test procedure proposals presented in a notice of proposed rulemaking (NOPR), published on May 21, 2014 (May 2014 NOPR). 79 FR 29271. The proposed revisions include modifications to the whole-home dehumidifier test setup and conduct, and revisions to the measurement of energy use in fan-only operation first proposed in the May 2014 NOPR. DOE also introduces a methodology to determine whole-home dehumidifier case volume, clarifies the equations used to calculate corrected relative humidity and capacity for portable and whole-home dehumidifiers, and provides additional technical corrections and clarifications. The additional proposals are to be combined with the initial proposals from the May 2014 NOPR and would be codified in title 10 of the Code of Federal Regulations (CFR), part 430, subpart B, appendix X1.

DATES: DOE will accept comments, data, and information regarding this supplemental notice of proposed rulemaking (SNOPR) submitted no later than [**INSERT DATE 30 DAYS AFTER FEDERAL REGISTER PUBLICATION**]. See Section V, "Public Participation," for details.

ADDRESSES: Any comments submitted must identify the SNOPR for Test Procedures for Dehumidifiers, and provide docket number EE-2014–BT–TP–0010 and/or regulatory information number (RIN) number 1904-AC80. Comments may be submitted using any of the following methods:

1. Federal eRulemaking Portal: www.regulations.gov. Follow the instructions for submitting comments.
2. E-mail: Dehumidifier2014TP0010@ee.doe.gov. Include the docket number and/or RIN in the subject line of the message.
3. Mail: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, Mailstop EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.
4. Hand Delivery/Courier: Ms. Brenda Edwards, U.S. Department of Energy, Building Technologies Office, 950 L'Enfant Plaza, SW., Suite 600, Washington, DC, 20024. Telephone: (202) 586-2945. If possible, please submit all items on a CD, in which case it is not necessary to include printed copies.

For detailed instructions on submitting comments and additional information on the rulemaking process, see Section V of this document (Public Participation).

Docket: 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 webpage can be found at: http://www1.eere.energy.gov/buildings/appliance_standards/rulemaking.aspx?ruleid=95 . This webpage contains a link to the docket for this notice on the www.regulations.gov site. The www.regulations.gov webpage contains instructions on how to access all documents, including public comments, in the docket. See Section V, "Public Participation," for information on how to submit comments through www.regulations.gov.

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

FOR FURTHER INFORMATION CONTACT:

Mr. Bryan Berringer, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies, EE-5B, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586-0371. Email: bryan.berringer@ee.doe.gov.

Mr. Peter Cochran, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue, SW., Washington, DC, 20585-0121. Telephone: (202) 586–9496. E-mail: peter.cochran@hq.doe.gov.

SUPPLEMENTARY INFORMATION: DOE intends to incorporate by reference the following industry standards into 10 CFR Part 430: Standard Method for Temperature Measurement, American National Standards Institute (ANSI)/American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 41.1-2013 and Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating, ANSI/Air Movement and Control Association (AMCA) 210-07.

Copies of ANSI/ASHRAE Standard 41.1-2013 can be obtained from the American National Standards Institute 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.

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

Table of Contents

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 today's proposed rule. (42 U.S.C. 6295(cc))

Under EPCA, the energy conservation program consists essentially of four parts: (1) testing, (2) labeling, (3) Federal energy conservation standards, and (4) certification and

[1] All references to EPCA refer to the statute as amended through the American Energy Manufacturing Technical Corrections Act (AEMTCA), Pub. L. 112-210 (Dec. 18, 2012).
[2] For editorial reasons, Part B was redesignated as Part A upon incorporation into the U.S. Code.

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.

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 in relevant part that any test procedures prescribed or amended under this section shall be reasonably designed to produce test results that 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))

DOE's test procedure for dehumidifiers is found at 10 CFR part 430, subpart B, appendix X (appendix X). For background on the establishment of the first test procedure for dehumidifiers, subsequent amendments to that procedure, and the rulemaking history for today's supplemental notice of proposed rulemaking (SNOPR), please see the May 2014 NOPR. 79 FR 29271.

II. Summary of the Supplemental Notice of Proposed Rulemaking

Upon further analysis and review of the public comments received in response to the May 2014 NOPR, DOE proposes in today's SNOPR the following additions and clarifications to its proposed dehumidifier test procedure: (1) various adjustments and clarifications to the whole-home dehumidifier test setup and conduct; (2) a method to determine whole-home dehumidifier case volume; (3) a revision to the method for measuring energy use in fan-only operation; (4) a clarification to the relative humidity and capacity equations incorporated from American National Standards Institute (ANSI)/Association of Home Appliance Manufacturers (AHAM) DH-1-2008, "Dehumidifiers" (ANSI/AHAM DH-1-2008); and (5) additional technical corrections and clarifications.

Other than the specific amendments newly proposed in today's SNOPR, DOE continues to propose the test procedure amendments originally included in the May 2014 NOPR. For the reader's convenience, DOE has reproduced in this SNOPR the entire body of proposed regulatory text from the May 2014 NOPR, amended as appropriate according to today's proposals. DOE's supporting analysis and discussion for the portions of the proposed regulatory text not affected by this SNOPR may be found in the May 2014 NOPR. 79 FR 29271.

III. Discussion

A. Whole-Home Dehumidifier Test Setup and Testing Conditions

As discussed in the May 2014 NOPR, whole-home dehumidifiers are intended to be installed and operated as part of a ducted air-delivery system. These units are designed with standard-size collars to interface with the home's ducting, and typically require two ducts for the process air stream: a supply air intake from the dehumidified space and an air outlet for delivery of the dehumidified air to the same space. Refrigerant-desiccant dehumidifiers incorporate intake and outlet ducts for reactivation air in addition to the process stream supply air intake and dehumidified air outlet. Reactivation air, as defined in the May 2014 NOPR, is air drawn from unconditioned space (e.g., outdoors, attic, or crawlspace) to remove moisture from the desiccant wheel of a refrigerant-desiccant dehumidifier and discharged to unconditioned space. 79 FR 29271, 29283.

Based on the unique installation and operation of whole-home dehumidifiers, DOE proposed in the May 2014 NOPR to adopt a new test procedure at 10 CFR part 430, subpart B, appendix X1 (appendix X1) that would contain, in part, a method for testing whole-home dehumidifiers.

Upon review of the public comments received in response to the May 2014 NOPR and comments received during the June 2014 public meeting, DOE determined that further clarifications and modifications were necessary to ensure the whole-home dehumidifier test procedure is repeatable and representative of actual use, while limiting test burden. In today's

SNOPR, DOE proposes the following additions and modifications to the proposals described in the May 2014 NOPR for whole-home dehumidifiers.

1. Inlet Temperature

As discussed in the May 2014 NOPR, DOE's analysis of weather data in regions associated with predominant dehumidifier usage and at times when dehumidification was necessary identified 65 degrees Fahrenheit (°F) as the most representative ambient dry-bulb temperature.[3] Therefore, DOE proposed in the May 2014 NOPR that all dehumidifier testing be conducted with an inlet dry-bulb temperature of 65 °F. However, DOE acknowledged that whole-home dehumidifiers may have inlet air dry-bulb temperatures consistent with the thermostat setting in homes. Based on an analysis of average indoor temperature data from the 2009 Residential Energy Consumption Survey (RECS), DOE proposed in the May 2014 NOPR a potential alternative inlet air dry-bulb temperature of 73 °F for testing whole-home dehumidifiers. 79 FR 29271, 29279.

In response to the May 2014 NOPR, Aprilaire, Inc. (Aprilaire) commented that the test procedure ambient conditions must represent the as-used conditions, and that the 80 °F dry-bulb temperature and 60-percent relative humidity requirements of the current test procedure are not representative of actual use conditions. Aprilaire stated that, although it tests its products at

[3] Dry-bulb temperature is an indicator of the heat content in air and can be measured using a thermometer or thermocouple exposed to air, but shielded from radiation and moisture. Wet-bulb temperature is the temperature of adiabatic saturation and is measured using a moistened thermometer or thermocouple exposed to the air flow. The adiabatic evaporation of water from the thermometer or thermocouple has a cooling effect that causes wet-bulb temperature to be less than or equal to dry-bulb temperature. Relative humidity is the ratio of the partial pressure of water vapor to the equilibrium vapor pressure of water at the same temperature, and is therefore dependent upon temperature and pressure. Relative humidity is also related to the difference between the dry-bulb and wet-bulb temperatures by means of psychrometric functions.

ambient dry-bulb temperatures as low as 60 °F, the alternate proposed dry-bulb temperature test condition of 73 °F is closer to the intended application for whole-home dehumidifiers and would be better than the current test condition because it better represents the normal use condition, allows for better comparison between whole-home dehumidifiers and portable dehumidifiers, and would allow building designers to better monitor and estimate home energy use. Aprilaire also noted that the American Society of Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE) has been trying to specify a design condition, and 73 °F is close to the temperature that the organization has agreed upon. Therefore, Aprilaire stated that it supports DOE's proposal to test whole-home dehumidifiers at 73 °F dry-bulb temperature and 60-percent relative humidity. However, Aprilaire further suggested that DOE consider an ambient dry-bulb temperature of 75 °F, which is halfway between the proposed 73 °F and the ENERGY STAR-recommended air conditioner cooling setpoint of 78 °F. Aprilaire believes that a proper cooling setpoint for a home should be 78 °F but that the average setpoint may be closer to 73 °F because consumers tend to over-cool to remove humidity. Nonetheless, Aprilaire noted that with proper humidity control, higher cooling setpoints can be used while still maintaining comfort. (Aprilaire, No. 5 at pp. 3–4; Aprilaire, Public Meeting Transcript, No. 10 at pp. 41–44, 46–47)[4]

[4] A notation in the form "Aprilaire, No. 5 at pp. 3–4" 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 pages 3–4 of document number 5. A notation in the form "Aprilaire, Public Meeting Transcript, No. 10 at pp. 41–44, 46–47" identifies an oral comment that DOE received on June 13, 2014 during the 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 maintained in the Resource Room of the Building Technologies Program. 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 41–44 and 46–47 of document number 10.

