
4.2.2.2.1 Annual cooking energy consumption. Calculate the annual energy consumption for cooking, \( E_{CC} \), in Btu's (kJ) per year for a gas cooking top, defined as:

\[
E_{CC} = \frac{O_{CT}}{Eff_{CT}}
\]

Where:
- \( O_{CT} = 527.6 \text{ Btu's} (556,618 \text{ kJ}) \) per year, annual useful cooking energy output.
- \( Eff_{CT} \) = the gas cooking top efficiency as defined in Section 4.2.1.3.

4.2.2.2.2 Annual energy consumption of any continuously burning gas pilots. Calculate the annual energy consumption of any continuously burning gas pilot lights of the cooking top, \( E_{CP} \), in Btu’s (kJ) per year, defined as:

\[
E_{CP} = Q_{CP} \times A \times H,
\]

Where:
- \( Q_{CP} = \) pilot light gas flow rate as measured in Section 3.2.2.1.
- \( A = 3,760 \) hours, the total number of hours in a year.
- \( H = \) either \( H_n \) or \( H_p \), the heating value of the gas used in the test as specified in Section 2.2.2.2. and Section 2.2.2.3, expressed in Btu’s per standard cubic foot (kJ/L) of gas.

4.2.2.2.3 Total annual energy consumption of a conventional gas cooking top. Calculate the total annual energy consumption of a conventional gas cooking top, \( E_{CT} \), in Btu’s (kJ) per year, defined as:

\[
E_{CT} = E_{CC} + E_{CP},
\]

Where:
- \( E_{CC} \) = energy consumption for cooking as determined in Section 4.2.2.2.1.
- \( E_{CP} \) = annual energy consumption of the pilot lights as determined in Section 4.2.2.2.

4.2.3 Conventional cooking top energy factor. Calculate the energy factor or ratio of useful cooking energy output for cooking to the total energy input, \( R_{CT} \), as follows:

For an electric cooking top, the energy factor is the same as the cooking efficiency as determined according to Section 4.2.1.3.

For gas cooking tops,

\[
R_{CT} = \frac{O_{CT}}{E_{CA}}
\]

Where:
- \( O_{CT} = 527.6 \text{ Btu's} (556,618 \text{ kJ}) \) per year, annual useful cooking energy output of cooking top.
- \( E_{CA} = \) total annual energy consumption of cooking top determined according to Section 4.2.2.2.3.

4.3 Combined components. The annual energy consumption of a kitchen range, e.g. a cooktop and oven combined, shall be the sum of the annual energy consumption of each of its components. The annual energy consumption for other combinations of ovens and cooktops will also be treated as the sum of the annual energy consumption of each of its components. The energy factor of a combined component is the sum of the annual useful cooking energy output of each component divided by the sum of the total annual energy consumption of each component.


APPENDIX J TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF AUTOMATIC AND SEMI-AUTOMATIC CLOTHES WASHERS

The provisions of this appendix J shall apply to products manufactured after April 13, 2001. The procedures and calculations in sections 3.3, 4.3, and 4.4 of this appendix need not be performed to determine compliance with the energy conservation standards for clothes washers.

1. Definitions

1.1 Adaptive control system means a clothes washer control system, other than an adaptive water fill control system, which is capable of automatically adjusting washer operation or washing conditions based on characteristics of the clothes load placed in the clothes container, without allowing or requiring consumer intervention or actions. The automatic adjustments may, for example, include automatic selection, modification, or control of any of the following: wash water temperature, agitation or tumble cycle time, number of rinse cycles, and spin speed. The characteristics of the clothes load, which could trigger such adjustments, could, for example, consist of or be indicated by the presence of either soil, soap, suds, or any other additive laundering substitute or complementary product.

Note: Appendix J does not provide a means for determining the energy consumption of a clothes washer with an adaptive control system. Therefore, pursuant to 10 CFR 430.27, a waiver must be obtained to establish an acceptable test procedure for each such clothes washer.

1.2 Adaptive water fill control system means a clothes washer water fill control system which is capable of automatically adjusting the water fill level based on the size or weight of the clothes load placed in the clothes container, without allowing or requiring consumer intervention and/or actions.

