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.

[77 FR 65995, Oct. 31, 2012, redesignated and amended at 79 FR 7370, Feb. 7, 2014; 80 FR 45825, July 31, 2015]

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

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

Any representations made on or after the compliance date of any amended energy conservation standards, with respect to the energy use or efficiency of 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 41.1* means the test standard published by ANSI and ASHRAE, titled ''Standard Method for Temperature Measurement,'' ANSI/ASHRAE 41.1–2013 (incorporated by reference; see §430.3).

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.17 *Standby mode* means any modes where the dehumidifier is connected to a mains power source and offers one or more of the following user-oriented or protective functions which may persist for an indefinite time:

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

(2) Continuous functions, including information or status displays (including clocks) or sensor-based functions. A timer is a continuous clock function (which may or may not be associated with a display) that provides regular scheduled tasks (*e.g.,* switching) and that operates on a continuous basis.

3. Test Apparatus and General Instructions

3.1 *Active mode.*

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

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

3.1.1.2 *Relative humidity instrumentation.* A relative humidity sensor with an accuracy within 1 percent relative humidity may be used in place of an aspirating psychrometer. When using a relative humidity sensor for testing, disregard the wet-bulb test tolerances in Table 1 of ANSI/AHAM DH–1 (incorporated by reference, see §430.3), the average relative humidity over the test period must be within 2 percent of the relative humidity setpoint, and all individual relative humidity readings must be within 5 percent of the relative humidity setpoint. When using a relative humidity sensor instead of an aspirating psychrometer, use a dry-bulb temperature sensor that meets the accuracy as required in section 4.1 of ANSI/AHAM DH–1.

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

3.1.1.4 *Condensate collection.* If means are provided on the dehumidifier for draining condensate away from the cabinet, collect the condensate in a substantially closed vessel to prevent re-evaporation and place the vessel on the weight-measuring instrument. If no means for draining condensate away from the cabinet are provided, disable any automatic shutoff of dehumidification mode operation that is activated when the collection container is full and collect any overflow in a pan. Select a collection pan large enough to ensure that all water that overflows from the full internal collection container during the rating test period is captured by the collection pan. Cover the pan as much as possible to prevent re-evaporation without impeding the collection of overflow water. Place both the dehumidifier and the

overflow pan on the weight-measuring instrument for direct reading of the condensate weight collected during the rating test. Do not use any internal pump to drain the condensate into a substantially closed vessel unless such pump operation is provided for by default in dehumidification mode.

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

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

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

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

3.1.2.2 *Instrumentation.*

3.1.2.2.1 *Temperature.* Install dry-bulb temperature sensors in a grid centered in the duct, with the plane of the grid perpendicular to the axis of the duct. Determine the number and locations of the sensors within the grid according to Section 5.3.5, ''Centers of Segments—Grids,'' of ANSI/ASHRAE 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, 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. The external static pressure is the difference between the measured inlet and outlet static pressure measurements, minus the sum of the inlet and outlet duct pressure losses. For any port with no duct attached, use a static pressure of 0.00 in. w.c. with no duct pressure loss in the calculation of external static pressure. During dehumidification mode testing, the external static pressure must equal 0.20 in. w.c. ± 0.02 in. w.c.

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

3.1.2.2.4 *Weight.* No weight-measuring instruments are required.

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

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

3.1.3 *Ducting for whole-home dehumidifiers.* Cover and seal with tape any port designed for intake of air from outside or unconditioned space, other than for supplying reactivation air for refrigerant-desiccant dehumidifiers. Use only ducting constructed of galvanized mild steel and with a 10-inch diameter. Position inlet and outlet

ducts either horizontally or vertically to accommodate the default dehumidifier port orientation. Install all ducts with the axis of the section interfacing with the dehumidifier perpendicular to plane of the collar to which each is attached. If manufacturer-recommended collars do not measure 10 inches in diameter, use transitional pieces to connect the ducts to the collars. The transitional pieces must not contain any converging element that forms an angle with the duct axis greater than 7.5 degrees or a diverging element that forms an angle with the duct axis greater than 3.5 degrees. Install mechanical throttling devices in each outlet duct consistent with Figure 1 and Figure 3 to adjust the external static pressure and in the inlet reactivation air duct for a refrigerant-desiccant dehumidifier. Cover the ducts with thermal insulation having a minimum R value of 6 h-ft^2 – °F/Btu (1.1 m^2 – K/W). Seal seams and edges with tape.

