ENERGY STAR® Program Requirements
Product Specification for
Water Coolers

Draft 2 Test Method
Rev. Feb-2012

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1 OVERVIEW

The following test method shall be used for determining product compliance with requirements in the ENERGY STAR Eligibility Criteria for Water Coolers.

Note: This document contains proposed changes to the ENERGY STAR test method for Water Coolers. The proposed changes incorporate the feedback received during and after the Water Cooler webinar, "Test Procedure Discussion", held on June 7, 2011. The U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) thank all stakeholders who participated and provided feedback and welcome additional comments on the changes outlined below.

The proposed changes are based on preliminary testing at both a DOE and an independent laboratory, performed on seven units representing a range of units currently available on the market. Additional testing may be required, depending on stakeholder comments on the proposed test method.

The most significant change proposed for the test procedure is the addition of water draw testing. DOE and EPA have included water draw to ensure that the test method provides a realistic and relevant estimate of Water Cooler energy consumption. The impact of this change will be dependent on the requirements set in the future specification. DOE and EPA are considering a number of options for the ENERGY STAR Water Cooler Specification. These options include: 1) Adopting the test method as proposed, with both "Water Draw" and "No Water Draw" tests utilized for program qualification; 2) Initially adopting the "Water Draw" test as a reporting metric and, following additional evaluation of the ensuing data, considering "Water Draw" as a metric for program qualification in the future. DOE and EPA welcome stakeholder feedback on these two options and other methods for incorporating "Water Draw" testing into the ENERGY STAR Water Cooler Specification.

The final test method will reside within the upcoming Water Cooler Specification Version 2.0. However, since that specification is not yet available, the Draft 1 Test Method references specific sections within the current Water Cooler Specification Version 1.3. It is expected that these section references will change once the Version 2.0 specification is available for review.

2 APPLICABILITY

This test method is applicable for the evaluation of Water Cooler energy consumption without water draw and with water draw for the following types:

- Water Source: Bottle, Point of Use (POU)
- Delivery Temperature: Hot and Cold, Cook and Cold, Cold Only
- Storage Method: Storage, On Demand

3 SCOPE

Unless otherwise specified, the scope of this document is consistent with the scope of the ENERGY STAR Eligibility Criteria for Water Coolers Version 2.0.

Note: For the purposes of initial discussion, the scope changes and notes below have been included in the test method. All scope discussion shall eventually be removed and changes applied to the Eligibility Criteria when Version 2.0 is initiated.

A) Included Products: Products that meet the definitions of a Water Cooler as specified herein are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.B (Version 1.3). Both bottled (included compartment-type) and Bottle-less Water Cooler types are covered under this specification. Bottle-less Water Coolers include Point of Use (POU) units.

Note: Air Source units were excluded from the Water Cooler scope since the units do not have an On Mode with No Water Draw comparable to conventional units. DOE and EPA welcome stakeholder comments on the products included in the ENERGY STAR program scope.

4 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Water Coolers Version 2.0.

Note: For the purposes of initial discussion, the acronyms, definitions, and discussion below have been included in the test method. The definitions are based on those in the current Version 1.3 Eligibility Criteria for Water Coolers, with changes discussed below. All definitions and acronyms will eventually be removed when Version 2.0 is initiated.

A) Conversion-type Water Cooler: Conversion-type Water Coolers are units that ship as either Bottle-type or POU and include a conversion kit intended to convert the Water Cooler from a Bottle-type unit to a POU unit or to convert a POU unit to a Bottle-type unit.

Note: DOE and EPA recommend adding the above definition for Conversion-type Water Coolers to the Water Cooler Specification to clearly define which units fall under this category and require testing in both configurations.

DOE and EPA welcome stakeholder comments on the proposal to revise the Conversion-type definition to clearly define which units require testing in both configurations.

B) Accuracy: Used herein is the error about the mean at the 90% confidence level taken over a number of metering trials. It does not refer to instrument bias.

C) Acronyms:

- ac: Alternating Current
- RH: Relative Humidity
- BTU: British Thermal Unit
- lbm: Pound Mass

- psig: Pounds Per Square Inch Gauge
- Wh: Watt Hours
- UUT: Unit Under Test
- Hz: Hertz
- F: Fahrenheit
- C: Celsius
- POU: Point of Use
- OMP: On Mode Water Draw Performance

Note: Above is a series of acronym references that may appear in this document. These acronyms will be moved to the specification when Version 2.0 is initiated.

