NEEA Energy Efficiency Test Procedure for Residential Clothes Dryers

Version 2.0 – Updated December 2022

A test procedure for clothes dryers used to generate utility energy savings estimates

Northwest Energy Efficiency Alliance
PHONE
503-688-5400
EMAIL
info@neea.org

NEEA Energy Efficiency Test Procedure for Residential Clothes Dryers

A test procedure for clothes dryers used to generate utility energy savings estimates

Version 2.0 – Updated December 2022

This document describes a clothes dryer laboratory test procedure used to calculate a real-world metric for residential clothes dryer energy use. The procedure describes the different cycles, settings, test load articles, and equipment needed to generate the energy metric referred to as the Utility Combined Energy Factor (UCEF). The resulting UCEF is a field study-validated weighted average of three laboratory tests specified in this procedure and a fourth manufacturer-reported U.S. Department of Energy (DOE) Appendix D2[1] residential clothes dryer test.

This NEEA procedure was developed because DOE's Appendix D2 only assesses dryer performance in a single mode with a uniform test load composed of thin, relatively small, half cotton/half synthetic test cloths. NEEA's field data revealed that real-world dryer operation was significantly different: consumers often dried loads of articles of varying size, cotton content, and dimensionality using multiple dryer modes.

This test procedure supplements Appendix D2 by accounting for additional real-world use conditions, testing dryers in a variety of operational modes with a load composed of more realistic test articles. Version 1 of this procedure was commissioned by the Northwest Energy Efficiency Alliance (NEEA) and Pacific Gas and Electric (PG&E). It included five tests representing a range of drying modes and settings as well as test articles of mostly 100 percent cotton garments and bath towels. For version 2, NEEA contracted Kannah Consulting and UL to update and further refine the test procedure based on test data collected with version 1 and changes in the dryer market since then. Version 2 specifies three tests and requires different test load articles, reducing test burden while maintaining representation of various real-world conditions. All changes from version 1 to version 2 are detailed in a 2022 NEEA report: *NEEA Dryer Test Procedure: Summary of Changes and Rationale*.[2]

Appendix D2 was designed to assess dryer performance during auto-terminating operation with a uniform test load. It was added to federal code in 2013 and last updated in 2021. Version 2 is modeled after Appendix D2, making it possible for laboratory technicians already familiar with it to carry out the tests without the need for new equipment or significant retraining. This procedure parallels sections outlined in Appendix D2, adding definitions, and clarifying information as needed. Sections 2.6 through 2.8 were modified with language for the new test loads, and Sections 3.3 through 4.8 were modified to include additional tests runs and calculations.

---

[1] 2021. *Uniform Test Method for Measuring the Energy Consumption of Clothes Dryers.* Appendix D2 to Subpart B of Part 430. 8 Oct. https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-430/subpart-B#Appendix-D2-to-Subpart-B-of-Part-430.

[2] Foster Porter, S., D. Denkenberger, and V. Fulbright. 2022. *NEEA Dryer Test Procedure Version 2.0: Summary of Changes and Rationale.* 24 Aug. Portland, OR: NEEA. https://neea.org/resources/neea-dryer-test-procedure-version-2-summary-of-changes-and-rationale.

CONTENTS

1. DEFINITIONS 3

2. TESTING CONDITIONS 6

2.1 Installation 6
2.2 Ambient temperature and humidity 6
2.3 Energy supply 6
2.4 Instrumentation 8
2.5 Lint Trap(s) 9
2.6 Test Items 9
2.7 Test Loads 9
2.8 Clothes dryer preconditioning 11

3. TEST PROCEDURES AND MEASUREMENTS 11

3.1 Drum Capacity 11
3.2 Dryer Loading 11
3.3 Test Cycle 11
3.4 Data recording 14
3.5 Modified Standby Mode and Modified Off Mode Power 15

4. CALCULATION OF DERIVED RESULTS FROM TEST MEASUREMENTS 16

4.1 Total per-cycle electric dryer energy consumption 16
4.2 Per-cycle gas dryer electrical energy consumption 16
4.4 Total per-cycle gas dryer energy consumption expressed in kilowatt-hours 17
4.5 Per-cycle modified standby mode energy consumption for tests 17
4.6 Per-cycle combined total energy consumption expressed in kilowatt-hours 18
4.7 Per-cycle Combined Energy Factor in pounds per kilowatt-hour 19
4.8 Utility Combined Energy Factor (UCEF) in pounds per kilowatt-hour 19

Notes that appear in these callout boxes are not specific test instructions but contain helpful information to support test procedure interpretation with a focus on differences relative to Appendix D2.

1. DEFINITIONS

1.1 **Active mode**: Mode in which the clothes dryer is connected to a main power source, has been activated and is performing the main function of tumbling the clothing with or without heated or unheated forced air circulation to remove moisture from the clothing, remove wrinkles or prevent wrinkling of the clothing, or both.

1.2 **AHAM**: Association of Home Appliance Manufacturers.

1.3 **AHAM HLD-1**: The test standard published by the Association of Home Appliance Manufacturers, titled "Household Tumble Type Clothes Dryers," ANSI-approved June 11, 2010, ANSI/**AHAM** HLD-1-2010.

1.4 **Automatic termination control**: Dryer control system with a sensor which monitors either the dryer load temperature or its **moisture content** and with a controller which automatically terminates the drying process. A mark, detent, or other visual indicator indicating a preferred automatic termination control setting must be present if the dryer is classified as having an "**automatic termination control**." A mark is a visible single control setting on one or more dryer controls.