Therma-Stor LLC (Therma-Stor) commented that the 65 °F test condition proposed in the May 2014 NOPR is more representative of a basement application than the current 80 °F, but it is not representative of above-grade conditioned spaces. Therma-Stor stated that consumers in the Southeast, Gulf Coast, and Pacific Northwest regions may be using portable and whole-home dehumidifiers in above-grade applications, which are better represented by an 80 °F test condition. Therma-Stor stated that whole-home dehumidifiers typically receive return air from the conditioned space, and the proposed 65 °F dry-bulb temperature is too low. Therma-Stor suggested that a 73 °F dry-bulb temperature test condition may represent some whole-home dehumidifier applications, but the test temperature should be even higher to correspond to real-world applications. According to Therma-Stor, whole-home dehumidifiers maintain adequate humidity control at higher indoor temperatures, and some whole-home dehumidifiers use fresh air inlets,[5] leading to a return air temperature that is higher than the indoor temperature. Therefore, Therma-Stor supports a standard rating test condition of 80 °F dry-bulb temperature for whole-home dehumidifiers. (Therma-Stor, No. 6 at pp. 3–4)

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”) recommended that DOE prescribe separate ambient test conditions for portable and whole-home dehumidifiers because the temperature of the intake air

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[5] In the May 2014 NOPR, DOE considered testing provisions for fresh air inlets, and proposed that any fresh air inlet be capped and sealed during testing because the impact of a fresh air connection was not significant enough to warrant the added test burden of providing separate fresh air inlet flow. 79 FR 29272, 29285. DOE maintains the same proposal in this SNOPR, and again invites comment on it from interested parties.

for whole-home dehumidifiers is likely to be close to the thermostat setting instead of the outdoor conditions. The Joint Commenters, ASAP, and NRDC agree with DOE's alternate proposal in the May 2014 NOPR that 73 °F is a representative test condition to determine whole-home dehumidifier performance, although NRDC expressed concern that it would be difficult to then compare whole-home and portable dehumidifier performance. (Joint Commenters, No. 8 at p. 4; ASAP, Public Meeting Transcript, No. 10 at p. 46; NRDC, Public Meeting Transcript, No. 10 at p. 45) The Joint Commenters also noted that because moisture removal is more difficult at lower dry-bulb temperatures for a given relative humidity, dehumidifiers that have good performance at 65 °F would also perform well at 73 °F. (Joint Commenters, No. 8 at p. 4)

In a recent field study conducted by Burke, et al., (hereinafter referred to as the Burke Study), whole-home dehumidifiers were metered at four different field locations in Wisconsin and Florida.[6] At each location, inlet air temperatures and additional setup and performance characteristics were monitored. The Burke Study found that the average inlet dry-bulb temperatures during compressor operation in dehumidification mode for each of the four whole-home dehumidifiers ranged from 70.4 °F to 75.1 °F, with an average among all four sites of 73.2 °F.

Although this sample was very limited, DOE notes that it encompasses homes in two geographical regions with substantially different climates, with different dehumidifier locations within the home. After considering the comments received and this new field data, DOE

[6] 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

tentatively determined that the alternative proposal of 73 °F inlet air dry-bulb temperature is most representative for whole-home dehumidifiers. DOE proposes in today's notice 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 recognizes that the results for portable and whole-home dehumidifiers will thus not be directly comparable, but points out 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.

2. External Static Pressure

Frictional forces and head losses due to the air flowing in the ducting impose an external static pressure (ESP) on a whole-home dehumidifier. As duct length and the number of flow restrictions in the air system increase, ESP increases as well. Therefore, DOE proposed in the May 2014 NOPR that whole-home dehumidifier testing be conducted at an ESP representative of typical residential installations. 79 FR 29271, 29287. DOE reviewed several sources of information to determine the appropriate ESP, including the residential furnace fan rulemaking,[7] whole-home dehumidifier product literature, and data from a residential furnace fan monitoring study conducted by the Center for Energy and Environment,[8] in addition to DOE's own testing and analysis. DOE tentatively concluded that an ESP of 0.5 inches of water column (in. w.c.) would, on average, represent the ESP for a whole-home dehumidifier installed in a typical home.

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[7] Supplemental Notice of Proposed Rulemaking for Test Procedures for Residential Furnace Fans, 78 FR 19606, 19618 (Apr. 2, 2013).
[8] Center for Energy and Environment Comment on Energy Conservation Standards for Residential Furnace Fans, Docket No. EERE–2010–BT–STD–0011, Comment Number 22 (July 27, 2010).

Therefore, DOE proposed in the May 2014 NOPR that whole-home dehumidifier testing in dehumidification mode be conducted with an ESP of 0.5 ± 0.02 in. w.c. for the process air stream of all units and for the reactivation air stream of refrigerant-desiccant dehumidifiers. 79 FR 29271, 29287–88.

The Joint Commenters agreed that whole-home dehumidifiers should be tested at an ESP of 0.5 in. w.c., aligning with the ESP in the furnace fans test procedure for furnace fans designed to be installed in systems with an internal evaporator coil. (Joint Commenters, No. 8 at pp. 4–5)

Aprilaire stated that residential heating, ventilation, and air conditioning (HVAC) systems operate at up to 0.8 in. w.c. ESP, and that 0.5 in. w.c. on average is likely representative of such systems. For whole-home dehumidifiers, however, Aprilaire commented that ESP varies due to the different potential configurations by which the products are integrated into the HVAC return and supply ducting. In addition, Aprilaire and Therma-Stor commented that whole-home dehumidifiers that utilize the higher flow rate HVAC blower will have a higher ESP than those dehumidifiers that operate with a lower flow rate internal fan. Aprilaire stated that an ESP of 0.5 in. w.c. would represent an extreme and unrealistic condition for whole-home dehumidifiers, and that testing them at this condition would require designs that would be inappropriate for typical installations. According to Therma-Stor, manufacturers would be forced to incorporate higher power, noisier fans. Therma-Stor further commented that it recommends its products be installed in a configuration that creates ESP much lower than 0.5 in. w.c., although the ESP in the field varies depending on the actual installation. Therma-Stor's whole-home dehumidifiers have duct connections that are designed to provide less than 0.15 in. w.c. ESP per 100 feet of duct. (Aprilaire, Public Meeting Transcript, No. 10 at pp. 72–74; Aprilaire, No. 5 at p. 4; Therma-Stor, No. 6 at p. 4)

The Burke Study monitored the ESP during unit operation for the three units installed in Florida sites. Static pressure probes were placed in the entry and exit ducts to the unit, with no more than one duct elbow between the probe and the dehumidifier. The ESP was initially measured with the air handler both off and on (at low and high speed), with the dehumidifier operational. The ESP was subsequently measured at 1-second intervals throughout the 7-month metering period, and data were analyzed to determine average ESP during those periods when the dehumidifier compressor and blower were activated regardless of HVAC blower activation. A summary of these measurements is presented in Table III.1.

Table III.1 Whole-Home Dehumidifier Average External Static Pressure

Site Designation	**Average External Static Pressure with Dehumidifier Blower On** (in. w.c.)			
	Air Handler Off	**Air Handler On at Low Speed**	**Air Handler On at High Speed**	**Average in Dehumidification Mode During Metering Period**
WHD-SiteB01	0.14–0.16	0.085–0.090	–	0.117
WHD-SiteB02	0.32	0.26–0.27	0.22–0.23	0.283
WHD-SiteB03	0.23	0.18–0.19	0.11	0.205
Average*	0.23	0.18	0.17	0.20

* Calculated using the midpoint of each range

As previously noted, this sample is very small, but the results suggest that the comments characterizing 0.5 in. w.c. as an unrealistic upper bound for ESP may be valid. To further validate this matter, DOE considered the equation in the recent NOPR for the residential furnace fan test procedure that calculated ESP from the product of the square of the volumetric air flow rate (in cubic feet per minute, CFM) and a reference system constant (a value that represents the losses within the average duct system). 77 FR 28673, 28684 (May 15, 2012). Based on the average furnace fan ESP of 0.5 in. w.c. and air flow rate of 1,200 CFM, DOE calculated a reference system constant of 3.47 x 10^{-7} in in. w.c. per CFM. Through its review of product literature, DOE found that the typical volumetric air flow rate for whole-home dehumidifiers is approximately 300 CFM, which is significantly less than that for a furnace fan. Inserting this air flow rate value into the equation results in an ESP of 0.03 in. w.c., exclusive of the additional losses associated with ducting a whole-home dehumidifier to the home ventilation system. Based on a typical installation with 10-inch diameter dehumidifier ducts, 2 elbows, and connections to the larger ventilation ducts for the home, DOE estimated a total ESP of 0.22 in. w.c. for a typical whole-home dehumidifier setup, which corresponds closely with the data gathered for the Burke Study.