1.3 Bone-dry means a condition of a load of test cloth which has been dried in a dryer

328
at maximum temperature for a minimum of 10 minutes, removed and weighed before cool down, and then dried again for 10-minute periods until the final weight change of the load is 1 percent or less.

1.4 Clothes container means the compartment within the clothes washer that holds the clothes during operation of the machine.

1.5 Compact means a clothes washer which has a clothes container capacity of less than 1.6 ft³ (45 L).

1.6 Deep rinse cycle means a rinse cycle in which the clothes container is filled with water to a selected level and the clothes load is rinsed by agitating it or tumbling it through the water.

1.7 Front-loader clothes washer means a clothes washer which sequentially rotates or tumbles portions of the clothes load above the water level allowing the clothes load to fall freely back into the water. The principal axis of the clothes container is in a horizontal plane and the access to the clothes container is through the front of the machine.

1.8 Lockout means that at least one wash/rinse water temperature combination is not available in the normal cycle that is available in another cycle on the machine.

1.9 Make-up water means the amount of fresh water needed to supplement the amount of stored water pumped from the external laundry tub back into the clothes washer when the suds-return feature is activated in order to achieve the required water fill level in the clothes washer.

1.10 Modified energy factor means the quotient of the cubic foot (or liter) capacity of the clothes washer container divided by the total clothes washer energy consumption per cycle, with such energy consumption expressed as the sum of the machine electrical energy consumption, the hot water energy consumption, and the energy required for removal of the remaining moisture in the wash load.

1.11 Most energy intensive cycle means the non-normal cycle that uses the most energy for a given wash/rinse temperature combination.

1.12 Non-normal cycle means a cycle other than the normal cycle, but does not include any manually selected pre-wash, pre-soak, and extra-rinse option.

1.13 Nonwater-heating clothes washer means a clothes washer which does not have an internal water heating device to generate hot water.

1.14 Normal cycle means the cycle recommended by the manufacturer for washing cotton and/or linen clothes.

1.15 Sensor filled means a water fill control which automatically terminates the fill when the water reaches an appropriate level in the tub.

1.16 Spray rinse cycle means a rinse cycle in which water is sprayed onto the clothes load for a definite period of time without maintaining any specific water level in the clothes container.

1.17 Standard means a clothes washer which has a clothes container capacity of 1.6 ft³ (45 L) or greater.

1.18 Suds-return means a feature or option on a clothes washer which causes the stored wash water obtained by utilizing the suds-saver feature to be pumped from the external laundry tub back into the clothes washer.

1.19 Suds-saver means a feature or option on a clothes washer which allows the user to store used wash water in an external laundry tub for use with subsequent wash loads.

1.20 Temperature use factor means the percentage of the total number of washes a user would wash with a particular wash/rinse temperature setting.

1.21 Thermostatically controlled water valves means clothes washer controls that have the ability to sense and adjust the hot and cold supply water.

1.22 Time filled means a water fill control which uses a combination of water flow controls in conjunction with time to terminate the water fill cycle.

1.23 Top-loader-horizontal-axis clothes washer means a clothes washer which: rotates or tumbles portions of the clothes load above the water level allowing the clothes load to fall freely back into the water with the principal axis in a horizontal plane and has access to the clothes container through the top of the clothes washer.

1.24 Top-loader-vertical-axis clothes washer means a clothes washer that: flexes and oscillates the submerged clothes load through the water by means of mechanical agitation or other movement; has a clothes container with the principal axis in a vertical plane; and has access to the clothes container through the top of the clothes washer.

1.25 Water consumption factor means the quotient of the total weighted per-cycle water consumption divided by the capacity of the clothes washer.

1.26 Water-heating clothes washer means a clothes washer where some or all of the hot water for clothes washing is generated by a water heating device internal to the clothes washer.