1.5 **Automatic termination control dryer**: Clothes dryer which can be preset to carry out at least one sequence of operations to be terminated by means of a system assessing, directly or indirectly, the **moisture content** of the load. An **automatic termination control dryer** with a supplementary timer or one which may also be manually controlled shall be tested as an **automatic termination control dryer**.

1.6 **Bone dry**: Condition of a load of test textiles which has been dried in a dryer at maximum temperature for a minimum of 10 minutes, removed, weighed before **cool down**, and then dried again for 10-minute periods until the final weight change of the load is 1.0 percent or less.

1.7 **Compact/compact size**: Clothes dryer with a **drum capacity** of less than 4.4 cubic feet.

1.8 **Cool down**: Portion of the clothes drying **cycle** when the added **gas** or electric heat is terminated, and the clothes continue to tumble and dry within the drum.

1.9 **Cycle**: Sequence of operation of a clothes dryer which performs a clothes drying operation and may include variations or combinations of heating, tumbling, and drying functions.

1.10 **Drum capacity**: Volume of the drying drum in cubic feet.

1.11 **Final moisture content (FMC)**: The ratio of the weight of water contained by the dry test load (*i.e.,* after completion of the drying **cycle**) to the bone-dry weight of the test load, expressed as a percent.

1.12 **IEC 62301 (Second Edition)**: The test standard published by the International Electrotechnical Commission ("IEC") titled "Household electrical appliances—Measurement of standby power," Publication 62301 (Edition 2.0 2011-01) (incorporated by reference; see § 430.3).

1.13 **Initial moisture content (IMC):** The ratio of the weight of water contained by the damp test load (*i.e.,* prior to completion of the drying **cycle**) to the bone-dry weight of the test load, expressed as a percent.

1.14 **Inactive mode**: **Standby mode** that facilitates the activation of **active mode** by remote switch (including remote control), internal sensor, or timer, or that provides a continuous status display.

1.15 **Moisture content***:* The ratio of the weight of water contained by the test load to the bone-dry weight of the test load, expressed as a percent.

1.16 **Off mode**: Mode in which the clothes dryer is connected to a main power source and is not providing any active or **standby mode** function, and where the mode may persist for an indefinite time. An indicator that only shows the user that the product is in the off position is included within the classification of an **off mode.**

1.17 **Standard size:** Clothes dryer with a **drum capacity** of 4.4 cubic feet or greater.

1.18 **Standby mode:** Any product mode where the energy using product is connected to a mains power source and offers one or more of the following user-oriented or protective functions which may persist for an indefinite time:

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

(b) 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 regularly scheduled tasks (*e.g.,* switching) and operates continuously.

1.19 **Timer dryer**: A clothes dryer that can be preset to carry out at least one operation to be terminated by a timer, but may also be manually controlled and does not include any **automatic termination** function.

1.20 **Vented clothes dryer:** A clothes dryer that exhausts the evaporated moisture from the cabinet.

1.21 **Ventless clothes dryer**: A clothes dryer that uses a closed-loop system with an internal condenser to remove the evaporated moisture from the heated air. The moist air is not discharged from the cabinet.

Note: Definitions above are consistent with Appendix D2. Definitions below are specific to interpreting the instructions for this supplemental test procedure.

1.22 **BTU (British Thermal Unit):** A measure of the heat content of fuels or energy sources. It is the quantity of heat required to raise the temperature of one pound of liquid water by 1 degree Fahrenheit at the temperature that water has its greatest density (approximately 39 degrees Fahrenheit).

1.23 **End of the program:** Moment in time when the dryer indicates the program is complete and the load is accessible to the user.

1.24 **Error:** ± the allowable error stated by this procedure over a 95 percent confidence interval.

1.25 **Fast program**: Product mode in which the clothes dryer operates using a group of automated settings to achieve a rapid rate of drying during the dryer **cycle**. The **fast program** shall use the "heavy-duty" setting to achieve a short **program time**. If there are supplemental settings that shorten the cycle time in "heavy duty" (*e.g.,* a "speed" mode) but are not intended to sanitize clothing, these supplemental settings shall also be engaged for the **fast program**. If the "heavy-duty" setting is unavailable, the **fast program** shall be created using the manufacturer-provided operating instructions, using a combination of settings that allows the highest temperature and shortest drying time, excluding any settings meant to sanitize clothing.

1.26 **Gas**: When "gas" is used alone, it shall refer to natural gas or propane gas.

1.27 **Modified off mode:** defined by Appendix D2 (and Section 1.16), except the network connectivity functionality is not disabled; instead, network connectivity is tested as shipped (in default mode).

1.28 **Modified standby mode:** defined by Appendix D2 (and Section 1.18), except the network connectivity functionality is not disabled; instead, network connectivity is tested as shipped (in default mode).

1.29 **Normal program:** Product mode in which the clothes dryer operates using a group of automated settings designated as normal. For dryers that do not have a "normal" program, the program recommended by the manufacturer for drying cotton or linen clothes shall be considered as "normal."

1.30 **Program time:** Measured period of time from the initiation of the program (excluding any user-programmed delay) until the **end of the program.**

1.31 **Test run (or runs):** a single energy efficient assessment on a **cycle** of a dryer where data are collected and reported under this test procedure.