5 TEST REQUIREMENTS

A) Input Power: Products intended to be powered from an ac mains power source shall be connected to a voltage source appropriate for the intended market, as specified in Table 1 or Table 2, below.

Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or Equal to 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 V ac	+/- 1.0 %	2.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 V ac	+/- 1.0 %	2.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 1.0 %	2.0 %	50 Hz/60 Hz	+/- 1.0 %

Table 2: Input Power Requirements for Products with Nameplate Rated Power Greater than 1500 W

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 V ac	+/- 4.0 %	5.0 %	60 Hz	+/- 1.0 %
Europe, Australia, New Zealand	230 V ac	+/- 4.0 %	5.0 %	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 4.0 %	5.0 %	50 Hz/60 Hz	+/- 1.0 %

B) Ambient Temperature: Ambient temperature shall be 75 °F +/- 2 °F (23.8°C +/- 1.2°C).

C) Relative Humidity: Relative humidity shall be from 10% to 80%.

D) Power Meter: Power meters shall possess the following attributes:

1) Minimum Frequency Response: 3.0 kHz

2) Minimum Resolution:

a) 0.01 W for measurement values less than 10 W;

b) 0.1 W for measurement values from 10 W to 100 W;

c) 1.0 W for measurement values greater than 100 W; and

d) 10 W for measurement values greater than 1.5 kW.

e) Measurements of accumulated energy should have resolutions which are generally consistent with these values when converted to average power. For accumulated energy measurements, the figure of merit for determining required accuracy is the maximum power value during the measurement period, not the average, since it is the maximum that determines the metering equipment and setup.

E) Power Measurement Uncertainty:

1) Power measurements of greater than or equal to 0.5 W shall be made with an accuracy of less than or equal to 2% at the 95% confidence level.

2) Power measurements of less than 0.5 W shall be made with an accuracy of less than or equal to 0.01 W at the 95% confidence level.

F) Energy Measurement Method: All measurements shall be recorded as accumulated energy over time, in Wh; all time shall be recorded in minutes.

G) Air Circulation: There shall be no devices with artificial means of increasing the airflow within six feet (1.83 meters) of the Unit Under Test (UUT). Airflow created by components integral to the unit itself, such as internal fans, is permitted.

H) Temperature Measurement: All temperature measurements shall be recorded using temperature measurement equipment with an accuracy of +/- 1 °F. The dispensed water temperature measurement device shall be suspended, one inch below the exit point, within the stream of dispensed water. The bottle supply water temperature measurement device shall be placed within the neck of the supply bottle, without contacting the side of the bottle. The POU supply water temperature measurement device shall be placed within the stream of water within six inches of entering the Water Cooler, without contacting the hose or tubing.

I) Time Measurement: Time measurements shall be performed with a standard stopwatch with resolution of at least 1 second.

J) Mass Measurement: The mass shall be measured using a scale with a minimum accuracy of 0.05 lbm and a resolution of 0.05 lbm.

K) Bottle-type Inlet Water Conditions: The inlet water supply to the Bottle-type Water Cooler shall be stabilized in the test room environment for a minimum of 12 hours prior to test.

L) POU Inlet Water Conditions: The inlet water to the POU Water Cooler shall have the following characteristics:

- Temperature maintained at 75.0 °F +/- 2.0 °F (23.8°C ± 1.2°C)
- Static water pressure at flow of 35 +/- 2.5 pounds per square inch gauge (psig).

M) Conversion-type Units: Water Coolers that are shipped by the manufacturer capable of operating in both Bottle-type and POU configurations shall be tested in both configurations.

N) On Demand Units: The maximum allowable time for on demand water delivery, from time of request to point of water draw, shall be four minutes.

Note: The On Demand Units tested required a minimum of three minutes to prepare hot water once requested by the technician. Therefore, the requirement for preparation time has been increased from three minutes to four minutes.

DOE and EPA welcome stakeholder comments on the recommendation to increase the maximum allowable preparation time for On Demand Water Coolers.