2. Testing Conditions

2.1 Installation. Install the clothes washer in accordance with manufacturer’s instructions.

2.2 Electrical energy supply. Maintain the electrical supply at the clothes washer terminal block within 2 percent of 120, 120/240 or 120/208Y volts as applicable to the particular terminal block wiring system as specified by the manufacturer. If the clothes washer has a dual voltage conversion capability, conduct the test at the highest voltage specified by the manufacturer.
2.3 Supply water. For nonwater-heating clothes washers not equipped with thermostatically controlled water valves, the temperature of the hot and cold water supply shall be maintained at 100 °F ±10 °F (37.8 °C ±5.5 °C). For nonwater-heating clothes washers equipped with thermostatically controlled water valves, the temperature of the hot water supply shall be maintained at 140 °F ±5 °F (60.0 °C ±2.8 °C) and the cold water supply shall be maintained at 60 °F ±5 °F (15.6 °C ±2.8 °C). For water-heating clothes washers, the temperature of the hot water supply shall be maintained at 140 °F ±5 °F (60.0 °C ±2.8 °C) and the cold water supply shall not exceed 60 °F (15.6 °C). Water meters shall be installed in both the hot and cold water lines to measure water consumption.

2.3.1 Supply water requirements for water and energy consumption testing. For nonwater-heating clothes washers not equipped with thermostatically controlled water valves, the temperature of the hot and cold water supply shall be maintained at 100 °F ±10 °F (37.8 °C ±5.5 °C). For nonwater-heating clothes washers equipped with thermostatically controlled water valves, the temperature of the hot water supply shall be maintained at 140 °F ±5 °F (60.0 °C ±2.8 °C) and the cold water supply shall be maintained at 60 °F ±5 °F (15.6 °C ±2.8 °C). For water-heating clothes washers, the temperature of the hot water supply shall be maintained at 140 °F ±5 °F (60.0 °C ±2.8 °C) and the cold water supply shall not exceed 60 °F (15.6 °C). Water meters shall be installed in both the hot and cold water lines to measure water consumption.

2.3.2 Supply water requirements for remaining moisture content testing. For nonwater-heating clothes washers not equipped with thermostatically controlled water valves, the temperature of the hot water supply shall be maintained at 140 °F ±5 °F (60.0 °C ±2.8 °C) and the cold water supply shall not exceed 60 °F (15.6 °C). Water meters shall be installed in both the hot and cold water lines to measure water consumption.

2.4 Water pressure. The static water pressure in the hot and cold water inlet connection of the machine shall be maintained during the test at 35 pounds per square inch gauge (psig) ±2.5 psig (241.3 kPa ±17.2 kPa). The static water pressure for a single water inlet connection shall be maintained during the test at 35 psig ±2.5 psig (241.3 kPa ±17.2 kPa). Water pressure gauges shall be installed in both the hot and cold water lines to measure water pressure.

2.5 Instrumentation. Perform all test measurements using the following instruments, as appropriate.

2.5.1 Weighing scales.

2.5.1.1 Weighing scale for test cloth. The scale shall have a resolution no larger than 0.2 oz (5.7 g) and a maximum error no greater than 0.3 percent of the measured value.

2.5.1.2 Weighing scale for clothes container capacity measurements. The scale shall have a resolution no larger than 0.50 lbs (0.23 kg) and a maximum error no greater than 0.5 percent of the measured value.

2.5.2 Watt-hour meter. The watt-hour meter shall have a resolution no larger than 1 Wh (3.6 kJ) and a maximum error no greater than 2 percent of the measured value for any demand greater than 50 Wh (180.0 kJ).

2.5.3 Temperature measuring device. The device shall have an error no greater than ±1 °F (±0.6 °C) over the range being measured.

2.5.4 Water meter. The water meter shall have a resolution no larger than 0.1 liters (0.4 liters) and a maximum error no greater than 2 percent for all water flow rates from 1 gal/min (3.8 L/min) to 5 gal/min (18.9 L/min).

2.5.5 Water pressure gauge. The water pressure gauge shall have a resolution no larger than 1 psig (6.9 kPa) and shall have an error no greater than 5 percent of any measured value over the range of 32.5 psig (224.1 kPa) to 37.5 psig (258.6 kPa).

2.6 Test cloths.

2.6.1 Energy test cloth. The energy test cloth shall be clean and consist of the following:

2.6.1.1 Pure finished bleached cloth, made with a momie or granite weave, which is 50 percent cotton and 50 percent polyester and weighs 5.75 oz/yd² (195.6 g/m²) and has 65 ends on the warp and 57 picks on the fill.