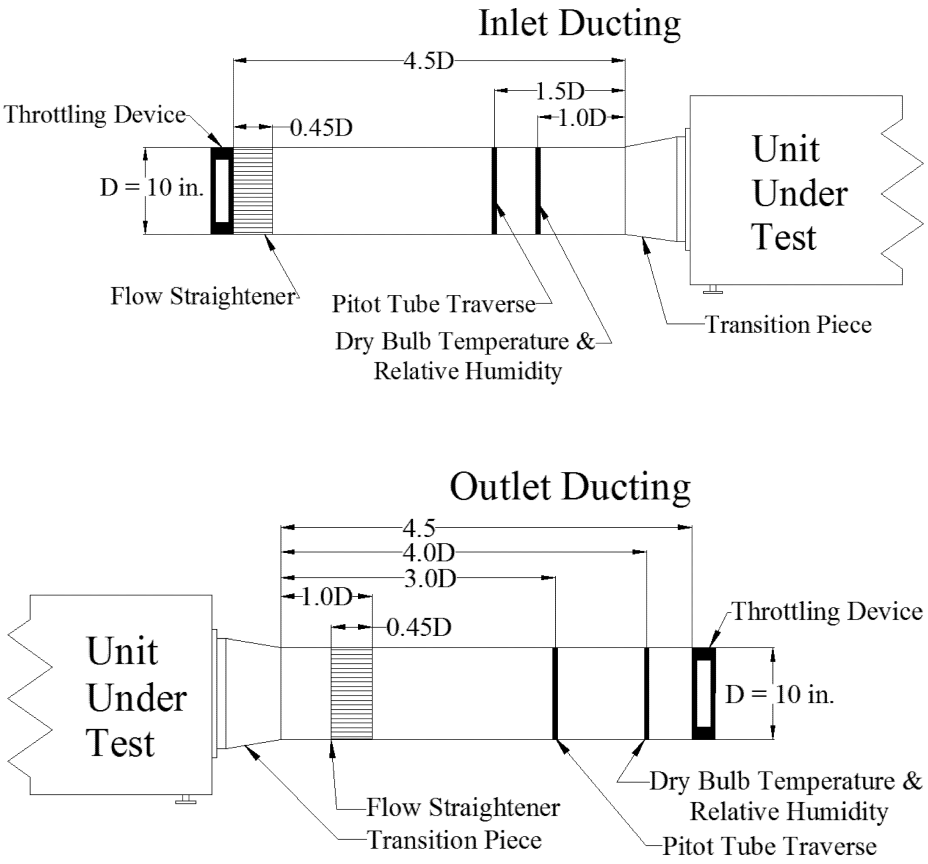

Figure 1. Inlet and Outlet Horizontal Duct Configurations and Instrumentation Placement