In sum, DOE's analysis for this SNOPR supports testing conditions for whole-home dehumidifiers at an ESP higher than 0.2 in. w.c. (the average in dehumidification mode from the Burke Study) but substantially less than the 0.5 in. w.c. proposed in the May 2014 NOPR. Due to the limited data available to more precisely define this value, DOE proposes in today's SNOPR to specify ESP at 0.25 in. w.c., the nearest value in quarter inch increments, as an appropriate test condition for whole-home dehumidifiers.

3. Test Duct Length

In the May 2014 NOPR, DOE proposed a whole-home dehumidifier ducted test setup with certain duct lengths and cell-type flow straighteners to achieve laminar air flow, and specified the placement of instrumentation based on numbers of duct diameters upstream of and downstream from the test unit. For a refrigerant-only whole-home dehumidifier, one duct would be attached to the process air exhaust to maintain the necessary ESP and would include a pitot-static traverse and throttling device. For a refrigerant-desiccant dehumidifier, three test ducts would be required (two for the process air inlet and exhaust and one for the reactivation air inlet), each with a flow straightener, pitot-static traverse, air sampling instrumentation, and throttling device. 79 FR 29271, 29286.

Aprilaire commented that it would be difficult to accommodate the full length of ducting proposed in the May 2014 NOPR in existing test chambers, and estimated a cost of $30,000 to construct a new test chamber with air conditioning equipment or to move existing test chamber walls, which would be burdensome to whole-home dehumidifier manufacturers. Aprilaire further stated that unit performance would not vary greatly if a shorter length of duct were used, and noted that in its internal testing, it has used a 5-foot duct length that produces an even distribution of inlet air over the internal coils. (Aprilaire, No. 5 at p. 4; Aprilaire, Public Meeting Transcript, No. 10 at pp. 63–64, 79–80, 91–93)

Therma-Stor stated that requiring whole-home dehumidifiers to be tested with ducts would impose an unfair testing burden on whole-home dehumidifier manufacturers. Therma-Stor noted that substantially larger test chambers are required for whole-home dehumidifiers compared with portable dehumidifiers, and the additional duct instruments, measurements, and 1-minute recording interval would require more capable data acquisition systems. Therma-Stor commented that preparing and performing the test would be much more involved than for the current test, and although the cost of the proposed ducts and accessories may be relatively low, the secondary costs of a test facility and staff to support the proposed test would be substantial. (Therma-Stor, No. 6 at p. 5)

In light of these comments, DOE acknowledges the test burden associated with specifying a minimum length of 10 duct diameters for the instrumented ducts and considered whether this length could be reduced without impacting test results. DOE first calculated the duct lengths that would be necessary to ensure fully developed flow in the ducts after a component such as an inlet or elbow. For a 10-inch diameter duct and the expected range of air flow rates for whole-home dehumidifiers, DOE calculated that duct lengths of approximately 8.5–9.5 duct diameters would be necessary, which is close to the requirement of 10 duct diameters proposed in the May 2014 NOPR. However, due to comments indicating that 10 duct diameters may be overly burdensome, following the publication of the May 2014 NOPR, DOE consulted with whole-home dehumidifier manufacturers regarding their internal performance testing and with whole-home dehumidifier installation specialists to determine an appropriate yet low-burden duct length for testing. These sources suggested that 3 diameters of duct length typically allows for adequately uniform air flow within the duct to ensure proper dehumidifier operation. With the inclusion of a flow straightener upstream in the duct, as proposed in the May 2014 NOPR, DOE expects that the air flow would be sufficiently uniform with a length of 3 duct diameters upstream of the instrumentation to allow for repeatable measurements. According to discussion with manufacturers and installers, the flow does not need to be fully developed to achieve representative measurements. Additionally, with the information provided by manufacturers about the dimensions of available test chambers, DOE expects that the longer ducts proposed in the May 2014 NOPR would likely be located near the walls of the test chamber, potentially inhibiting air flow into or out of the duct. A shorter duct length would allow for a larger distance between the test ducts and the test chamber walls, allowing for unrestricted air flow into or out of the test duct.

Therefore, DOE proposes to reduce the required minimum duct lengths by placing the flow straightener at the entrance to the inlet ducting and reducing the total minimum length for all test ducts from 10 diameters to 4.5 diameters. Under DOE's modified proposal, a minimum of 3 duct diameters would be provided between any throttling device or transition section and any instrumentation measuring the air flow properties. See Figures 1, 2, and 3 in proposed Section 3.1.3 of appendix X1 in today's notice for specific placement of all test components (including the flow straightener, pitot-static traverse, dry-bulb temperature and relative humidity measurement devices, and throttling device) and illustrations of these configurations.

4. Relative Humidity Instrumentation

In the May 2014 NOPR, DOE considered two types of instruments to measure the water vapor content in the air: (1) a cooled surface condensation hygrometer that measures dew-point temperature, which can be used in conjunction with dry-bulb temperature to determine relative humidity; and (2) an aspirating psychrometer that measures wet-bulb temperature. DOE proposed in the May 2014 NOPR that relative humidity be measured using an aspirating psychrometer because of its simplicity, accuracy of ±1 percent, and relatively low cost. 79 FR 29271, 29287.

Aprilaire noted that the ±1 percent and ±0.1 °F accuracy of the relative humidity measurement (as determined by the psychrometer) and temperature sensors, respectively, are inconsistent because a ±0.1 °F accuracy for the wet-bulb temperature sensor correlates with a ±0.44 percent accuracy in relative humidity. Aprilaire noted that temperature is less expensive to control and measure than relative humidity. (Aprilaire, Public Meeting Transcript, No. 10 at pp. 67–68; Aprilaire, No. 5 at p. 3)

Therma-Stor recommended that the whole-home dehumidifier test procedure use relative humidity measuring devices other than aspirating psychrometers that achieve similar accuracy and directly output relative humidity. According to Therma-Stor, these instruments may reduce the burden of placing the psychrometer within the duct and would require less frequent calibration than large aspirating psychrometers. (Therma-Stor, No. 6 at p. 2)

DOE notes that the different accuracies in relative humidity measurement arise because the aspirating psychrometers utilize thermocouples to measure both dry-bulb and wet-bulb temperatures, which leads the instrument to have a cumulative accuracy for relative humidity that is lower than the accuracy of the wet-bulb temperature measurement alone. However, DOE considered stakeholder input that certain relative humidity sensors may provide similar accuracy in relative humidity measurements as aspirating psychrometers, but would be less burdensome to implement. In a review of product specifications, DOE identified several solid-state relative humidity sensors currently available with accuracies of ±1 percent at prices similar to or less than the price of a calibrated aspirating psychrometer, which DOE estimated at $1,000 in the May 2014 NOPR. 79 FR 29271, 29293. DOE notes that these relative humidity sensors are specifically designed to be mounted and used in a duct, whereas aspirating psychrometers may be difficult to install, calibrate, and maintain in a duct. DOE is also aware that certain laboratories may already be using these relative humidity sensors, so it does not expect that switching the relative humidity instrumentation from an aspirating psychrometer to a relative humidity sensor for in-duct measurements would significantly increase test burden, and may in fact reduce test burden. Based on the two refrigerant-desiccant dehumidifiers in DOE's test sample, which is the only type of dehumidifier that would require measuring relative humidity in the ducts, duct air velocity ranges from 500 to 650 feet per minute, which is similar to the minimum air velocity of 700 feet per minute specified in ANSI/AHAM DH-1-2008 for the aspirating psychrometer. Therefore DOE tentatively concludes that there is sufficient air flow in the duct to properly monitor the relative humidity conditions of the air for these units.

Therefore, DOE proposes that refrigerant-desiccant dehumidifier testing be conducted with a relative humidity sensor accurate to within ±1 percent relative humidity. DOE is aware that some test laboratories are currently using this instrumentation, and tentatively concludes that, for other laboratories, the proposal to use a relative humidity sensor instead of an aspirating psychrometer would not add significant test burden because of the sensor's simplicity and relatively low cost. DOE expects that this proposal will likely reduce test burden associated with maintenance and calibration compared to the test setup proposed in the May 2014 NOPR.

DOE notes that refrigerant-desiccant dehumidifier testing requires in-duct relative humidity sensors to allow for capacity calculations. Because moisture is removed by the desiccant wheel and the refrigeration system, the typical condensate weighing approach for measuring capacity is not feasible for these dehumidifiers and instead, the psychrometrics in the process air inlet and outlet ducts must be measured. However, portable and refrigerant-only whole-home dehumidifiers would continue to use an aspirating psychrometer to measure inlet air relative humidity, as proposed in the May 2014 NOPR. Based on the extensive industry experience in using these instruments, along with sampling trees, to measure ambient conditions in the absence of inlet ducting, DOE determined that an aspirating psychrometer most reliably measures representative dry-bulb and wet-bulb temperatures in these conditions by inducing controlled air flow over the sensing elements. DOE also expects that when testing these units, there are typically no space constraints in test chambers that would preclude the installation and maintenance of an aspirating psychrometer. DOE also notes that dehumidifiers and other similar products are currently tested with aspirating psychrometers and typically with sampling trees, and because relative humidity sensors provide neither better accuracy nor significant cost savings, DOE proposes to maintain the current approach for portable and refrigerant-only whole-home dehumidifiers to minimize burden.