2.6.1.2 Cloth material that is 24 in by 36 in (61.0 cm by 91.4 cm) and has been hemmed to 22 in by 34 in (55.9 cm by 86.4 cm) before washing. The maximum shrinkage after five washes shall not be more than four percent on the length and width.

2.6.1.3 The number of test runs on the same energy test cloth shall not exceed 60 test runs. All energy test cloth must be permanently marked identifying the lot number of the material. Mixed lots of material shall not be used for testing the clothes washers.

2.6.2 Energy Stuffer Cloth. The energy stuffer cloths shall be made from energy test cloth material and shall consist of pieces of material that are 12 inches by 12 inches (30.5 cm by 30.5 cm) and have been hemmed to 10 inches by 10 inches (25.4 cm by 25.4 cm) before washing. The maximum shrinkage after five washes shall not be more than four percent on the length and width. The number of test runs on the same energy stuffer cloth shall not exceed 60 test runs. All energy stuffer cloth must be permanently marked identifying the lot number of the material. Mixed lots of material shall not be used for testing the clothes washers.

2.7 Composition of test loads.

2.7.1 Seven pound test load. The seven pound test load shall consist of bone-dry energy test cloths which weigh 7 lbs ±0.67 lbs (3.18 kg ±0.30 kg). Adjustments to the test
3.1 Place the clothes washer in such a position that the uppermost edge of the clothes container opening is leveled horizontally, so that the container will hold the maximum amount of water.

3.1.2 Line the inside of the clothes container with 2 mil (0.051 mm) plastic sheet. All clothes washer components which occupy space within the clothes container and which are recommended for use with the energy test cycle shall be in place and shall be lined with 2 mil (0.051 mm) plastic sheet to prevent water from entering any void space.

3.1.3 Record the total weight of the machine before adding water.

3.1.4 Fill the clothes container manually with either 60 °F ± 5 °F (15.6 °C ±2.8 °C) or 100 °F ± 10 °F (37.8 °C ±5.5 °C) water to its uppermost edge. Measure and record the weight of water, W, in pounds.

3.1.5 The clothes container capacity is calculated as follows:

\[ C = \frac{W}{d} \]

where:

- \( C \) = Capacity in cubic feet (or liters).
- \( W \) = Mass of water in pounds (or kilograms).
- \( d \) = Density of water (62.0 lbs/ft\(^3\) for 100 °F (995 kg/m\(^3\) for 37.8 °C) or 62.8 lbs/ft\(^3\) for 60 °F (998 kg/m\(^3\) for 15.6 °C)).
these two tests shall be averaged to determine the adaptive water fill energy consumption value. If a clothes washer with an adaptive water fill control system allows consumer selection of manual controls as an alternative, both the manual and adaptive modes shall be tested and the energy consumption values, $E_m$, $M_m$, and $D_m$ (if desired), calculated in section 4 for each mode, shall be averaged between the manual and adaptive modes.

3.2.2.2 Clothes washers with multiple warm wash temperature combination selections.

3.2.2.2.1 If a clothes washer’s temperature combination selections are such that the temperature of each warm wash setting that is above the mean warm wash temperature (the mean temperature of the coldest and warmest warm settings) is matched by a warm wash setting that is an equal distance below the mean, then the energy test shall be conducted at the mean warm wash temperature if such a selection is provided, or if there is no position on the control that permits selection of the mean temperature, the energy test shall be conducted with the temperature selection set at the next hotter temperature setting that is available above the mean.

3.2.2.2.2 If the multiple warm wash temperature combination selections do not meet criteria in section 3.2.2.2.1, the energy test shall be conducted with the temperature selection set at the warm wash temperature setting that gives the next higher water temperature setting that is available above the mean.

3.2.2.2.3 Clothes washers with multiple temperature settings within a temperature combination selection. When a clothes washer is provided with a secondary control that can modify the wash or rinse temperature within a temperature combination selection, the secondary control shall be set to provide the hottest wash temperature available and the hottest rinse temperature available. For instance, when the temperature combination selection is set for the middle warm wash temperature and a secondary control exists which allows this temperature to be increased or decreased, the secondary control shall be set to provide the hottest wash temperature available and the middle warm wash temperature.

