ENERGY STAR® Program Requirements Product Specification for Water Coolers

Test Method May-2013

1 OVERVIEW

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

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 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.

A) 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

4 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.

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 (+/- 0.6°C). 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 (22.67 grams) and a resolution of 0.05 lbm (22.67 grams).

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.

O) Dispensed Water Temperature: Cold water dispensed shall not exceed a temperature of 50°F (10°C) and hot water shall be at least 165°F (73.9°C). These temperatures shall be confirmed based on the initial temperature value recorded during the On Mode with Water Draw test.[1] 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 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.

Q) 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.

5 PRE-TEST UUT CONFIGURATION

5.1 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 (15.24 centimeters) from a test wall. The test wall shall be at least seven feet (2.13 meters) high and extend a minimum of two feet (0.61 meters) to each side of the unit.

[1] For Version 2.0 ENERGY STAR qualification, the dispensed water temperatures may be confirmed prior to conducting the On Mode with No Water Draw test when the respective function, compressor or heater element turns on.

5.2 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.

5.3 UUT Initialization

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

1) Set up the UUT as described in Sections 5.1 and 5.2.

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.

5) Following the 12 hour initialization period, where applicable, enable the heater element and allow for at least one heater cycle prior to performing additional tests.

6 ENERGY CONSUMPTION TEST PROCEDURE

6.1 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, and these features can be disabled, the unit shall be tested with these features disabled. If these features cannot be disabled, the unit shall be tested in the as-shipped state and the inability to disable the features shall be documented.

B) Record the total no water draw energy consumption, Q_{nodraw}, in Wh, and the duration of the no water draw test period, T_{nodraw}, in minutes.

6.2 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 5.3.

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 the cooling (or heating) 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 6.1).

6) Repeat steps 6.2.C.1 through 6.2.C.5 for water draw time periods of 40 seconds, 60 seconds, 90 seconds, and 120 seconds.

6.3 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 5.3.

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 within 2 °F (0.2°C) of 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 6.3.C) through 6.3.H) two additional times.

7 METRIC CALCULATIONS

7.1 Calculate On Mode with No Water Draw Energy Consumption

Normalize the On Mode with No Water Draw energy consumption to a 24 hour period.

Equation 1: Normalize the No Water Draw Energy

$$Q_{24hr} = \frac{Q_{nodraw} \times 1440}{T_{nodraw}}$$

Where:

- *Q_{24hr} is the normalized 24 hour energy consumption (Wh)*

- *Q_{nodraw} is the energy consumption during the On Mode with No Water Draw test (Wh)*
- *T_{nodraw} is the duration of the On Mode with No Water Draw test (minutes)*
- *1440 is the number of minutes in 24 hours*

7.2 Convert Energy Measurements

Convert the energy measurements gathered in Wh to BTU.

Equation 2: 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*

7.3 Average Water Temperature

Calculate the average dispensed and supply water temperatures.

Equation 3: Calculation of the Average Water Temperatures

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

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)*

7.4 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 4: Calculation of the Adjusted Replenish Energy

$$Q_{\mathrm{Re}\,plenishA} = Q_{\mathrm{Re}\,plenish} - Q_{heater}$$
$$Q_{\mathrm{Re}\,plenishA} = Q_{\mathrm{Re}\,plenish} - Q_{cooler}$$

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)*

7.5 Water Energy Calculation

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

Equation 5: 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 7.3 (°F)*
- *$T_{o\text{-}avg}$ is the average supply temperature of the water source calculated in section 7.3 (°F)*

7.6 On Mode Water Draw Energy Fraction

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

Equation 6: 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 7.5*
- *$Q_{ReplenishA}$ is the adjusted energy consumed to return the UUT to natural cycling (BTU) as calculated in Section 7.4*