



ENERGY STAR® Program Requirements for Water Coolers

Partner Commitments

Following are the terms of the ENERGY STAR Partnership Agreement as it pertains to the manufacture and labeling of ENERGY STAR certified products. The ENERGY STAR Partner must adhere to the following partner commitments:

Qualifying Products

1. Comply with current ENERGY STAR Eligibility Criteria, which define performance requirements and test procedures for water coolers. A list of eligible products and their corresponding Eligibility Criteria can be found at www.energystar.gov/specifications.
2. **Prior to associating the ENERGY STAR name or mark with any product**, obtain written certification of ENERGY STAR certification from a Certification Body recognized by EPA for water coolers. As part of this certification process, products must be tested in a laboratory recognized by EPA to perform water cooler testing. A list of EPA-recognized laboratories and Certification Bodies can be found at <http://www.energystar.gov/testingandverification>.

Using the ENERGY STAR Name and Marks

3. Comply with current ENERGY STAR Identity Guidelines, which define how the ENERGY STAR name and marks may be used. Partner is responsible for adhering to these guidelines and ensuring that its authorized representatives, such as advertising agencies, dealers, and distributors, are also in compliance. The ENERGY STAR Identity Guidelines are available at www.energystar.gov/logouse.
4. Use the ENERGY STAR name and marks only in association with certified products. Partner may not refer to itself as an ENERGY STAR Partner unless at least one product is certified and offered for sale in the U.S. and/or ENERGY STAR partner countries.
5. Provide clear and consistent labeling of ENERGY STAR certified water coolers.
 - 5.1. The ENERGY STAR mark must be clearly displayed on the top/front of the product, in product literature (i.e., user manuals, spec sheets, etc.), and on the manufacturer's Internet site where information about ENERGY STAR certified models is displayed.
 - 5.2. It is also recommended that the mark appear on the product packaging.

Verifying Ongoing Product Certification

6. Participate in third-party verification testing through a Certification Body recognized by EPA for water coolers, providing full cooperation and timely responses. EPA/DOE may also, at its discretion, conduct tests on products that are referred to as ENERGY STAR certified. These products may be obtained on the open market, or voluntarily supplied by Partner at the government's request.

Providing Information to EPA

7. Provide unit shipment data or other market indicators to EPA annually to assist with creation of ENERGY STAR market penetration estimates, as follows:
 - 7.1. Partner must submit the total number of ENERGY STAR certified water coolers shipped in the calendar year or an equivalent measurement as agreed to in advance by EPA and Partner.

Partner shall exclude shipments to organizations that rebrand and resell the shipments (unaffiliated private labelers).

- 7.2. Partner must provide unit shipment data segmented by meaningful product characteristics (e.g., type, capacity, presence of additional functions) as prescribed by EPA.
- 7.3. Partner must submit unit shipment data for each calendar year to EPA or an EPA-authorized third party, preferably in electronic format, no later than March 1 of the following year.

Submitted unit shipment data will be used by EPA only for program evaluation purposes and will be closely controlled. If requested under the Freedom of Information Act (FOIA), EPA will argue that the data is exempt. Any information used will be masked by EPA so as to protect the confidentiality of the Partner.

8. Report to EPA any attempts by recognized laboratories or Certification Bodies (CBs) to influence testing or certification results or to engage in discriminatory practices.
9. Notify EPA of a change in the designated responsible party or contacts within 30 days using the My ENERGY STAR Account tool (MESA) available at www.energystar.gov/mesa.

Performance for Special Distinction

In order to receive additional recognition and/or support from EPA for its efforts within the Partnership, the ENERGY STAR Partner may consider the following voluntary measures, and should keep EPA informed on the progress of these efforts:

- Provide quarterly, written updates to EPA as to the efforts undertaken by Partner to increase availability of ENERGY STAR certified products, and to promote awareness of ENERGY STAR and its message.
- Consider energy efficiency improvements in company facilities and pursue benchmarking buildings through the ENERGY STAR Buildings program.
- Purchase ENERGY STAR certified products. Revise the company purchasing or procurement specifications to include ENERGY STAR. Provide procurement officials' contact information to EPA for periodic updates and coordination. Circulate general ENERGY STAR certified product information to employees for use when purchasing products for their homes.
- Feature the ENERGY STAR mark(s) on Partner website and other promotional materials. If information concerning ENERGY STAR is provided on the Partner website as specified by the ENERGY STAR Web Linking Policy (available in the Partner Resources section of the ENERGY STAR website), EPA may provide links where appropriate to the Partner website.
- Ensure the power management feature is enabled on all ENERGY STAR certified displays and computers in use in company facilities, particularly upon installation and after service is performed.
- Provide general information about the ENERGY STAR program to employees whose jobs are relevant to the development, marketing, sales, and service of current ENERGY STAR certified products.
- Provide a simple plan to EPA outlining specific measures Partner plans to undertake beyond the program requirements listed above. By doing so, EPA may be able to coordinate, and communicate Partner's activities, provide an EPA representative, or include news about the event in the ENERGY STAR newsletter, on the ENERGY STAR website, etc. The plan may be as simple as providing a list of planned activities or milestones of which Partner would like EPA to be aware. For example, activities may include: (1) increasing the availability of ENERGY STAR certified products by converting the entire product line within two years to meet ENERGY STAR guidelines; (2) demonstrating the economic and environmental benefits of energy efficiency through special in-store displays twice a year; (3) providing information to users (via the website and user's manual) about energy-saving features and operating characteristics of ENERGY STAR certified products; and (4) building awareness of the ENERGY STAR Partnership and brand identity by collaborating with EPA on one print advertorial and one live press event.