3.2.3 Clothes washers that do not lockout any wash/rinse temperature combinations in the normal cycle. Test in the normal cycle all temperature combination selections that are required to be tested.

3.2.3.1 Hot water consumption, cold water consumption, and electrical energy consumption at maximum fill. Set the water level selector at maximum fill available on the clothes washer, if manually controlled, and insert the appropriate test load, if applicable. Activate the normal cycle of the clothes washer and also any suds-saver switch.

3.2.3.1.1 For automatic clothes washers, set the wash/rinse temperature selector to the hottest temperature combination setting. For semi-automatic clothes washers, open the hot water faucet valve completely and close the cold water faucet valve completely to achieve the hottest temperature combination setting.

3.2.3.1.2 Measure the electrical energy consumption of the clothes washer for the complete cycle.

3.2.3.1.3 Measure the respective number of gallons (or liters) of hot and cold water used for all spray rinse cycles.

3.2.3.1.4 Measure the respective number of gallons (or liters) of hot and cold water used for all deep rinse cycles.

3.2.3.1.5 Measure the respective gallons (or liters) of hot and cold water used for all spray rinse cycles.

3.2.3.1.6 For non-water-heating automatic clothes washers repeat sections 3.2.3.1.3 through 3.2.3.1.5 for each of the other wash/rinse temperature selections available that uses heated water and is required to be tested. For water-heating clothes washers, repeat sections 3.2.3.1.2 through 3.2.3.1.5 for each of the other wash/rinse temperature selections set at the warm wash temperature if such a selection is provided, or if there is no position on the control that permits selection of the mean temperature, the energy test shall be conducted with the temperature selection set at the next hotter temperature setting that is available above the mean.

3.2.3.1.7 If the clothes washer is equipped with a suds-saver cycle, repeat sections 3.2.3.1.2 to 3.2.3.1.5 with suds-saver switch set to suds return for the Warm/Cold temperature setting.

3.2.3.2 Hot water consumption, cold water consumption, and electrical energy consumption with the water level selector at minimum fill. Set the water level selector at minimum fill, if manually controlled, and insert the appropriate test load, if applicable. Activate the normal cycle of the clothes washer and also any suds-saver switch. Repeat sections 3.2.3.1.1 through 3.2.3.1.7.

3.2.3.3 Hot and cold water consumption for clothes washers that incorporate a partial fill during the rinse cycle. For clothes washers that incorporate a partial fill during the rinse cycle, activate any suds-saver switch and operate the clothes washer for the complete normal cycle at both the maximum water temperature combinations.

3.2.3.3.1 Measure the respective number of gallons (or liters) of hot and cold water used for all spray rinse cycles.

3.2.3.3.2 Measure the respective number of gallons (or liters) of hot and cold water used for all deep rinse cycles.

3.2.3.3.3 Measure the respective gallons (or liters) of hot and cold water used for all spray rinse cycles.

3.2.3.3.4 Measure the respective gallons (or liters) of hot and cold water used for all deep rinse cycles.

3.2.3.3.5 Measure the respective gallons (or liters) of hot and cold water used for all spray rinse cycles.
water fill level and the minimum water fill level for each of the wash/rinse temperature selections available. Measure the respective hot and cold water consumed during the complete normal cycle.

3.2.4 Clothes washers that lock out any wash/rinse temperature combinations in the normal cycle. In addition to the normal cycle tests in section 3.2.3, perform the following tests on non-normal cycles for each wash/rinse temperature combination selection that is locked out in the normal cycle.

3.2.4.1 Set the cycle selector to a non-normal cycle which has the wash/rinse temperature combination setting that is locked out. Set the water level selector at maximum fill and insert the appropriate test load, if applicable. Activate the cycle of the clothes washer and also any suds-saver switch. Set the wash/rinse temperature selector to the temperature combination setting that is locked out in the normal cycle and repeat sections 3.2.3.1.2 through 3.2.3.1.5.

3.2.4.2 Repeat section 3.2.4.1 under the same temperature combination setting for all other untested non-normal cycles on the machine that have the wash/rinse temperature combination selection that is locked out.