O) Dispensed Water Temperature: Cold water dispensed shall not exceed a temperature of 50°F and hot water shall be at least 165°F. These temperatures shall be confirmed based on the initial temperature value recorded during the On Mode with Water Draw test. The UUT default temperature settings shall conform to the temperature requirements. A Water Cooler must maintain these temperatures through its internal sensors and natural cycling of the heating or cooling components. The water temperature setting shall not be adjusted at any time during the test.

P) Compartment-type Bottled Water Cooler: If the unit being tested is a Compartment-type Water Cooler, there shall be no melting of ice, nor shall the average temperature exceed 46.0 °F [7.8 °C] in the refrigerated compartment during the test.

Note: The current requirement for Compartment-type Water Coolers may result in confusion or misinterpretation during testing. The requirement in section 4.I of the current test method stipulates that there shall be no melting of ice and the average temperature in the refrigerated compartment must be less than 46°F; however, the test method provides no way to verify that these requirements are met.

Compartment-type Water Coolers can be included in the scope without a specific test requirement. DOE and EPA recommend removing the requirement found in section 4.I for Compartment-type Water Coolers.

DOE and EPA welcome stakeholder comment on the proposal to remove the requirement for Compartment-type Water Coolers.

6 PRE-TEST UUT CONFIGURATION

6.1 General Configuration

A) UUT Setup: The UUT shall be assembled and set up in accordance with the manufacturer installation and use instructions. The UUT shall be placed a maximum of six inches from a test wall. The test wall shall be at least seven feet high and extend a minimum of two feet to each side of the unit.

6.2 Water Source Installation

A) Bottle-type Configuration: Install the five gallon water bottle in accordance with the manufacturer installation and use instructions.

B) POU Configuration: Connect the POU Water Cooler to a water source as specified by the manufacturer installation and use instructions.

6.3 UUT Initialization

A) Prior to the start of testing, the UUT shall be initialized as follows:

1) Set up the UUT as described in Section 6.

2) Connect the UUT to its power source.

3) For UUTs with an on/off switch for a heater, the UUT shall be stabilized with the heater element in the off position.

4) Power on the UUT and allow the UUT to run at least 12 hours in the test room at the specified ambient conditions and with the specified water supply installed.

Note: A comment was submitted after the Water Cooler webinar on June 7, 2011, requesting a stabilization period before conducting the 24 hour test. Testing showed that in some cases the cycle duration and energy consumption in the first 12 hours differed by up to 25% from that of the next adjacent 12 hours. Consistent 12 hour energy consumption values were seen for all 12 hour periods following the initial 12 hours. Based on these data, the test method for determining No Water Draw energy consumption will continue to use a 24 hour test period but will introduce a 12 hour stabilization period.

7 ENERGY CONSUMPTION TEST PROCEDURE

Note: The current ENERGY STAR Version 1.3 specification requires a 24 hour test period during which no water is drawn from the Water Cooler. This test is referred to as the "Standby Energy Consumption" test. Standby Energy Consumption traditionally refers to the relatively stable energy consumption of a device in a low power state during which it does not deliver usable data or perform any tasks. This terminology does not apply to a water cooler that is always on and constantly cooling and/or heating water to maintain proper water temperatures.

DOE and EPA have renamed the 24 hour test previously referred to as "Standby Energy Consumption" to "On Mode with No Water Draw" for the Version 2.0 specification. This implies that the unit is on and maintaining constant water temperatures but no water is being drawn. Similarly, an "Active Mode" test during which water is drawn will be referred to as "On Mode with Water Draw". This terminology more accurately describes Water Cooler operation.

DOE and EPA welcome stakeholder feedback on the terminology change from "Standby Mode" and "Active Mode" to "On Mode with No Water Draw" and "On Mode with Water Draw", respectively.

7.1 On Mode with No Water Draw – All Unit Types

A) Operate the UUT for an additional 24 hours with the prescribed water source installed, without drawing water.

   1) Begin the 24 hour test period immediately following a compressor or heater on cycle.

   2) If, after 24 hours, the compressor, heater, or both are on, the measurement shall be taken until the end of all on operations and the additional time included in the calculation.