- Join EPA's SmartWay Transport Partnership to improve the environmental performance of the company's shipping operations. The SmartWay Transport Partnership works with freight carriers, shippers, and other stakeholders in the goods movement industry to reduce fuel consumption, greenhouse gases, and air pollution. For more information on SmartWay, visit www.epa.gov/smartway.
- Join EPA's Green Power Partnership. EPA's Green Power Partnership encourages organizations to buy green power as a way to reduce the environmental impacts associated with traditional fossil fuel based electricity use. The partnership includes a diverse set of organizations including Fortune 500 companies, small and medium businesses, government institutions as well as a growing number of colleges and universities. For more information on Green Power, visit www.epa.gov/greenpower.



ENERGY STAR® Program Requirements Product Specification for Water Coolers

Eligibility Criteria Version 3.0

Following is the Version 3.0 product specification for ENERGY STAR certified water coolers. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1) Definitions: Below are the definitions of the relevant terms in this document.

- A. Water Cooler: A freestanding device that consumes energy to cool and/or heat potable water. Products that have dispensing functions such as sparkling, alkaline, or flavored water, in addition to cold and hot water will also be recognized by the classification below.
 - a. Cold Only Units: Units that dispense cold water only.
 - b. Cook and Cold Units: Units that dispense both cold and room-temperature water.
 - c. Hot and Cold Units: Units that dispense both hot and cold water.
 - d. Hot, Cook, and Cold Units: Units that dispense hot, cold, and room-temperature water. Only units that simultaneously offer all three water temperature choices meet this definition.

- B. Water Source:
 - a. Bottle: A bottle or reservoir supplies water to the water cooler.
 - b. Point of Use (POU): The water cooler is connected to a pressurized water source.
 - c. Conversion-type Water Cooler: A unit that ships as either Bottle-source or POU and includes a conversion kit intended to convert the Water Cooler from a Bottle-source unit to a POU unit or to convert a POU unit to a Bottle-source unit.

- C. Water Conditioning:
 - a. Conditioned Storage: Hot and cold thermally conditioned water is stored in tanks located within the body of the water cooler. The conditioned water is available instantaneously.
 - b. On Demand Heating: The unit heats water as it is requested (i.e., without a hot water storage tank), which typically takes a few minutes to deliver. On demand units use storage tanks to condition and provide cold water only.

- D. Product Family: A group of product models that (1) are manufactured by the same manufacturer, (2) use the same primary energy source, and (3) have electrical characteristics that are essentially identical, and which do not have any differing physical or functional characteristics that affect energy consumption.

- E. High Capacity Water Cooler: A water cooler with a cold-water dispenser capacity that is greater than 0.50 gallons per hour, as measured per ANSI/ASHRAE Standard 18. For units that also provide hot water, the unit must have a hot-water dispenser capacity greater than 41 exact 6 oz.

cups per hour, as rated per ANSI/ASHRAE Standard 18. These products provide adequate capacity for offices or other high-traffic installations.

- F. Low Capacity Water Cooler: A water cooler with a cold-water dispenser capacity of 0.50 gallons per hour or less, as measured per ANSI/ASHRAE Standard 18. For units that also provide hot water, the unit must have a hot-water dispenser capacity that is equal to or less than 41 exact 6 oz. cups per hour, as rated per ANSI/ASHRAE Standard 18. These products provide adequate conditioned water for residential and other low-traffic installations while offering improved energy savings.
- G. Test Modes:
- a. On Mode with No Water Draw: A test that records the 24-hour energy consumption of a water cooler with no water drawn during the test period. This test is also known as “Standby”.
 - b. On Mode with Water Draw: A test that records the energy delivered in a water draw and the subsequent energy consumed while recovering from that water draw.
 - Section 6.2. On Mode with Water Draw – All Unit Types Test cold water draw in Conditioned Storage units and On Demand units, and test hot water draw in Conditioned Storage units,
 - Section 6.3. On Mode with Water Draw – On Demand Units Only Test hot water draw in On Demand units.
 - Section 7.6. On Mode Water Draw Performance (OMP): A metric for water draw performance that compares the energy delivered and energy consumed by the water cooler.