5. External Static Pressure Instrumentation

In the May 2014 NOPR, DOE proposed that ESP would be measured using pitot-static tubes and pitot-static tube traverses that conform with the specifications in Sections 4.2.2 and 4.3.1, respectively, of ANSI/ASHRAE 51-07 / Air Movement and Control Association International, Inc. (AMCA) 210-07, "Laboratory Methods of Testing Fans for Certified Aerodynamic Performance Rating" (hereinafter "ANSI/AMCA 210"). 79 FR 29271, 29288.

Upon further review of ANSI/AMCA 210, DOE determined that Figure 3 referenced in Section 4.2.2.3 shows three rows of pressure taps, each crossing in the center of the duct. DOE performed a search of the market and was unable to locate any commercially available pitot-static tube traverses that comply with the requirements of ANSI/AMCA 210. DOE also consulted with the test laboratory that conducted whole-home dehumidifier testing in support of the May 2014 NOPR, and was informed that an instrument with two perpendicular rows of pressure taps that cross at the center of the duct would likely be sufficient to accurately measure the average ESP in the duct. Therefore, DOE proposes in today's SNOPR that two intersecting and perpendicular rows of pitot-static tube traverses be used for whole-home dehumidifier testing.

In the May 2014 NOPR, DOE also proposed that static pressures at each pitot-static tube in a traverse would be measured at the static pressure tap and averaged. 79 FR 29271, 29288. Upon further consideration, DOE determined that this requirement could be interpreted to mean that the individual static pressures must be measured and recorded at each tap, and then averaged following testing. However, DOE's proposed methodology only requires that the average static pressure among all of the taps be recorded. DOE notes that commercially available pitot-static tube traverses have the individual tubes manifolded, with a single pressure tap that would measure a static pressure that is the average of the static pressures at each tube location, facilitating measurements according to DOE's proposal. Accordingly, DOE proposes to clarify the pressure measurement as follows: "The static pressure within the test duct shall be recorded as measured at the pressure tap in the manifold of the traverses that averages the individual static pressures at each pitot-static tube."

B. Whole-Home Dehumidifier Case Volume Measurement

On May 22, 2014, DOE published in the Federal Register a notice of public meeting that also announced the availability of the preliminary technical support document (79 FR 29380), which contained DOE's preliminary analysis for considering amended energy conservation standards for residential dehumidifiers. DOE proposed establishing product classes for whole-home dehumidifiers based on case volume: one for units with case volume less than or equal to 8 cubic feet, and another for units with case volume greater than 8 cubic feet. Therefore, in today's SNOPR, DOE proposes methodology in appendix X1 to determine case volume for whole-home dehumidifiers. In particular, DOE proposes 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. DOE proposes the following equation to determine whole-home dehumidifier case volume, in cubic feet:

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

Where:

D_L is the product case length, in inches;

D_W is the product case width, in inches;

D_H is the product case height, in inches; and

1,728 converts cubic inches to cubic feet.

DOE proposes to amend 10 CFR 429.36 to require that manufacturers include whole-home dehumidifier case volume, in cubic feet, in their certification reports. DOE also proposes to require that the average of the measured case volumes for a given basic model sample size be used for compliance purposes.

For verification purposes, DOE proposes to require that the test facility measurement of case volume must be within 2 percent of the rated volume, or 0.2 cubic feet, whichever is greater. DOE notes that this tolerance is the same as for compact refrigerators, refrigerator-freezers, and freezers, which have volumes similar to whole-home dehumidifiers, under 10 CFR 429.134. If DOE determines that a rated case volume is not within 2 percent of the measured case volume, or 0.2 cubic feet, whichever is greater, the volume measured by the test facility shall be used to determine the energy conservation standard applicable to the tested model. DOE proposes to include the case volume verification requirements in 10 CFR 429.134, along with the proposed capacity verification protocol.

C. Off-Cycle Mode

As discussed in the May 2014 NOPR, DOE is aware that certain dehumidifier models maintain blower operation without activation of the compressor after the humidity setpoint has been reached. DOE proposed defining this fan operation without activation of the compressor as “fan-only” mode, and proposed a test procedure to measure the average power in this mode. Because DOE observed that the blower may operate continuously in fan-only mode, or may cycle on and off intermittently, DOE proposed monitoring the power consumption in fan-only mode for a minimum of 1 hour for units with continuous fan operation, or, for units with cyclical fan operation, for 3 or more full fan cycles for no less than 1 hour. This proposal was based on

DOE's observation that fan cycle duration, although variable for certain units, was approximately 10 minutes. 79 FR 29271, 29290–91.

AHAM requested clarification on whether fan-only mode would include fans that operate to facilitate active defrost. AHAM was concerned that if the test procedure includes active defrost in fan-only mode, manufacturers would not be able to provide active defrost capabilities, and dehumidifiers would have to wait for ice to fall off passively or melt, which would reduce consumer utility. AHAM also expressed concern that DOE's proposal would effectively remove fan operation with the compressor off, such that the consumer would no longer be able to control humidity as accurately and there would be a higher fluctuation of humidity in the room, impacting consumer utility. AHAM noted that for cyclic fan-only mode operation, the proposed method may work for products that cycle three or more times, but there are products that may stop cycling after only one or two cycles. For these products, AHAM stated that the proposed method may overstate the fan-only mode energy use and such products would also be impossible to test. (AHAM, No. 7 at p. 4)

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)") commented that fan-only mode is used when the relative humidity setpoint has been reached to blow air to ensure the humidistat is monitoring changes in relative humidity or to keep air circulating in the room. However, the California IOUs suggested that fan-only mode can result in re-evaporation, thereby re-humidifying the space and reducing efficiency. They believe that improved control of fan-only mode is an energy saving measure that is currently not captured by the existing test procedure. (California IOUs, No. 9 at p. 2)

DOE notes that the proposal in the May 2014 NOPR would not preclude manufacturers from implementing fan-only mode operation, but would include the energy consumption in fan-only mode in the overall performance metric as a measure of representative energy use. However, to clarify measurement of energy consumption in periods when the refrigeration system has cycled off due to the humidistat, DOE proposes to withdraw the fan-only mode definition included in the May 2014 NOPR and instead modify the proposed off-cycle mode definition to encompass all operation when dehumidification mode has cycled off, including any intermittent, cyclic, or continuous fan operation. Therefore, in today's notice, DOE proposes to define off-cycle mode as 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.

Under this proposed definition, when the refrigeration system has cycled off because the ambient relative humidity has fallen below the relative humidity setpoint (but is in a condition to cycle on when the ambient relative humidity has risen above the relative humidity setpoint), the dehumidifier is in off-cycle mode. The fan or blower may continue to operate in off-cycle mode. Conversely, when the refrigeration system has cycled on because the ambient relative humidity has risen above the relative humidity setpoint (but will cycle off when the ambient relative humidity falls below the relative humidity setpoint), the dehumidifier is in dehumidification mode.

In addition, although the lower ambient temperature test conditions may increase the likelihood of ice formation on the evaporator, operating the fan without the refrigeration system for purposes of defrosting the coil would not be considered off-cycle mode as long as the humidity setpoint has not been reached. Any defrost events when the ambient relative humidity is above the relative humidity setpoint would be considered part of dehumidification mode.

DOE intends for the definitions of dehumidification and off-cycle mode to capture all energy used by the dehumidifier, whether the ambient relative humidity is either above or below the relative humidity setpoint, when the dehumidifier is not in inactive or off mode. DOE requests comments as to whether the proposed definitions of dehumidification mode and off-cycle mode clearly reflect this intent. In response to comments received, DOE may modify these definitions in the final rule.

The test procedure proposed in the May 2014 NOPR did not require a specific test sequence between the end of dehumidification mode and the start of fan-only mode to minimize test burden and provide flexibility in testing facilities. However, commenters raised questions about which type of fan operation should be measured and when the fan-only mode testing should be conducted in relation to dehumidification mode testing. To ensure there is sufficient condensation on the evaporator to initiate fan operation for any units that dry the evaporator after compressor operation, DOE proposes that the off-cycle mode measurement begin immediately following compressor operation for the dehumidification mode test. This would be achieved by performing the 6-hour dehumidification mode test, and then adjusting the unit set point above the ambient relative humidity to begin the off-cycle mode test immediately after the compressor cycles off. DOE asserts that conducting the off-cycle mode test subsequent to 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. By capturing these types of fan operation in the off-cycle mode, DOE expects the proposed test method to reflect typical dehumidifier operation in the field while limiting potential confusion over what operations should be measured during testing.

Section 4.2 of Appendix X specifies that off-cycle mode testing be performed in accordance with "Household electrical appliances–Measurement of standby power," published by the International Electrotechnical Commission (IEC), publication 62301 (Edition 2.0 2011-01) (hereinafter "IEC Standard 62301"). However, due to the possibility for periods of fan operation and thus varying power levels during a dehumidifier's off-cycle mode, as tentatively defined in this SNOPR, the test method in IEC Standard 62301 may not be applicable for power consumption measurements in off-cycle mode. In particular, DOE notes that IEC Standard 62301 states that its methods are intended to measure power consumption of low-power modes, and not the power of products in active mode. In this case, dehumidifier fan power consumption would be considered consistent with an active mode power level instead of a low-power mode level. Therefore, DOE proposes that off-cycle mode testing be conducted in accordance with the general instrumentation and data recording requirements for dehumidification mode. With the proposed modification to the off-cycle mode test procedure to begin immediately following dehumidification mode testing, the test setup would not need to be modified, and the same instrumentation would be utilized for testing in both modes.