   3) If the unit has an integral, automatic timer, occupancy sensor, or other feature designed to reduce the number of hours during the day the unit is running, the unit shall be tested with these features disabled.

B) Report the total no water draw energy consumption, Q_{nodraw}, in Wh, for the UUT based on the 24 hour No Water Draw test.

Note: Testing showed where compressor and/or heater cycles occurred at the end of some 24 hour test periods. In these cases, the recorded energy consumption could differ by up to 34 Wh, or 17.6%, from the majority of calculated 24 hour energy consumption data. Based on these data and as part of an effort to create a fair and equal test method, DOE has included an additional end-to-end guideline for recording No Water Draw energy consumption.

7.2 On Mode with Water Draw - All Unit Types

The method described in this section is applicable to both hot and cold water draws for a Storage Water Cooler and only applicable to cold water draws for On Demand units.

A) Ensure the UUT has been stabilized as described in section 6.3.

B) Where applicable for hot water dispensing tests, the heater element shall be switched to the on position.

C) Conduct the steps below for cold water dispensing followed by a separate test series for hot water dispensing, where applicable.

1) With both the heating element and cooler cycled off, draw water for a total of twenty seconds.

2) Begin gathering energy and power data when cooling or heating operations start due to the water draw. If the heater element (or cooler) cycles on during the water draw test, record the power and energy associated with the heater element (or cooler), $Q_{heater,,}$and P_{heater} (Q_{cooler} and P_{cooler}) and record the time it is activated, t.

3) Record the temperature of the water supply, T_o, and the dispensed water at the exit point of the UUT at a frequency of one second or less, T_f. Report the minimum delivered cold water temperature T_{min} (maximum delivered hot water temperature, T_{max}).

4) Immediately after the water draw, record the mass, m, of the collected water.

5) Record the power at one second intervals, and energy consumed by the UUT, $Q_{replenish}$, to fully recover from the water draw. The recovery energy is recorded from the beginning of a heating or cooling operation initiated by a water draw until full recovery from that same water draw. Recovery from the water draw is achieved when the automatic cycling frequency equals that measured during the On Mode with No Water Draw test (Section 7.1).

6) Repeat steps 7.2.C.1 through 7.2.C.5 for water draw time periods of 40 seconds, 60 seconds, 90 seconds, and 120 seconds.

Note: The On Mode with Water Draw test provides a method for determining the energy consumption performance of a Water Cooler while delivering and recovering from a water draw. This method, used in conjunction with the On Mode with No Water Draw test, provides a complete Water Cooler energy consumption profile.

Water draws at 20, 40, 60, 90 and 120 seconds provide integrated repeatability and confirmation of test results, with minimal added test burden. Testing has shown that there should be little deviation between results calculated for each water draw time period.

DOE and EPA welcome stakeholder feedback on the proposed On Mode with Water Draw test.

7.3 On Mode Test with Water Draw - On Demand Units Only

The test described in this section is applicable to hot water draws from On Demand units only.

A) Ensure the UUT has been stabilized as described in section 6.

B) Prior to submitting a request for hot water, the heater element shall be switched to the on position, where applicable.

C) When the compressor has cycled off, submit a request for hot water and begin recording the energy consumption and power draw of the UUT.

D) When ready, as verified by a cessation in heater power consumption, draw hot water until the dispensed water temperature is equivalent to the water supply temperature.

E) If the cooler cycles on during the water draw test, record the power and energy associated with the cooler, P_{cooler} and Q_{cooler}, and record the time it is activated, t.

F) Record the temperature of the water supply, T_o, and the dispensed water at the exit point of the UUT at a frequency of one second or less, T_f. Report the maximum delivered hot water temperature, T_{max}.

G) Immediately after the hot water draw, record the mass, m, of the collected water.

H) Report the energy consumed by the UUT, $Q_{Replenish}$.

I) Repeat steps 7.3.C) through 7.3.H) two additional times.

8 METRIC CALCULATIONS

8.1 Convert Energy Measurements

Convert the energy measurements gathered in Wh to BTU.

Equation 1: Conversion from Wh to BTU

$$Q_{BTU} = Q_{Wh} \times 3.41$$

Where:

- Q_{BTU} *is energy in units of BTU*
- Q_{Wh} *is energy in units of Wh*

8.2 Average Water Temperature

Calculate the average dispensed and supply water temperatures.