1.32 **Weighted average test load age**: As per the equation in Section C2 of **AHAM HLD- 1- 2010**, summing up the product of the ages and weights of each test item in a load and dividing by the total weight of the load.

1.33 **Wrinkle prevention mode:** A mode of operation that may be initiated at the conclusion of a **cycle** to reduce the prevalence of wrinkles in clothing when the load is not removed immediately from the tumble dryer.

2. TESTING CONDITIONS

2.1 Installation.

2.1.1 ***All clothes dryers.*** For both **vented clothes dryers** and **ventless clothes dryers**, install the clothes dryer in accordance with the manufacturer's instructions as shipped with the unit. If the manufacturer's instructions do not specify the installation requirements for a specific component, it shall be tested in the as-shipped condition. Where the manufacturer gives the option to use the dryer both with and without a duct, the dryer shall be tested without the exhaust simulator described in Section 3.3.5.1 of **AHAM HLD-1- 2010** (incorporated by reference into Appendix D2; see § 430.3). Control setting indicator lights showing the **cycle** progression, temperature or dryness settings, or other **cycle** functions that cannot be turned off during the test **cycle** shall not be disconnected during the **active mode** test **cycle**. For **standby** and **off mode** testing, the clothes dryer shall also be installed in accordance with Section 5, paragraph 5.2 of **IEC 62301** (Second Edition) (incorporated by reference; see § 430.3), disregarding the provisions regarding batteries and the determination, classification, and testing of relevant modes. For **standby** and **off mode** testing, all lighting systems shall remain connected.

2.1.2 ***Vented clothes dryers.*** For **vented clothes dryers**, the dryer exhaust shall be restricted by adding the **AHAM** exhaust simulator described in Section 3.3.5.1 of **AHAM HLD-1- 2010** (incorporated by reference; see § 430.3).

2.1.3 ***Ventless clothes dryers.*** For **ventless clothes dryers**, the dryer shall be tested without the **AHAM** exhaust simulator. If the manufacturer gives the option to use a **ventless clothes dryer**, with or without a condensation box, the dryer shall be tested with the condensation box installed. For **ventless clothes dryers**, the condenser unit of the dryer must remain in place and not be taken out of the dryer for any reason between tests.

2.2 Ambient temperature and humidity.

2.2.1 For drying testing, maintain the room ambient air temperature at 75 ± 3° F and the room relative humidity at 50 ± 10 percent.

2.2.2 For **standby** and **off mode** testing, maintain room ambient air temperature conditions as specified in Section 4, paragraph 4.2 of **IEC 62301** (Second Edition) (incorporated by reference; see § 430.3).

2.3 Energy supply.

2.3.1 ***Electrical supply.*** Maintain the electrical supply at the clothes dryer terminal block within 1 percent of 120/240 or 120/208Y or 120 volts as applicable to the particular terminal block wiring system and within 1 percent of the nameplate frequency as specified by the manufacturer for at least 95 percent of the time. If the dryer has a dual voltage conversion capability, conduct the test at the highest voltage specified by the manufacturer.

Note: This specification for electrical supply differs from Appendix D2 in that it clarifies that voltage shall be maintained 95% of the time, consistent with current laboratory practice.

2.3.1.1 ***Supply voltage waveform.*** For the clothes dryer **standby mode** and **off mode** testing, maintain the electrical supply voltage waveform indicated in Section 4, paragraph 4.3.2 of **IEC 62301** (Second Edition) (incorporated by reference; see § 430.3). If the power measuring instrument used for testing is unable to measure and record the total harmonic content during the test measurement period, it is acceptable to measure and record the total harmonic content immediately before and after the test measurement period.

2.3.2 ***Gas supply.***

2.3.2.1 ***Natural gas supply***. Maintain the gas supply to the clothes dryer immediately ahead of all controls at a pressure of 7 to 10 inches of water column. The natural gas supplied should have a heating value of approximately 1,025 BTUs per standard cubic foot. The actual heating value, H_n in BTUs per standard cubic foot, for the natural gas to be used in the test shall be obtained either from measurements using a standard continuous flow calorimeter as described in Section 2.4.6 or by the purchase of bottled natural gas whose BTU rating is certified to be at least as accurate a rating as could be obtained from measurements with a standard continuous flow calorimeter as described in Section 2.4.6.

2.3.2.2 ***Propane gas supply.*** Maintain the gas supply to the clothes dryer immediately ahead of all controls at a pressure of 11 to 13 inches of water column. The propane gas supplied should have a heating value of approximately 2,500 BTUs per standard cubic foot. The actual heating value, H_p in BTUs per standard cubic foot, for the propane gas to be used in the test shall be obtained either from measurements using a standard continuous flow calorimeter as described in Section 2.4.6 or by the purchase of bottled gas whose BTU rating is certified to be at least as accurate a rating as could be obtained from measurement with a standard continuous calorimeter as described in Section 2.4.6.

2.3.2.3 ***Hourly BTU Rating.*** Maintain the hourly BTU rating of the burner within ±5 percent of the rating specified by the manufacturer. If the hourly BTU rating of the burner cannot be maintained within ±5 percent of the rating specified by the manufacturer, make adjustments in the following order until an hourly BTU rating of the burner within ±5 percent of the rating specified by the manufacturer is achieved:

(1) Modify the **gas** inlet supply pressure within the allowable range specified in Section 2.3.2.1 or 2.3.2.2, as applicable.