DOE notes that although the IEC Standard 62301 test method would not be applicable due to fan operation, the power meter accuracy specified in IEC Standard 62301 would still be necessary to accurately measure power consumption at lower power levels in off-cycle mode associated with periods of no fan operation. DOE proposes that the power metering instrumentation during dehumidification mode comply with the requirements of ANSI/AHAM DH-1-2008 and during off-cycle mode with 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 proposals would significantly increase testing burden associated with instrumentation. DOE requests comment on the potential burden associated with maintaining the accuracy requirements of both ANSI/AHAM DH-1-2008 and IEC Standard 62301 when performing off-cycle mode testing immediately following dehumidification mode.

To determine a representative test duration for off-cycle mode, DOE monitored power, ambient relative humidity, and ambient dry-bulb temperature of several portable dehumidifiers in residential installations. The data encompassed multiple days of continuous operation. Based on this data, DOE estimates an average off-cycle duration of approximately 2 hours.

In the May 2014 NOPR, DOE stated that cyclic fan operation in off-cycle mode is typically about 10 minutes in duration. 79 FR 29291. DOE notes that even if a fan were to operate for only 10 minutes during the off-cycle to dry the evaporator coil, it would still represent a significant percentage of the energy consumption during that off-cycle mode based on the typical duration identified in DOE's limited test data. In response to the California IOU's comment, DOE notes that the proposed off-cycle mode test procedure would incorporate fan operation, thereby capturing energy savings associated with improved control schemes.

In sum, DOE proposes that the off-cycle mode testing be conducted over a duration representative of the typical off-cycle. Based on the metered off-cycle duration, DOE proposes 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.

D. Additional Technical Corrections and Clarifications

1. Average Relative Humidity

In the May 2014 NOPR, DOE proposed that ANSI/AHAM DH-1-2008 be the basis in the proposed updated test procedure for the measurement of dehumidification mode energy use in dehumidifiers but with lower ambient temperatures (65 °F dry-bulb and 56.6 °F wet-bulb temperature) that correspond to 60-percent relative humidity. 79 FR 29271, 29276–83. AHAM commented that these proposed ambient temperatures are not within the range of Table II in ANSI/AHAM DH-1-2008 that is used to determine relative humidity under the actual testing conditions. AHAM also requested that DOE clarify the calculations used to determine the corrected relative humidity for use in the capacity calculation. (AHAM, No. 7 at pp. 7)

DOE agrees that the data in Table II in ANSI/AHAM DH-1-2008 do not cover the range of dry-bulb and wet-bulb temperatures that would be necessary to determine relative humidity at the proposed ambient test conditions. Therefore, DOE proposes to include in appendix X1 the following tables that present the relative humidity at dry-bulb and wet-bulb temperatures within the test tolerances at the 65 °F and 73 °F dry-bulb temperature inlet air test conditions for portable and whole-home dehumidifiers, respectively.

Table III.2 Percent Relative Humidity Determination 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	56.69	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 III.3 Percent Relative Humidity Determination for Whole-Home 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	56.69	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

2. Refrigerant-Desiccant Dehumidifier Calculations

a. Absolute Humidity

Upon further review of the test procedure proposed for refrigerant-desiccant dehumidifiers in the May 2014 NOPR, DOE determined that clarification is needed to calculate the absolute humidity of the process air, which is used to calculate the amount of water removed from the process air stream. The proposed provisions for refrigerant-desiccant dehumidifiers would specify recording the dry-bulb temperature and relative humidity in the ducts, and ambient barometric pressure. Based on these data, DOE proposes the following equations to calculate the absolute humidity of the process air in the inlet and exhaust ducts. The equations proposed are based on those presented in Section 7.3 of ANSI/ASHRAE Standard 41.6-1994 (RA 2006), "Standard Method for Measurement of Moist Air Properties."

First, the measured dry-bulb temperature of the air at each sampling time is converted from °F to Kelvin (K) according to the following equation:

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

Where:

T_K is the calculated air dry-bulb temperature in K; and

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

The water saturation pressure is then calculated at each sampling time as follows:

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

Where:

P_{ws} is the water vapor saturation pressure in kilopascals (kPa); and

T_K is the dry-bulb temperature of the air in K.

The water vapor pressure (P_w) under the specific ambient barometric pressure at each sampling time is calculated as follows:

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

Where:

P_w is the water vapor pressure in kPa;

RH is the percent relative humidity; and

P_{ws} is the water vapor saturation pressure in kPa.

The mixing humidity ratio (HR) at each sampling time is then calculated as follows:

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

Where:

HR is the mixing humidity ratio, the mass of water per mass of dry air;

P_w is the water vapor pressure in kPa;

P is the ambient barometric pressure in in. Hg;

3.386 converts from in. Hg to kPa; and

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

The specific volume (*v*), in cubic feet per pound of dry air, is used to calculate the absolute humidity. The specific volume is calculated at each sampling time as follows:

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

Where:

ν is the specific volume in cubic feet per pound of dry air;

T_K is the dry-bulb temperature of the air in K;

P is the ambient barometric pressure in in. Hg; and

P_w is the water vapor pressure in kPa;

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

3.386 converts from in. Hg to kPa; and

16.016 converts from cubic meters per kilogram to cubic feet per pound.

The absolute humidity (AH), in units of pounds of water per cubic foot of air, at each sampling time is then calculated as follows:

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

Where:

AH is the absolute humidity in pounds of water per cubic foot of air;

HR is the mixing humidity ratio, the mass of water per mass of dry air; and

ν is the specific volume in cubic feet per pound of dry air.

b. Capacity

In the May 2014 NOPR, DOE proposed that the capacity of refrigerant-desiccant dehumidifiers be calculated by measuring the total amount of moisture removed from the process air. Specifically, the measured dry-bulb temperature and relative humidity would be used to determine the absolute humidity in pounds of water per cubic foot of dry air at both the process air inlet and process air outlet. The absolute humidity would then be multiplied by the process air volumetric flow rate, measured in CFM, to determine the process air inlet and outlet moisture flow rates, measured in pounds of water per minute. The difference between the inlet and outlet moisture flow rates would equal the amount of moisture the unit removes from the process air. 79 FR 29271, 29284.

As part of the proposed vapor analysis approach, DOE proposed that the weight of water removed during the test period be calculated for each data point, collected at intervals no greater than 1 minute. The calculated water weights for each air stream at each of these data points would be summed for the entire test period and the total weight would then be used to calculate the capacity.

DOE recognizes that this approach would require calculating the absolute humidity using the equations described in the previous section for each data point to ultimately calculate the total weight of moisture removed during the test period. To consider means to reduce this testing burden, DOE compared test results obtained by using individual data points to calculate absolute humidity to those obtained by using the average temperature, average relative humidity, and average barometric pressure to calculate average absolute humidity during the test period. DOE found that the results from both methods produced overall capacities that agreed within 1 percent. In addition to reducing test burden, the average data approach may also mitigate the opportunity for potential calculation errors by requiring only one calculation of absolute humidity per test. Thus, although DOE continues to propose the summation method as proposed in the May 2014 Test Procedure NOPR because it is the most precise, DOE seeks comment from interested parties on the alternative approach that would use the average temperature, average relative humidity, and average barometric pressure to calculate the average absolute humidity during the entire test period. Under this alternative approach, the weight of water collected during the test would be calculated from the average absolute humidity and average volumetric flow rate as follows:

$$W = \left((AH_{I,a} \times X_{I,a}) - (AH_{O,a} \times X_{O,a}) \right) \times 360$$

Where:

W is the weight of water removed during the test period in pounds;

$AH_{I,a}$ is the average absolute humidity of the process air on the inlet side of the unit in pounds of water per cubic foot of dry air;

$X_{I,a}$ is the average volumetric flow rate of the process air on the inlet side of the unit in CFM;

$AH_{O,a}$ is the average absolute humidity of the process air on the outlet side of the unit in pounds of water per cubic foot of dry air;

$X_{O,a}$ is the average volumetric flow rate of the process air on the outlet side of the unit in CFM; and

360 is the number of minutes in the 6-hour test.

DOE requests comment on whether the proposed method from the May 2014 Test Procedure NOPR represents a significant burden over the averaging approach, and whether the averaging approach would accurately reflect potential variations in the air stream conditions throughout the test period.

3. Corrected Capacity and Corrected Relative Humidity Equations

In the May 2014 NOPR, DOE proposed that product capacity be calculated in accordance with the test requirements specified in Section 7, "Capacity Test and Energy Consumption Test," of ANSI/AHAM DH-1-2008, except that the standard test conditions would be maintained at 65 °F ± 2.0 °F dry-bulb temperature and 56.6 °F ± 1.0 °F wet-bulb temperature. 79 FR 29271, 29305. The calculations in Section 7 include adjustments for variations during the rating test period in the ambient temperature, relative humidity, and barometric pressure from the standard rating conditions.