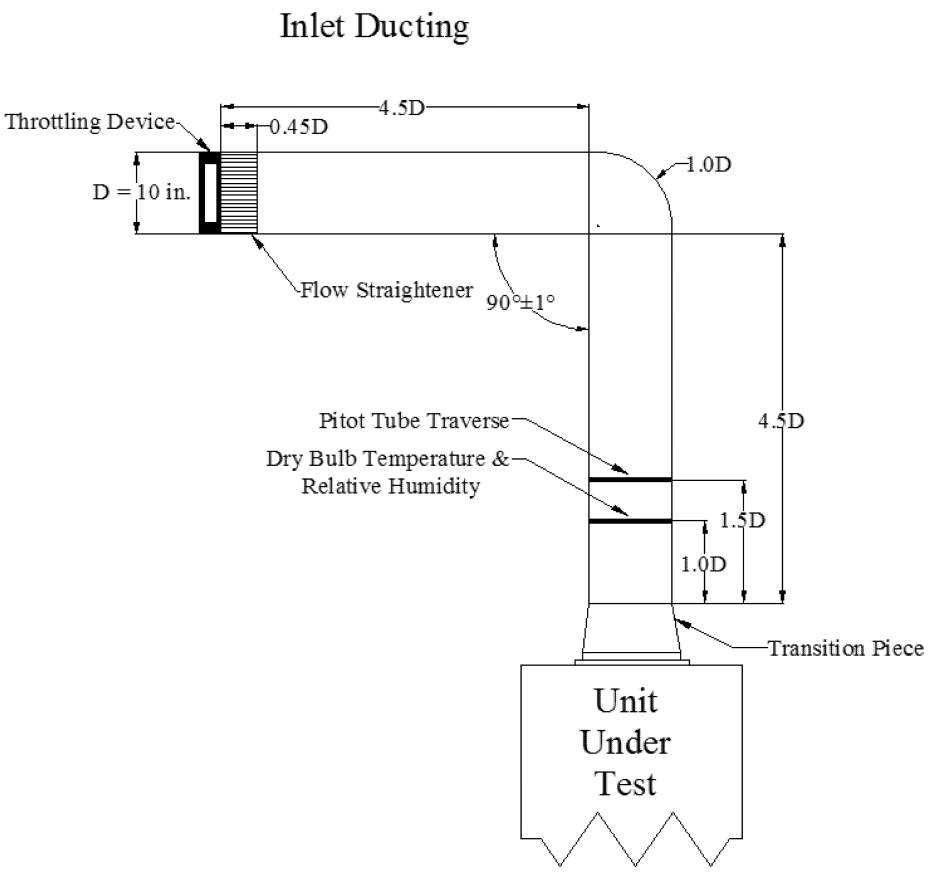

Figure 2: Inlet Vertical Duct Configuration and Instrumentation Placement

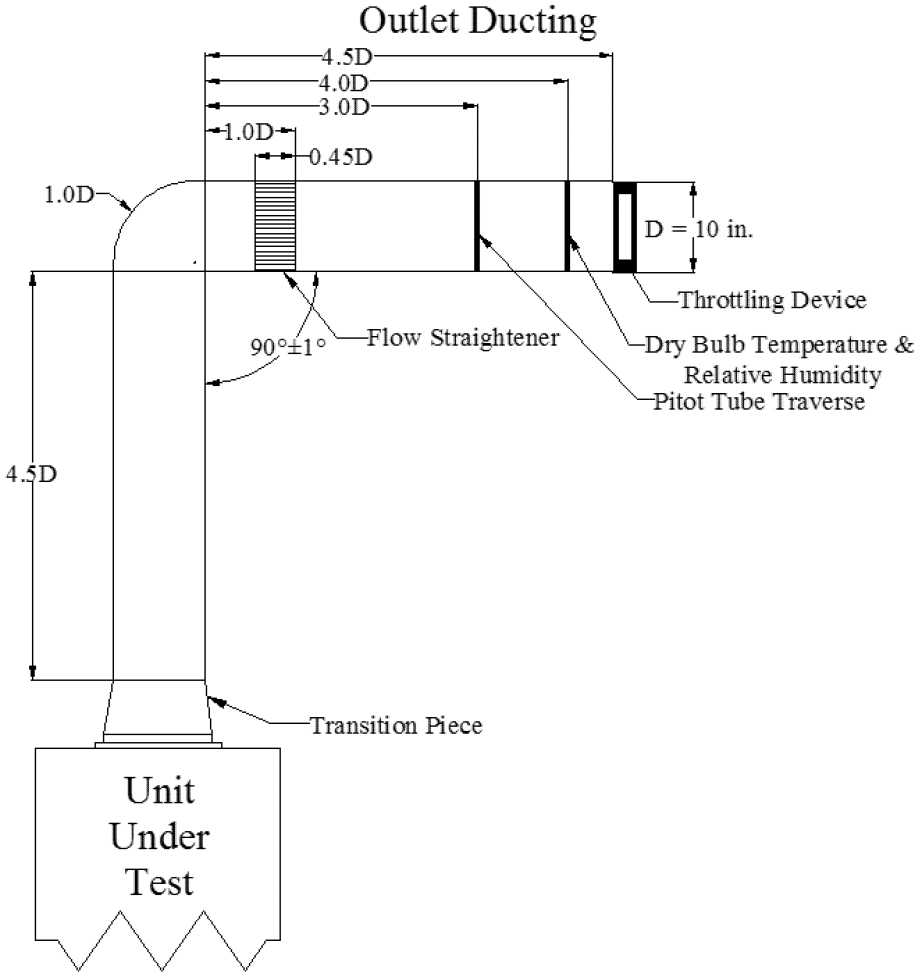

Figure 3: Outlet Vertical Duct Configurations and Instrumentation Placement

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

3.2 *Inactive mode and off mode.*

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

3.2.2 *Electrical energy supply.*

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

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

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

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

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

4. Test Measurement

4.1 *Dehumidification mode*.

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

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

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

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

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

4.1.2 *Refrigerant-desiccant dehumidifiers*. Establish the testing conditions set forth in section 3.1.2 of this appendix. Measure the energy consumption, E_{DM}, expressed in kWh,

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

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

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

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

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

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

5. Calculation of Derived Results From Test Measurements

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

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

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

Where:

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

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

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

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

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

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

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

Where:

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

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

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

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

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

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

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

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

Where:

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

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

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

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

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

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

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

Where:

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

t = test duration in hours;

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

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

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

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

1.04 = the density of water in pounds per pint;

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

24 = the number of hours per day.

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

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

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

Where:

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

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

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

Where:

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

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

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

Where:

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

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

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

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

Where:

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

P = measured ambient barometric pressure in in. Hg;

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

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

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

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

Where:

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

P = measured ambient barometric pressure in in. Hg;

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

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

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

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

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

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

Where:

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

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

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

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

Where:

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

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

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

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

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

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

60 = conversion from minutes to seconds.

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

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

Where:

24 = number of hours per day;

1.04 = density of water in pounds per pint; and

T = total test period time in hours.

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

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

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

Where:

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

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

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

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

[80 FR 45826, July 31, 2015]

APPENDIX Y TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF BATTERY CHARGERS

Prior to November 16, 2016, manufacturers must make any representations regarding the energy consumption of battery chargers other than uninterruptible power supplies based upon results generated under this appendix or the previous version of this appendix as it appeared in the Code of Federal Regulations on January 1, 2016. On or after November 16, 2016, manufacturers must make any representations regarding the energy