(2) If the clothes dryer is equipped with a **gas** pressure regulator, modify the outlet pressure of the **gas** pressure regulator within ± 10 percent of the value recommended by the manufacturer in the installation manual, on the nameplate sticker, or wherever the manufacturer makes such a recommendation for the basic model.

Note: The Appendix D2 instruction to modify the orifice as a possible third step has been removed from the instructions above given it is not representative of real-world use. Furthermore, modifying the orifice is almost never necessary to obtain the required hourly BTU rating.

2.4 Instrumentation.

Perform all test measurements using the following instruments as appropriate.

2.4.1 ***Weighing scales.***

2.4.1.1 ***Weighing scale for test cloth.*** The scale shall have a range of 0 to a maximum of 30 pounds, with a resolution of at least 0.001 pounds and a maximum **error** no greater than 0.1 percent of any measured value within the range of 3 to 15 pounds.

2.4.1.2 ***Weighing scale for drum capacity measurements.*** The scale should have a range of 0 to at least 600 pounds with resolution of 0.50 pounds and a maximum **error** no greater than 0.5 percent of the measured value.

2.4.2 ***Kilowatt-hour meter.*** The kilowatt-hour meter shall have a resolution of 0.001 kilowatt-hours and a maximum **error** no greater than 0.5 percent of the measured value.

2.4.3 ***Gas meter.*** The **gas** meter shall have a resolution of 0.001 cubic feet and a maximum **error** no greater than 0.5 percent of the measured value.

Note: As a clarification, the measured values for kilowatt hours and **gas** refer to the integrated **cycle** values, not the instantaneous values.

2.4.4 ***Dry and wet bulb psychrometer.*** The dry and wet bulb psychrometer shall have an **error** no greater than ±1 °F. A relative humidity meter with a maximum **error** tolerance expressed in °F equivalent to the requirements for the dry and wet bulb psychrometer or with a maximum **error** tolerance of ± 2 percent relative humidity would be acceptable for measuring the ambient humidity.

2.4.5 ***Temperature.*** The temperature sensor shall have an **error** no greater than ±1 °F.

2.4.6 ***Standard Continuous Flow Calorimeter.*** The calorimeter shall have an operating range of 750 to 3,500 BTU per cubic foot. The maximum **error** of the basic calorimeter shall be no greater than 0.2 percent of the actual heating value of the **gas** used in the test. The indicator readout shall have a maximum **error** no greater than 0.5 percent of the measured value within

the operating range and a resolution of 0.2 percent of the full-scale reading of the indicator instrument.

2.4.7 ***Standby mode and off mode watt meter.*** The watt meter used to measure **standby mode,** and **off mode** power consumption shall meet the requirements specified in Section 4, paragraph 4.4 of **IEC 62301** (Second Edition) (incorporated by reference; see § 430.3). If the power measuring instrument used for testing is unable to measure and record the crest factor, power factor, or maximum current ratio during the test measurement period, it is acceptable to measure the crest factor, power factor, and maximum current ratio immediately before and after the test measurement period.

2.4.8 ***Measurements of time.*** All time measurements, including measurements of **program time** used in the test procedure shall have a maximum **error** of ± 5 seconds.

Note: Section 2.4.8 (Measurements of time) is not found in Appendix D2. Using the data acquisition system or other instrument time stamp is recommended to determine the **program time** as required by the test procedure. A minimum of 5 second interval data on the electrical energy meter is one method to easily achieve this maximum **error** of ± 5 s. **Gas** flow often does not begin immediately at the start of a dryer **cycle**; however, the tumbling motor and fan turn on immediately upon start.

2.5 Lint Trap(s).

Clean the lint trap(s) thoroughly before each **test run**.

2.6 Test Items.

2.6.1 The test items are according to Section 3.2 and Annex A of **AHAM HLD- 1- 2010**.

Note: The **AHAM HLD-1-2010** test items specified for this procedure are 100 percent cotton flat bed sheets, pillowcases, and hand towels. This contrasts with the Appendix D2 test items that are 50 percent synthetic, 50 percent cotton two dimensional cloths.

2.6.2 ***Test Cloth Pre-treatment and Normalization.***

Test cloth pre-treatment and normalization are according to Section 3.2 and Annex I of **AHAM HLD- 1- 2010**.

Note: Normalization regularly occurs after 9 drying **cycles**. Furthermore, the test load must have a weighted average age of 29 to 51 **runs**, and a minimum of 9 **runs** and a maximum of 84 **runs** (not counting normalization and pre-treatment **cycles**). In contrast, Appendix D2 specifies a test load age between 0 to 25 **runs** (excluding preconditioning).

2.7 Test Loads.

2.7.1 ***Test Loads.***

2.7.1.1 ***Small Test Load***. Prepare a bone-dry test load composed of articles according to Table 2.7, for a total weight of 4.22 lb ± 0.125 lb. **Per AHAM HLD-1-2010** Section 3.2.2, if the measured weight differs from the desired weight by more than 0.125 lb, final adjustment of the test load weight is made by adding or removing towels as necessary.

2.7.1.2 ***Large Test Load***. Prepare a bone-dry test load composed of articles according to Table 2.7 for a total weight of 16.90 lb ± 0.125 lb for **standard size** dryers and 10.20 lb ± 0.125 lb for **compact size** dryers. Per **AHAM HLD-1-2010** Section 3.2.2, if the measured weight differs from the desired weight by more than 0.125 lb, final adjustment of the test load weight is made by adding or removing towels as necessary.