AHAM stated that it was not clear if and how DOE adjusted the capacity equation to account for the 65 °F dry-bulb temperature condition. AHAM stated that the product capacity equation in ANSI/AHAM DH-1-2008 is based on 80 °F and 60-percent relative humidity, and would require adjustment for a different nominal temperature or relative humidity. AHAM asked DOE to clarify whether and how it was proposing to adjust the capacity calculations. (AHAM, Public Meeting Transcript, No. 10 at p. 94; AHAM, No. 7 at p. 5; AHAM Std, No. 22 at p. 3)

DOE confirms that for the May 2014 NOPR, it revised the adjusted capacity equation in its analysis to include the lower nominal dry-bulb temperature (65 °F versus the current 80 °F). Upon closer examination, however, DOE concludes that the coefficients in the corrected capacity equation (adjusted for variations in temperature and relative humidity) and the corrected relative humidity equation (adjusted for variations in barometric pressure) also should be revised as follows to be representative of the proposed dry-bulb temperature test conditions.

a. Corrected Capacity

To determine the appropriate coefficients for the corrected capacity equation, 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. From this analysis, DOE proposes that corrected capacity be calculated for portable and whole-home dehumidifiers at the 65 °F and 73 °F dry-bulb temperature rating conditions, respectively, by substituting the equation included in Section 7.1.7 of ANSI/AHAM DH-1-2008 with:

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

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

Where:

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

$C_{r,wh}$ is the 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 is the product capacity determined from test data in pints/day;

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

$H_{C,p}$ is the portable dehumidifier corrected relative humidity, in percent, as discussed below; and

$H_{C,wh}$ is the whole-home dehumidifier corrected relative humidity, in percent, as also discussed below;

0.0352 and 0.0344 are the capacity correction factors for variations in temperature for portable and whole-home dehumidifiers, respectively, in $(°F)^{-1}$; and

0.0169 and 0.017 are the capacity correction factors for variations in relative humidity for portable and whole-home dehumidifiers, respectively.

b. Corrected Relative Humidity

DOE used a similar approach to that for corrected product capacity to determine the appropriate coefficients for the corrected relative humidity equation in Section 7.1.7 of ANSI/AHAM DH-1-2008. DOE calculated the linear percent change in relative humidity from the standard rating condition (60-percent relative humidity) for small perturbations in the barometric pressure. DOE proposes, therefore, that corrected relative humidity be calculated for portable and whole-home dehumidifiers at the 65 °F and 73 °F dry-bulb temperature rating conditions, respectively, by substituting the following equations for the corrected relative humidity equation in Section 7.1.7 of ANSI/AHAM DH-1-2008:

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

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

Where:

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

$H_{c,wh}$ is the 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 is the average relative humidity from the test data, in percent;

B is the average barometric pressure during the test period in in. Hg; and

0.0083 and 0.0072 are the relative humidity correction factors for variations in barometric pressure for portable and whole-home dehumidifiers, respectively, in $(\text{in. Hg})^{-1}$.

4. 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, and the fan-only mode energy consumption, E_{FM}, in kWh per year, with 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.

In response to the May 2014 NOPR, AHAM suggested that instead of using the amount of condensate measured during the test, DOE's IEF calculation should use a corrected capacity to account for variation in temperature and relative humidity. AHAM stated that the IEF equation, as proposed in the May 2014 NOPR, is not an accurate representation of the real-time test conditions in the chamber, which affect the amount of moisture that is removed from the air. (AHAM, No. 7 at pp. 9–10)

DOE agrees that use of the corrected capacity would account for variations in test chamber temperature and relative humidity; therefore, DOE proposes a modified IEF equation that utilizes the corrected capacity.

Because DOE proposes to remove fan-only mode and to consider operation in off-cycle mode, DOE also proposes to modify the IEF equation to remove fan-only mode annual energy consumption. DOE proposes an update to the definition of combined low-power mode in both appendix X and appendix X1 to clarify that it is the aggregate of available modes other than dehumidification mode. The proposed combined low-power mode would include contributions from off-cycle mode and inactive mode or off mode.

Based on these updates, DOE proposes the following IEF calculation.

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

Where:

IEF is the integrated energy factor in liters per kWh;

C_r is the corrected product capacity in pints per day;

t is the test duration in hours;

E_{DM} is the dehumidification mode test 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;

6 is the hours per dehumidification mode test;

1,095 is the number of dehumidification mode annual hours;

1.04 is the density of water in pounds per pint; and

24 is the number of hours per day.

5. Compressor Run-In

In the May 2014 NOPR, DOE noted that Section 5.5 of ANSI/AHAM DH-1-2008 does not define the term “run-in” when requiring a run-in period be conducted prior to testing to ensure all components work properly. Therefore, DOE proposed in appendix X1 that a single run-in period during which the compressor operates would be performed before active mode testing, and no additional run-in period would be conducted between dehumidification mode testing and fan-only mode testing. 79 FR 29271, 29291.

In response to the proposal in the May 2014 NOPR, AHAM commented that for run-in, the compressor must run for 24 hours; otherwise the unit may not perform as it would in a consumer setting. AHAM stated that if the run-in is performed in a dry environment, the unit may not run in dehumidification mode and the compressor will not engage. Therefore, AHAM proposed to require that the run-in period be conducted inside the test chamber for a complete 24 hours for units without a continuous compressor on function. (AHAM, No. 7 at p. 11)

To minimize test burden, DOE is not proposing to require that the 24 hours run-in period be conducted in the test chamber. However, DOE proposes 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. If the conditions outside of the test chamber are too dry, then the unit would need to be run-in in a more humid environment, which may include the test chamber.

6. Definition of "Dehumidifier"

In the May 2014 NOPR, DOE proposed to add clarification to 10 CFR 430.2 that the definition of "dehumidifier" does not apply to portable air conditioners and room air conditioners. 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). DOE notes that packaged terminal air conditioners (PTACs) are currently excluded from the room air conditioner definition. Because PTACs provide a primary function similar to the other products proposed to be excluded in the dehumidifier definition, DOE additionally proposes that PTACs be excluded in the dehumidifier definition codified at 10 CFR 430.2.

7. Additional Operating Mode Definitions

Inactive mode currently means a standby mode that facilitates the activation of active mode by remote switch (including remote control), internal sensor, or timer, or that provides continuous status display. Because, unlike off-cycle mode, inactive mode does not initiate dehumidification mode when the humidity setpoint has been exceeded, DOE proposes to exclude the humidistat and humidity sensor from the "internal sensor" mentioned in the inactive mode definition.

Because DOE is aware that some dehumidifiers may be operated continuously in dehumidification mode by means of a user-selected option, DOE also proposes to add "by control setting" to the dehumidification mode definition as a means to activate the main moisture removal function.

IV. Procedural Issues and Regulatory Review

DOE has concluded that the determinations made pursuant to the various procedural requirements applicable to the May 2014 NOPR, set forth at 79 FR 29271, 29292–95, remain unchanged for this SNOPR, except for the following additional analysis and determination DOE conducted in accordance with the Regulatory Flexibility Act (5 U.S.C. 601 et seq.).

The Regulatory Flexibility Act requires preparation of an initial regulatory flexibility analysis (IFRA) for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by Executive Order 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (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 today's proposed rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. DOE's initial regulatory flexibility analysis is set forth in the May 2014 NOPR, with additional analysis below based on the proposals in this SNOPR. DOE seeks comment on its analysis and the economic impacts of the rule on small manufacturers. In the May 2014 NOPR, DOE estimated that there are five small businesses that manufacture dehumidifiers.

This SNOPR proposes modifications to the proposals included in the May 2014 NOPR. DOE believes that the proposed modifications to whole-home dehumidifier testing would not increase test burden and, in some cases, may even reduce test burden with respect to the proposals in the May 2014 NOPR and would therefore not increase the burden on small businesses. DOE investigated the following proposed modifications to determine the impact on small businesses.

In the May 2014 NOPR, DOE estimated that a non-instrumented duct with a length of 10 duct diameters would cost approximately $1,500. In this SNOPR, DOE proposes to reduce the duct length from 10 duct diameters to 4.5 duct diameters. DOE estimates that the associated cost of the non-instrumented duct would decrease to about $1,000. The reduction in duct length provides an immediate savings in the cost of the test duct setup and allows manufacturers to test in significantly smaller test chambers, thereby reducing the overall test burden. As discussed in Section III.A.3 of this notice, one manufacturer estimated that testing in an existing chamber would avoid a cost of $30,000 for a new or expanded chamber.

In today's notice, DOE proposes to require that ducted refrigerant-desiccant whole-home dehumidifier testing be conducted with relative humidity sensors instead of aspirating psychrometers. Based on preliminary market research and a review of product specifications, DOE identified several solid-state relative humidity sensors currently available with accuracies of ±1 percent at prices similar to or less than the price of a calibrated aspirating psychrometer, which DOE estimated at $1,000 in the May 2014 NOPR. DOE is also aware that many laboratories already use relative humidity sensors, so DOE expects little or no change in test burden with the proposal to require relative humidity sensors be used for refrigerant-desiccant whole-home dehumidifier testing. The proposed switch to relative humidity sensors may actually reduce test burden because the sensors are relatively simple and require less maintenance compared to aspirating psychrometers.

V. Public Participation

Submission of Comments

DOE will accept comments, data, and information regarding this SNOPR no later than the date provided in the DATES section at the beginning of this notice. Interested parties may submit comments using any of the methods described in the ADDRESSES section at the beginning of this notice.

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

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

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

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

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

Include contact information each time you submit comments, data, documents, and other information to DOE. If you submit via mail or hand delivery/courier, please provide all items on a CD, if feasible, in which case it is not necessary to submit printed copies. No facsimiles (faxes) will be accepted.

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

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

Confidential Business Information. According to 10 CFR 1004.11, any person submitting information that he or she believes to be confidential and exempt by law from public disclosure should submit via email, postal mail, or hand delivery/courier two well-marked copies: one copy of the document marked "confidential" including all the information believed to be confidential, and one copy of the document marked "non-confidential" with the information believed to be confidential deleted. Submit these documents via email or on a CD, if feasible. DOE will make its own determination about the confidential status of the information and treat it according to its determination.