2) Scope:

- A. Included Products: Products that meet the definition of a water cooler as specified herein are eligible for ENERGY STAR certification, with the exception of products listed in Section 2.B. Products with additional dispensing features including sparkling, alkaline, or flavored water, are also included in the scope of this specification.
- B. Excluded Products: Units that provide pressurized water and are not free standing (i.e., wall mounted, under sink, or otherwise building integrated) are not eligible for ENERGY STAR. Air-source units and other units with a water source other than bottled or tap water (POU) are not eligible. Units with provisions for making, storing and dispensing small amounts of ice and units that are primarily ice makers that have a water dispensing function, or that meet the definition of an Automatic Commercial Ice Maker (ACIM) as defined by the ENERGY STAR Product Specification for that category, are not eligible for the water cooler product category.

3) Certification Criteria:

A. Energy Efficiency Requirements:

Table 1: Energy-Efficiency Criteria for Certified Water Coolers

Product Type	Conditioning Method	Capacity	On Mode with No Water Draw (kWh/day)	OMP for Cold Water Draw	OMP for Hot Water Draw
Cold Only & Cook and Cold units	Conditioned Storage	All	≤ 0.16	Reported	N/A
Hot and Cold & Hot, Cook, and Cold Units	Conditioned Storage	Low Capacity	≤ 0.68	Reported	Reported
		High Capacity	≤ 0.80	Reported	Reported
Hot and Cold & Hot, Cook, and Cold Units	On Demand Heating	All	≤ 0.18	Reported	Reported

B. Significant Digits and Rounding:

- a. All calculations shall be carried out with actual measured or observed values. Only the final result of a calculation shall be rounded. Calculated results shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.
- b. Unless otherwise specified, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.

C. Additional Reporting Requirements:

- a. Report the cold water capacity per hour, tested per ANSI/ASHRAE 18-2008 (RA 2013), Section 5.7 Capacity Test for Ratings, in gallons per hour.
- b. For all hot and cold and hot, cook, and cold units, report the hot water capacity per hour, tested per ANSI/ASHRAE 18-2008 (RA 2013), Section 5.8 Hot-Water-Dispenser Capacity Test, in number of exact 6 fl oz draws per hour.
- c. Report the type of refrigerant used in the respective water cooler unit, for example: R-410A, R-134a, or R-290.

4) Test Requirements:

- A. A representative model shall be selected for testing per the following requirements:
 - a. For certification of an individual product model, the representative model shall be equivalent to that which is intended to be marketed and labeled as ENERGY STAR.
 - b. For certification of a product family, any model within that product family can be tested and serve as the representative model.
- B. When testing water coolers, the following test methods shall be used to determine ENERGY STAR certification.

Table 2: Test Methods for ENERGY STAR Certification

ENERGY STAR Requirement	Conditioning Method	Test Method Reference
On Mode with No Water Draw	Conditioned Storage and On Demand	ENERGY STAR Test Method for Water Coolers (Rev. May-2013), Sections 6.1 and 7.1
OMP for Cold Water Draw*	Conditioned Storage and On Demand Heating	ENERGY STAR Test Method for Water Coolers (Rev. May-2013), Sections 6.2 and 7.6
OMP for Hot Water Draw*	Conditioned Storage	ENERGY STAR Test Method for Water Coolers (Rev. May-2013), Sections 6.2 and 7.6
	On Demand Heating	ENERGY STAR Test Method for Water Coolers (Rev. May-2013), Sections 6.3 and 7.6
Cold-Water Dispenser Capacity	Conditioned Storage and On Demand Heating	ANSI/ASHRAE 18-2008 (RA 2013) 5. Methods of Testing
Hot-Water Dispenser Capacity	Conditioned Storage and On Demand Heating	ANSI/ASHRAE 18-2008 (RA 2013) 5.8 Hot-Water-Dispenser Capacity Test
<i>* OMP for Cold Water Draw and OMP for Hot Water Draw are required for reporting only.</i>		

5) Effective Date: This ENERGY STAR Water Cooler Specification shall take effect on **March 23, 2022**. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

6) Future Specification Revisions: EPA reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model.



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, $Q_{\text{replenish}}$, 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, $Q_{\text{Replenish}}$.
- 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

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

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

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

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

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

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)

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-avg} is the average dispensed temperature of the removed water calculated in section 7.3 (°F)
- T_{o-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

$$OMP = \frac{Q_{Draw}}{Q_{ReplenishA}}$$

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