2.7.1.3 ***Fast Test Load***. Prepare a bone-dry test load composed of articles according to Table 2.7 for a total weight of 8.45 lb ± 0.125 lb. Per **AHAM HLD-1-2010** Section 3.2.2, if the measured weight differs from the desired weight by more than 0.125 lb, final adjustment of the test load weight is made by adding or removing towels as necessary.

Note: These weight tolerances apply only at the building of the load and the rebuilding of the load at each normalization.

Table 2.7 –Test Load Composition

Dryer Test:	Small	Large (compact size dryer)	Large (standard size dryer)	Fast
Bone Dry Weight (lb):	4.22	10.20	16.90	8.45
Towels:	11	22	23	16
Pillowcases:	4	6	12	4
Sheets:	0	2	4	2

Note: The number for each test article were developed by interpolating the numbers of article for integer pound weights in **AHAM HLD-1-2010**, Table A.2.

2.7.2 ***Test Load Preparation.*** Dampen the load by agitating it in water whose temperature is 60 °F ± 5 °F and consists of 0 to 17 parts per million hardness for approximately 2 minutes to saturate the fabric. Then, extract water from the wet test load by spinning until the load's **moisture content** is between 56 and 62 percent of the bone-dry weight of the test load. Make a final mass adjustment such that the **moisture content** is 62 percent ±0.33 percent, by adding water uniformly distributed among all of the test cloths with a very fine spray using a spray bottle.

2.7.3 ***Method of loading.*** Load sheets, pillowcases, and towels individually into the dryer drum, alternating large and small items. Sheets shall be loosely folded into thirds and laid in the drum in a Z-shape. No items shall be twisted and tangled.

2.8 Clothes dryer preconditioning.

2.8.1 ***Vented non-heat pump clothes dryers.*** Before any test **cycle** using **vented** non-heat pump clothes dryers, operate the dryer without a test load in the non-heat mode for 15 minutes or until the discharge air temperature is varying less than 1 °F for 10 minutes—whichever is longer—in the test installation location with the ambient conditions within the specified test condition tolerances of Section 2.2.1.

2.8.2 ***Ventless and heat pump clothes dryers.*** Before any test **cycle** using **ventless** or heat pump clothes dryers, the steady-state temperature measured at the compressor or heat exchanger inlet and outlet must be within the ambient room temperature range described in Section 2.2.1 for a minimum of 10 minutes. The machine may be left at ambient room conditions for at least 6 hours between tests as an alternative to measuring compressor inlet and outlet temperature.

Note: The temperature measurement instructions in section 2.8.2 are more specific than Appendix D2. Furthermore, the alternative 6-hour rest period is shorter than the Appendix D2 rest period of 12 hours.

3. TEST PROCEDURES AND MEASUREMENTS

3.1 Drum Capacity.

The drum measurement value reported to DOE via the compliance database[3] shall be used.

3.2 Dryer Loading.

Load the dryer as specified in Section 2.73.

3.3 Test Cycle.

3.3.1 ***Test Cycle Dryer Settings.***

Table 3.3 provides a summary of the three different test **cycles** used. Refer to Sections 3.3.1.1 through 3.3.1.3 for explicit test instructions.

[3] U.S. DOE. *Compliance Certification Database, Clothes Dryers, Appendix D2.* https://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*.

Table 3.3 –Dryer Tests

Test Name	Cycle Setting	Cycle Temp	Initial Dryness Level	Nominal Load Weight (lb)	IMC	FMC
Small (3.3.1.1)	Normal	Medium	Middle	4.22	62 ± 0.33 %	6% [a]
Large (3.3.1.2)	Normal	Medium	Middle	< 4.4 cu ft: 10.20 ≥ 4.4 cu ft: 16.90	62 ± 0.33 %	6% [a]
Fast (3.3.1.3)	Heavy-Duty	High	Highest	8.45	62 ± 0.33 %	4% [a]

[a] Test **cycles** that do not reach the target **FMC** are not valid and must be re-run at an increased dryness setting or with additional timed dry **cycles**.
IMC = **initial moisture content**, **FMC** = **final moisture content**

Note: Appendix D2 specifies that the network mode should be disabled if instructions are provided to do so. For these tests, the network mode shall not be disabled.

3.3.1.1 ***Small Test.*** The purpose of this test condition is to evaluate dryer performance with a small test load operating in the dryer's **normal program**. The 4.22 lb test load is defined in Section 2.7.1.1. For dryers that do not have a **normal program**, the **cycle** recommended by the manufacturer for drying cotton clothes shall be selected. If there is no recommended program for cotton clothes, then the setting for linen clothes shall be selected. Where the drying temperature setting can be chosen independently of the program, it shall be set to medium.

Where the dryness level setting can be chosen independently of the program, it shall be set to the "normal" or "medium" dryness level setting. If such designation is not provided, then the dryness level shall be set at the mid-point between the minimum and maximum settings. If an even number of discrete settings are provided, use the next-highest setting above the midpoint, in the direction of the maximum dryness setting. Any other optional **cycle** settings that do not affect the program, temperature, or dryness settings shall be tested in the as-shipped position.

Note: Appendix D2 has different instructions for an even number of discrete dryness level settings. For these tests, if an even number of discrete settings are provided, do not use the next-lowest setting below the midpoint (in the direction of the minimum dryness setting).