Equation 2: Calculation of the Average Water Temperatures

$$T_{f-avg} = \text{Average}(T_f)$$
$$T_{o-avg} = \text{Average}(T_o)$$

Where:

- $T_{f\text{-}avg}$ *is the average of the dispensed water temperature measurements (°F)*
- T_f *is the dispensed water temperature recorded at one second intervals (°F)*
- $T_{o\text{-}avg}$ *is the average of the supply water temperature measurements gathered at one second intervals (°F)*
- T_o *is the supply water temperature recorded at one second intervals (°F)*

8.3 Adjusted Energy Consumed to Replenish Internal Water Supply

Adjust the recorded energy consumed to replenish the internal water supply if either the heater element (during a cold draw test) or the cooler (during a hot draw test) are activated.

Equation 3: Calculation of the Adjusted Replenish Energy

$$Q_{ReplenishA} = Q_{Replenish} - Q_{heater}$$
$$Q_{ReplenishA} = Q_{Replenish} - Q_{cooler}$$

Where:

- $Q_{ReplenishA}$ *is the adjusted energy consumed to return the UUT to natural cycling (BTU)*
- $Q_{Replenish}$ *is the recorded energy consumed to return the UUT to natural cycling (BTU)*
- Q_{heater} *is the energy consumed by the heater element when activated during a recovery from a cold water draw test (BTU)*
- Q_{cooler} *is the energy consumed by the cooler when activated during a recovery from a hot water draw test (BTU)*

Note: The final metric must include only the energy consumed to recover from the water being withdrawn. Any additional energy consumed during the recovery period to maintain water temperature in an alternate internal reservoir (i.e. the hot reservoir when recovering from a cold draw) must be removed from the calculation.

8.4 Water Energy Calculation

Calculate the usable energy delivered during the On Mode Test with Water Draw.

Equation 4: Calculation of Delivered Water Energy

$$Q_{Draw} = m \times c_p \times (T_{f-avg} - T_{o-avg})$$

Where:

- Q_{Draw} *is the energy delivered during the water draw (BTU)*
- *m is the mass of water dispensed (lbm)*
- c_p *is the specific heat of water (1 BTU/lbm-°F)*
- $T_{f\text{-}avg}$ *is the average dispensed temperature of the removed water calculated in section 8.2(°F)*
- $T_{o\text{-}avg}$ *is the average supply temperature of the water source calculated in section 8.2 (°F)*

8.5 On Mode Water Draw Energy Fraction

Calculate the On Mode water draw performance (OMP) of the UUT.

Equation 5: Calculation of the On Mode Water Draw Performance

$$OMP = \frac{Q_{Draw}}{Q_{\mathrm{Re}\,plenishA}}$$

Where:

- *OMP is the On Mode water draw performance*
- Q_{Draw} *is the energy delivered during the water draw (BTU) as calculated in Section 8.4*
- $Q_{ReplenishA}$ *is the adjusted energy consumed to return the UUT to natural cycling (BTU) as calculated in Section 8.3*

Note: Testing showed that the On Mode with Water Draw has a significant impact on Water Cooler measured daily energy use when compared to the On Mode with No Water Draw energy consumption and significantly impacts Water Cooler annual energy use.

The On Mode with Water Draw energy consumption is captured and presented by an On Mode Performance (OMP) metric. This metric compares the energy delivered during water draw with the energy consumed by the Water Cooler to replenish the internal supply of water to its previous temperature (T_o). The OMP includes energy that is used for delivery and recovery from the water draw. The OMP is a measure of performance and often ranges from 0 to 1; however, some units are capable of an OMP greater than 1. The higher the OMP, the better a unit performs at converting electric energy to delivered water energy. DOE's testing indicates that this is a consistent and universally applicable way of determining the performance of various Water Cooler types.

DOE and EPA welcome stakeholder feedback on the On Mode Water Draw Performance metric.

DOE and EPA are also soliciting feedback on the relevance of combining the On Mode Water Draw energy consumption with the energy consumption of the On Mode without Water Draw, resulting in a single metric for comparing Water Coolers.