Factors of interest to DOE when evaluating requests to treat submitted information as confidential include: (1) a description of the items; (2) whether and why such items are customarily treated as confidential within the industry; (3) whether the information is generally known by or available from other sources; (4) whether the information has previously been made available to others without obligation concerning its confidentiality; (5) an explanation of the competitive injury to the submitting person which would result from public disclosure; (6) when such information might lose its confidential character due to the passage of time; and (7) why disclosure of the information would be contrary to the public interest.

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

VI. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this supplemental notice of proposed rulemaking.

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

January 27, 2015.

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

For the reasons stated in the preamble, DOE proposes to amend parts 429 and 430 of Chapter II of Title 10, Code of Federal Regulations as set forth below:

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

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

Authority: 42 U.S.C. 6291–6317.

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

§429.36 Dehumidifiers.

(a) * * *

(3) The value of capacity of a basic model reported in accordance with paragraph (b)(2) of this section shall be 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 value of case volume of a basic model reported in accordance with paragraph (b)(2) of this section shall be 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 shall 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. Revise §429.134 to read as follows:

§429.134 Product-specific enforcement provisions.

* * * * *

(c) – (e) [Reserved]

(f) Dehumidifiers.

(1) Verification of capacity. The capacity of the basic model 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. 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 of the basic model 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. 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

a. Revising the definition of “Dehumidifier”; and

b. Adding the definitions for “Portable dehumidifier”, “Refrigerant-desiccant dehumidifier”, and “Whole-home dehumidifier” in alphabetical order;

The revisions and additions read as follows:

*	*	*	*	*

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. Redesignating paragraphs (f)(10) and (f)(11) as paragraphs (f)(12) and (f)(13);

b. Redesignating paragraphs (f)(6) through (f)(9) as paragraphs (f)(7) through (f)(10); and

c. Adding new paragraphs (f)(6) and (f)(11);

The 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.

* * * * *

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, the capacity, expressed in pints per day (pints/day), and the energy factor, expressed in liters per kilowatt hour (L/kWh), shall be measured in accordance with section 4.1 of appendix X of this subpart. When using appendix X1, the capacity, expressed in pints/day, for dehumidifiers other than refrigerant-desiccant dehumidifiers and the energy factor, expressed in L/kWh, shall be measured in accordance with section 4.1.1.1 of appendix X1 of this subpart, and the integrated energy factor, expressed in L/kWh, shall be determined according to section 5.3 of appendix X1 to this subpart. When using appendix X1, the capacity, expressed in pints/day, for refrigerant-desiccant dehumidifiers shall be measured in accordance with section 5.4 of appendix X1 of this subpart and the case volume, expressed in cubic feet, for whole-home dehumidifiers shall be measured in accordance with section 5.5 of appendix X1 of this subpart.

*　　　　*　　　　*　　　　*　　　　*

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

8. 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 (date 180 days after the date of publication of the final rule 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 (date 180 days after the publication of the final rule 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. Any representations made with respect to the energy use or efficiency of such dehumidifiers must be in accordance with whichever version is selected. DOE notes that, because testing under this appendix X must be completed as of (date 180 days after publication of the final rule 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 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 on or after the compliance date of any amended energy conservation standards, with respect to the energy use or efficiency of portable or whole-home dehumidifiers, 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. The psychrometer shall be placed perpendicular to, and 1 ft. in front of, the center of the intake grille. For dehumidifiers with multiple intake grilles, a separate sampling tree shall be placed 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, the condensate shall be collected in a substantially closed vessel to prevent re-evaporation and shall be placed on the weight-measuring instrument. If no means for draining condensate away from the cabinet are provided, any automatic shutoff of dehumidification mode operation that is activated when the collection container is full shall be disabled and any overflow shall be collected in a pan. The pan shall be covered as much as possible to prevent re-evaporation without impeding the collection of overflow water. Both the dehumidifier and the overflow pan shall be placed on the weight-measuring instrument for direct reading of the condensate weight during the test. Any internal pump shall not be used to drain the condensate into a substantially closed vessel 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, that setting shall be selected. Otherwise, the controls shall be set to the lowest available relative humidity level and, if the dehumidifier has a user-adjustable fan speed, the maximum fan speed setting shall be selected.

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 as follows:

(i) A fractional number at or above the midpoint between two consecutive decimal places shall be rounded up to the higher of the two decimal places; and

(ii) A fractional number below the midpoint between two consecutive decimal places shall be rounded down to the lower of the 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

9. 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 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 whichever version is selected.

Any representations made on or after the compliance date of any amended energy conservation standards, with respect to the energy use or efficiency of portable or 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 37 means the test standard published by ANSI and ASHRAE titled "Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment," ANSI/ASHRAE 37-2009 (incorporated by reference; see § 430.3).

2.4 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).

2.5 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.

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

2.7 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.

2.8 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).

2.9 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.).

2.10 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).

2.11 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.

2.12 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.

2.13 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.

2.14 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.

2.15 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.

2.16 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.

2.17 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.

2.18 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 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. 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 shall 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 Psychrometer placement. Place the psychrometer perpendicular to, and 1 ft. in front of, the center of the process air intake grille. 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.

3.1.1.3 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. 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.

3.1.1.4 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.

3.1.1.5 Run-in period. Perform a single run-in period during which the compressor operates continuously for 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 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), 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 shall 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 0.25 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.

3.1.2.4 Run-in period. Perform a single run-in period during which the compressor operates continuously for at least 24 hours before 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.

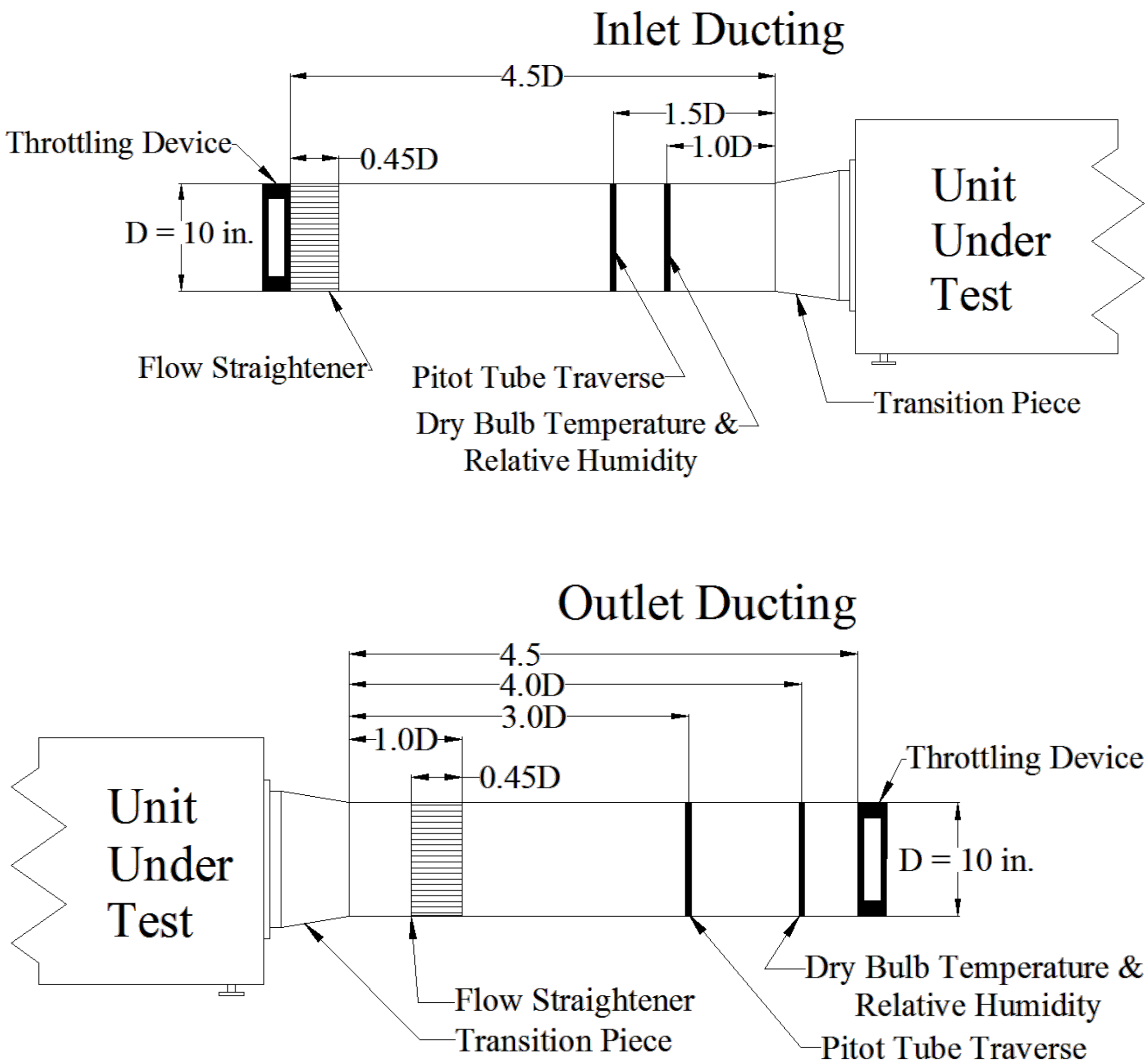

Figure 1. Inlet and Outlet Horizontal Duct Configurations and Instrumentation Placement