The test load **IMC** shall be 62 percent ± 0.33 percent and prepared per Section 2.7.2. If the **FMC** is greater than the targeted **FMC** value of 6 percent, the test shall be deemed invalid, and a new **run** shall be conducted using the highest dryness level setting. If the **FMC** is still above 6 percent when the highest dryness setting is used, the test load shall be placed back into the dryer and dried using a 10-minute timed-dry interval and the maximum **cycle** temperature setting, excluding any **cycles** meant to sanitize. If the timed dry **cycle** setting is unavailable, then the settings used for these 10-minute intervals shall be the **fast** program, and the 10-minute intervals shall be determined using a timepiece external to the dryer.

3.3.1.2 ***Large Test.*** The purpose of this test condition is to evaluate dryer performance with a large test load operating in the dryer's **normal program** for cotton/linen loads. The 16.90 lb test load for **standard size** dryers and 10.20 lb for **compact size** dryers is defined in Section 2.7.1.2. For dryers that do not have a **normal program**, the **cycle** recommended by the manufacturer for drying cotton or linen clothes shall be selected. Where the drying temperature setting can be chosen independently of the program, it shall be set to medium.

Where the dryness level setting can be chosen independently of the program, it shall be set to the "normal" or "medium" dryness level setting. If such designation is not provided, then the dryness level shall be set at the mid-point between the minimum and maximum settings. If an even number of discrete settings are provided, use the next-highest setting above the midpoint, in the direction of the maximum dryness setting. Any other optional **cycle** settings that do not affect the program, temperature or dryness settings shall be tested in the as-shipped position.

Note: Appendix D2 has different instructions for an even number of discrete dryness level settings. For these tests, if an even number of discrete settings are provided, do not use the next-lowest setting below the midpoint (in the direction of the minimum dryness setting).

The test load's **IMC** shall be 62 percent ± 0.33 percent and prepared per Section 2.7.2. If the **FMC** is greater than the targeted **FMC** value of 6 percent, the test shall be invalid and a new **run** shall be conducted using the highest dryness level setting. If the final **FMC** is still above 6 percent when the highest dryness setting is used, the test load shall be placed back into the dryer and dried using a 10-minute timed-dry interval and the maximum **cycle** temperature setting, excluding any **cycles** meant to sanitize. If the timed dry **cycle** setting is unavailable, then the settings used for these 10-minute intervals shall be the **fast** program, and the 10-minute intervals shall be determined using a timepiece external to the dryer.

3.3.1.3 ***Fast Test.*** The purpose of this test is to evaluate dryer performance with a medium test load operated in the **fast program**. The 8.45 lb load is defined in Section 2.7.1.3.

Where the drying temperature setting can be chosen independently of the program, it shall be set to the maximum (highest temperature setting), excluding any **cycles** meant to sanitize clothing. Where the dryness level setting can be chosen independently of the program, it shall be set to the driest setting possible. Any other optional **cycle** settings that do not affect the program, such as temperature or dryness settings, shall be tested in the as-shipped position.

The test load's **IMC** shall be 62 percent ± 0.33 percent and prepared per Section 2.7.2. If the **FMC** is greater than the targeted **FMC** value of 4 percent, the test load shall be placed back into the dryer and dried using a 10-minute timed-dry interval and the maximum **cycle** temperature setting, excluding any **cycles** meant to sanitize. If the timed dry **cycle** setting is unavailable, then the settings used for these 10-minute intervals shall be the **fast** program, and the 10-minute intervals shall be determined using a timepiece external to the dryer.

3.3.2 ***Program time measurement.***

The **program time**, T , shall be measured from the moment the start is initiated on the control panel of the dryer (excluding any user-programmed delay) to the moment that the dryer terminates the **program** and the test load is accessible to the user (**end of the program**). If the clothes dryer is equipped with a **wrinkle prevention mode** (*i.e.,* a mode that continuously or intermittently tumbles the clothes dryer drum after the clothes dryer indicates to the user that the **cycle** has finished) that is activated by default in the as-shipped position, or if manufacturers' instructions specify that the feature is recommended to be activated for normal use, the **cycle** shall be considered complete after the end of the **wrinkle prevention mode**.

3.3.3 ***Other test cycle instructions.***

3.3.3.1 ***Condensation box instructions.*** When applicable, the technician shall empty the condensation box before running a test. If the dryer automatically stops during a **cycle** because the condensation box is full of water, the test is stopped, and the **test run** is invalid. The condensation box shall be emptied, and the test re-run from the beginning.

3.3.3.2 ***Position of dryer door*****.** During the time between two **cycles**, the door of the dryer shall be closed except for loading (and unloading).

3.3.3.3 ***Removal of load and data recording instructions at end of cycle.*** After the completion of the test **cycle,** remove and weigh the test load no more than 5 minutes following the termination of the test **cycle.** Record the data specified in Section 3.4.

3.4 Data recording.

Record for each **test run**:

3.4.1 ***Bone-dry weight of the test load.*** As described in Section 2.7.1.

3.4.2 ***IMC of the wet test load before the test.*** As described in Section 2.7.2.

3.4.3 ***FMC obtained after the test.*** As described in Section 3.3.1.

3.4.4 ***Average test room conditions and percent of the time in tolerance.*** This shall include temperature and percent relative humidity as described in Section 2.2.1.

3.4.5 **For electric dryers** only: the total kilowatt-hours of electric energy, E_t, consumed during the test described in Section 3.3.1.

3.4.6 **For gas dryers** only:

3.4.6.1 Total kilowatt-hours of electrical energy, E_{te}, consumed during the test described in Section 3.3.1.

3.4.6.2 The actual cubic feet of **gas** per **cycle**, E_{tg}, consumed during the test described in Section 3.3.1.

3.4.6.3 Correct the **gas** heating value, GEF, as measured in Sections 2.3.2.1 or 2.3.2.2, to standard pressure and temperature conditions in accordance with U.S. Bureau of Standards, circular C417, 1938 and report this value.

3.4.6.4 Manufacturer reported burner BTU per hour input rating.

3.4.7 ***Cycle settings.*** Record **cycle** settings used during the **test run**. The test report shall include a photograph of the **cycle** settings taken just before the beginning of the **cycle** of the **run**.

Note: A photograph is added to increase fidelity.

3.4.8 ***Supply of electricity to dryer.*** Average voltage and frequency and the percentage of time within tolerance (described in Section 2.3.1).

3.4.9 ***Notable deviations in conditions of the test load.*** This includes notations of dampness of load at end of **cycle** and condition of test load if likely to be unsatisfactory to a user.

3.4.10 ***Program time.*** Record the measured duration of the test, T, described in Section 3.3.2.

3.4.11 ***Wrinkle prevention mode.*** Presence or absence of **wrinkle prevention mode** at the end of a **test run**.

3.4.12 **Weighted average test load age**. Provided in number of **cycles.**

3.4.13 ***Manufacturer and model number.*** This including details about the specific configuration of the dryer (as needed), and other unique features.

3.4.14 ***Heat source of the dryer.*** Report natural gas, propane gas, electric resistance only, or electric heat pump.

3.4.14 ***Venting configuration of the dryer.*** Record **vented clothes dryer** or **ventless clothes dryer**.

3.4.15 ***Size of the dryer.*** Record **compact** or **standard sized**.

3.4.16 ***Automatic termination control.*** Record the presence or absence of **automatic termination control** in the as-shipped condition.

3.4.17 ***Modified standby and modified off mode measurement.*** $P_{default,mod}$ and $P_{lowest,mod}$, in watts.

3.4.18 ***The applicable run that was performed.*** Options are: **Small**, **Large**, or **Fast**.

3.5 Modified Standby Mode and Modified Off Mode Power.

Connect the clothes dryer to a watt meter as specified in Section 2.4.7. Establish the testing conditions set forth in Section 2.

3.5.1 Perform **modified standby mode** and **modified off mode** testing after completion of the **active mode** drying **cycle** for the **Fast** test as described in Section 3.3.1.3. Start the test after removing the test load; without changing the control panel settings used for the **active mode** drying **cycle**; with the door closed; and without disconnecting the electrical energy supply to the clothes dryer between completion of the **active mode** drying **cycle** and the start of **modified standby mode** and **modified off mode** testing.

3.5.2 For clothes dryers that take some time to automatically enter a stable **inactive mode** or **modified off mode** state from a higher power state as discussed in Section 5, Paragraph 5.1, Note 1 of **IEC 62301**, allow sufficient time for the clothes dryer to automatically reach the default **inactive/modified off mode** state before proceeding with the test measurement.

3.5.3 Once the stable **inactive/modified off mode** state has been reached, measure and record the default **inactive/modified off mode** power, $P_{default,mod}$, in watts, following the test procedure for the sampling method specified in Section 5, Paragraph 5.3.2 of **IEC 62301**.

3.5.4 For a clothes dryer with a switch (or other means) that can be optionally selected by the end user to achieve a lower-power **inactive/modified off mode** state than the default **inactive/off mode** state measured in Section 3.5.3, after performing the measurement in Section 3.5.3, activate the switch (or other means) to the position resulting in the lowest power consumption and repeat the measurement procedure described in Section 3.5.3. Measure and record the lowest **inactive/modified off mode** power, $P_{lowest,mod}$, in watts.

Note: Appendix D2 specifies that the network mode should be disabled if instructions are provided to do so. For these tests, the network mode shall not be disabled.

Subscript "mod" means modified to indicate that the network mode is not disabled as it is in Appendix D2.

4. CALCULATION OF DERIVED RESULTS FROM TEST MEASUREMENTS

Repeat Sections 4.1 through 4.7 for each test (Sections 3.3.1.1 through 3.3.1.3).

4.1 Total per-cycle electric dryer energy consumption.

Calculate the total electric dryer energy consumption per **cycle**, E_{ce}, expressed in kilowatt-hours per **cycle** and defined as:

$E_{ce} = E_t$

Where:

E_t = the energy recorded in Section 3.4.5.

4.2 Per-cycle gas dryer electrical energy consumption.

Calculate the **gas** dryer electrical energy consumption per **cycle**, E_{ge}, expressed in kilowatt-hours per cycle and defined as:

$E_{ge} = E_{te}$

Where:

E_{te} = the energy recorded in Section 3.4.6.1.

4.3 Per-cycle gas dryer gas energy consumption.

Calculate the **gas** dryer **gas** energy consumption per **cycle**, E_{ge}, expressed in BTUs per **cycle** and defined as:

$E_{gg} = E_{tg} \times GEF$

Where:

E_{tg} = the energy recorded in Section 3.4.6.2.

GEF = corrected **gas** heat value (BTU per cubic foot) as defined in Section 3.4.6.3.