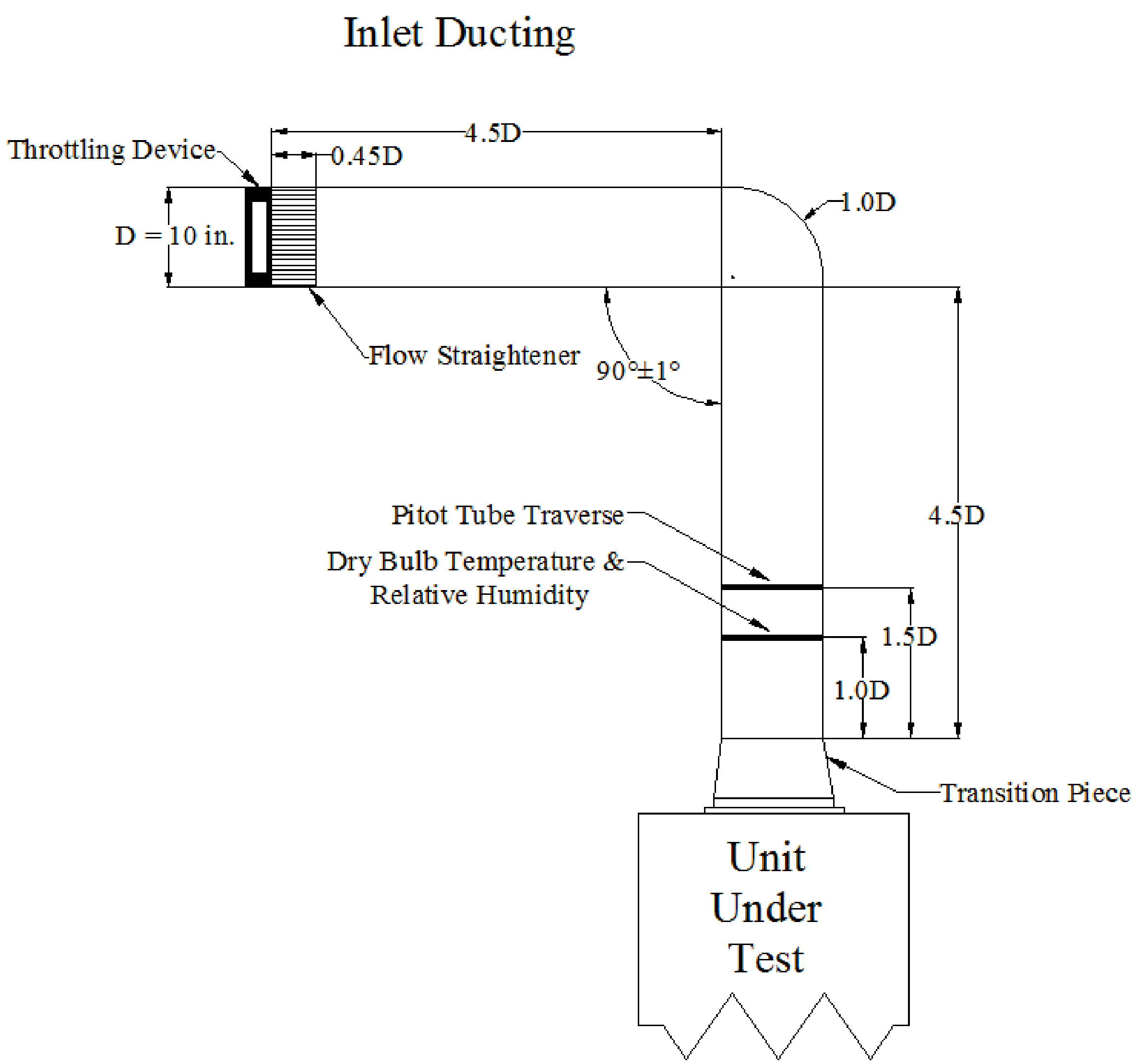

Figure 2: Inlet Vertical Duct Configuration and Instrumentation Placement

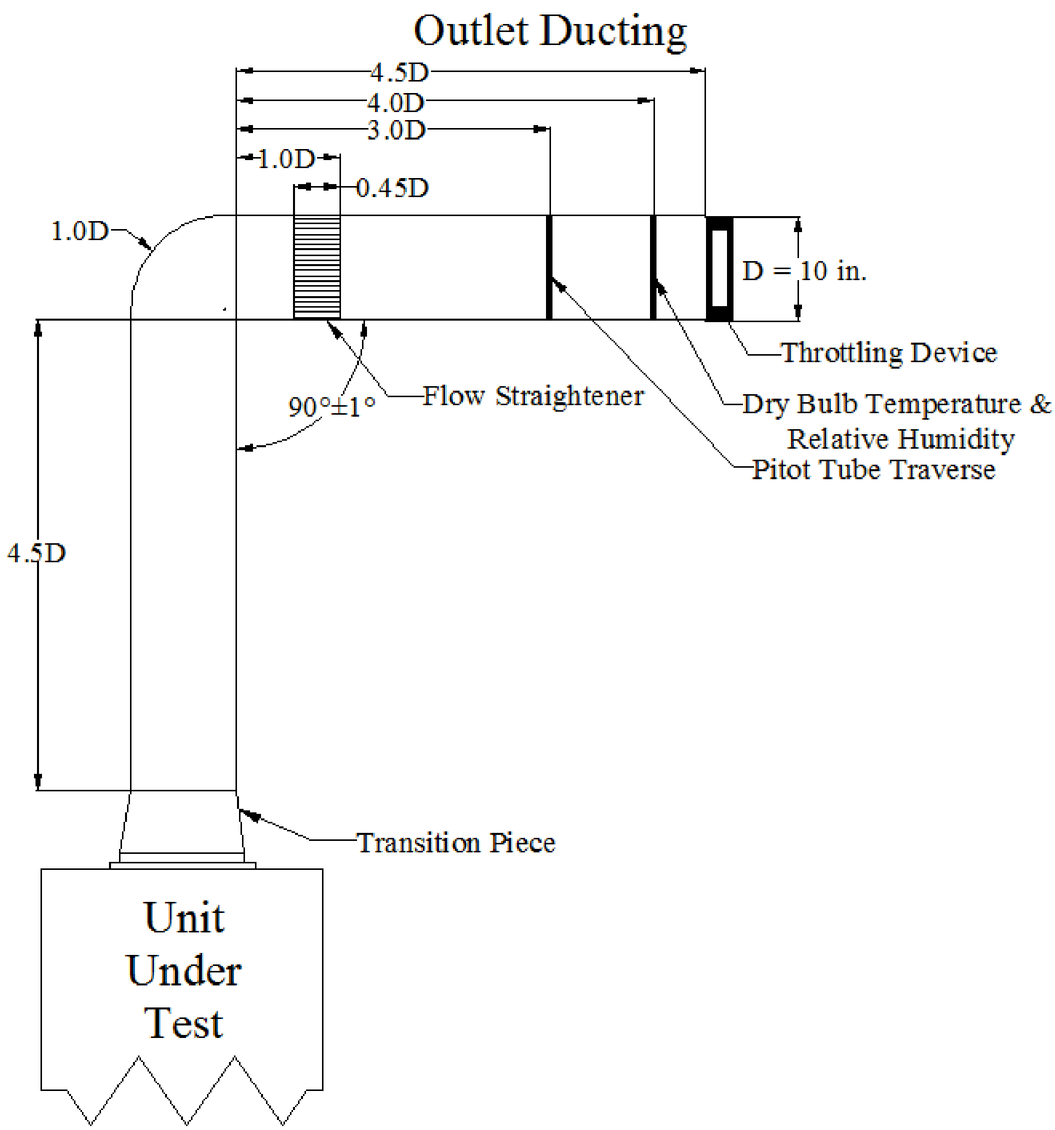

Figure 3: Outlet Vertical Duct Configurations and Instrumentation Placement

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, as follows:

(i) A fractional number at or above the midpoint between two consecutive decimal places shall be rounded up to the higher of the two decimal places; and

(ii) A fractional number below the midpoint between two consecutive decimal places shall be rounded down to the lower of the two decimal places.

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. Establish the testing conditions set forth in section 3.1.1 of this appendix and measure the energy consumption in dehumidification mode, E_{DM}, expressed in kilowatt-hours (kWh), the average relative humidity, H_t, using the tables provided below, 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, and for whole-home dehumidifiers must be maintained at 73 °F ± 2.0 °F dry-bulb temperature and 63.6 °F ± 1.0 °F wet-bulb temperature. Position the psychrometer as specified in section 3.1.1.2 of this appendix.

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

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	56.69	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

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) the standard test conditions at the air entering the process air inlet duct and the reactivation air inlet must be maintained at 73 °F ± 2.0 °F dry-bulb temperature and 63.6 °F ± 1.0 °F wet-bulb temperature; (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 tables in section 4.1.1 of this appendix for determining average relative humidity.

4.2 Off-cycle mode. Establish the test conditions specified in section 3.1.1 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 2.11 of this appendix, but not an off mode, as defined in section 2.12 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 2.12 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;

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:

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

Where:

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

t = test duration in hours;

L_W = water removed from the air during the 6-hour dehumidification mode test in liters, as measured in section 4.1.1 of this appendix;

E_{DM} = energy consumption during the 6-hour dehumidification mode test in kWh, as measured in section 4.1.1 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; and

24 = the number of hours per day.

5.5 <u>Absolute humidity for refrigerant-desiccant de humidifiers</u>. 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, and capacity, C_t, expressed in pints/day, 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); and

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

60 = conversion from minutes to seconds.

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

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.