4.4 Total per-cycle gas dryer energy consumption expressed in kilowatt-hours.

Calculate the total **gas** dryer energy consumption per **cycle**, E_{cg}, expressed in kilowatt-hours per **cycle** and defined as:

$E_{cg} = E_{ge} + (E_{gg} / 3412 \text{ BTU / kWh})$

Where:

E_{ge} = the energy calculated in Section 4.2, and

E_{gg} = the energy calculated in Section 4.3.

4.5 Per-cycle modified standby mode energy consumption for tests.

Calculate the clothes dryer per-**cycle modified standby mode** and **modified off mode** energy consumption, E_{TSO}, expressed in kilowatt-hours per **cycle** and defined as:

$E_{TSO} = [(P_{default,mod} \times S_{default}) + (P_{lowest,mod} \times S_{lowest})] \times K/C_{annual}$

Where:

$P_{default,mod}$ = Default **inactive/modified off mode** power, in watts, as measured in Section 3.5.3.

$P_{lowest,mod}$ = Lowest **inactive/modified off mode** power, in watts, as measured in Section 3.5.4 for clothes dryer with a switch (or other means) that can be optionally selected by the end user to

achieve a lower-power **inactive/modified off mode** than the default **inactive/modified off mode**; otherwise, $P_{lowest,mod}$ = NA.

$S_{default}$ = Annual hours in default **inactive/modified off mode**, defined as 8,620 if no optional lowest-power **inactive/modified off mode** is available; otherwise 4,310.

S_{lowest} = Annual hours in lowest-power **inactive/modified off mode**, defined as 0 if no optional lowest-power **inactive/modified off mode** is available; otherwise 4,310.

K = Conversion factor of watt-hours to kilowatt-hours = 0.001.

C_{annual} = 311 = representative average number of clothes dryer **cycles** in a year

8,620 = Combined annual hours for **inactive** and **modified off mode**.

4,310 = One-half of the combined annual hours for **inactive** and **modified off mode**.

Note: The representative annual number of dryer **cycles** in a year is from NEEA's 2014 residential building stock assessment laundry study, NEEA report # E14-287, Table 1.

Subscript "mod" means modified to indicate that the network mode is not disabled as it is in Appendix D2.

4.6 Per-cycle combined total energy consumption expressed in kilowatt-hours.

Calculate the per-**cycle** combined total energy consumption, E_{CC}, expressed in kilowatt-hours per **cycle** and defined for an **electric clothes dryer** as:

$E_{CC} = E_{ce} + E_{TSO}$

Where:

E_{ce} = the energy calculated in Section 4.1, and

E_{TSO} = the energy calculated in Section 4.5,

and defined for **a gas clothes dryer** as:

$E_{CC} = E_{cg} + E_{TSO}$

Where:

E_{cg} = the energy calculated in Section 4.4, and

E_{TSO} = the energy calculated in Section 4.5.

4.7 Per-cycle Combined Energy Factor in pounds per kilowatt-hour.

Calculate the combined energy factor, CEF, expressed in pounds per kilowatt-hour and defined as:

$CEF = W_{bonedry}/E_{cc}$

Where:

$W_{bonedry}$ = the **bone dry** test load weight recorded in Section 3.4.1, and

E_{cc} = the energy calculated in Section 4.6

If the **test run** was invalid, the CEF shall be NA.

4.8 Utility Combined Energy Factor (UCEF) in pounds per kilowatt-hour.

Calculate the Utility Combined Energy Factor, UCEF, expressed in pounds per kilowatt-hour and defined as:

$UCEF = W_0 \times CEF_0 + W_1 \times CEF_1 + W_2 \times CEF_2 + W_3 \times CEF_3$

Where:

UCEF = the Utility Combined Energy Factor, a weighted average of the CEF calculated for the three tests herein and DOE D2 CEFs.

W_0 = the DOE D2 weighting factor; see table below.

CEF_0 = the calculated combined energy factor for DOE D2, taken from the DOE compliance certification database or, if unavailable there, the ENERGY STAR® qualified product list.

W_1 = the Small Test weighting factor in Table 4.8 below.

CEF_1 = the calculated combined energy factor for the Small Test, calculated in Section 4.7 for the test case described in Section 3.3.1.1.

W_2 = the Large Test weighting factor in Table 4.8 below.

CEF_2 = the calculated combined energy factor for the Large Test, calculated in Section 4.7 for the test case described in Section 3.3.1.2.

W_3 = the **Fast** Test weighting factor in Table 4.8 below.

CEF_3 = the calculated combined energy factor for the **Fast** Test, calculated in Section 4.7 for the test case described in Section 3.3.1.3.

Table 4.8 – UCEF Weighting Factors

Test Run	Appendix D2 Test (from DOE's compliance database)[a]	Small Test	Large Test	Fast Test
Load Weight (lb)	8.45	4.22	< 4.4 cu ft: 10.2 ≥ 4.4 cu ft: 16.9	8.45
Starting Moisture	57.5% ± 0.33%	62% ± 0.33%	62% ± 0.33%	62% ± 0.33%
End Target Moisture	2%	6%	6%	4%
Moisture Delta	56%	56%	56%	58%
Weighting Factor	W_0	W_1	W_2	W_3
Weightings	20%	30%	10%	40%

[a] If the CEF from DOE's compliance database is not available, then it is permissible to use the CEF value as published on the ENERGY STAR® qualified product list.

Revision History

Version	Date (M/D/Y)	Description of Changes
2.0	12/21/2022	New test procedure.