3.2.4.3 Total the measured hot water consumption of the wash, deep rinse, and spray rinse of each non-normal cycle tested in sections 3.2.4.1 through 3.2.4.2 and compare the total for each cycle. The cycle that has the highest hot water consumption shall be the most energy intensive cycle for that particular wash/rinse temperature combination setting.

3.2.4.4 Set the water level selector at minimum fill and insert the appropriate test load, if applicable. Activate the most energy intensive cycle, as determined in section 3.2.4.3, of the clothes washer and also any suds-saver switch. Repeat tests as described in section 3.2.4.1.

3.3 Remaining Moisture Content (RMC).

3.3.1 The wash temperature shall be the same as the rinse temperature for all testing. Cold rinse is the coldest rinse temperature available on the machine. Warm rinse is the hottest rinse temperature available on the machine.

3.3.2 Determine the test load as shown in the following table:

<table>
<thead>
<tr>
<th>Container volume</th>
<th>Test load</th>
</tr>
</thead>
<tbody>
<tr>
<td>cu. ft. ≥ &lt;</td>
<td>liter ≥ &lt;</td>
</tr>
<tr>
<td>0.80</td>
<td>0-22.7</td>
</tr>
<tr>
<td>0.80-0.90</td>
<td>22.7-25.5</td>
</tr>
<tr>
<td>0.90-1.00</td>
<td>25.2-28.3</td>
</tr>
<tr>
<td>1.00-1.10</td>
<td>28.3-31.1</td>
</tr>
<tr>
<td>1.10-1.20</td>
<td>31.1-34.0</td>
</tr>
<tr>
<td>1.20-1.30</td>
<td>34.0-36.8</td>
</tr>
<tr>
<td>1.30-1.40</td>
<td>36.8-39.6</td>
</tr>
<tr>
<td>1.40-1.50</td>
<td>39.6-42.5</td>
</tr>
<tr>
<td>1.50-1.60</td>
<td>42.5-45.3</td>
</tr>
</tbody>
</table>

NOTES: (1) All test load weights are bone dry weights. (2) Allowable tolerance on the test load weights are ±0.10 lbs (0.05 kg).

3.3.3 For clothes washers with cold rinse only.

3.3.3.1 Record the actual bone dry weight of the test load (WI), then place the test load in the clothes washer.

3.3.3.2 Set water level selector to maximum fill.

3.3.3.3 Run the normal cycle.

3.3.3.4 Record the weight of the test load immediately after completion of the normal cycle (WC).

3.3.3.5 Calculate the remaining moisture content of the test load, RMC, expressed as a percentage and defined as:

\[ RMC = \left( \frac{WC - WI}{WI} \right) \times 100\% \]

3.3.4 For clothes washers with cold and warm rinse options.

3.3.4.1 Complete steps 3.3.3.1 through 3.3.3.4 for the cold rinse. Calculate the remaining moisture content of the test load for cold rinse, RMCcold, expressed as a percentage and defined as:

\[ RMC_{\text{cold}} = \left( \frac{WC_{\text{cold}} - WI_{\text{cold}}}{WI_{\text{cold}}} \right) \times 100\% \]

3.3.4.2 Complete steps 3.3.3.1 through 3.3.3.4 for the warm rinse. Calculate the remaining moisture content of the test load for warm rinse, RMCwarm, expressed as a percentage and defined as:

\[ RMC_{\text{warm}} = \left( \frac{WC_{\text{warm}} - WI_{\text{warm}}}{WI_{\text{warm}}} \right) \times 100\% \]

3.3.4.3 Calculate the remaining moisture content of the test load, RMC, expressed as a percentage and defined as:

\[ RMC = 0.73 \times RMC_{\text{cold}} + 0.27 \times RMC_{\text{warm}} \]

3.3.5 Clothes washers which have options that result in different RMC values, such as multiple selection of spin speeds or spin times that are available in the normal cycle,
shall be tested at the maximum and minimum settings of the available options, excluding any “no spin” (zero spin speed) settings, in accordance with requirements in 3.3.3 or 3.3.4. The calculated RMC<sub>max</sub> extraction and RMC<sub>min</sub> extraction at the maximum and minimum settings, respectively, shall be combined as follows and the final RMC to be used in section 4.2 shall be:

\[
RMC = 0.75 \times \text{RMC}_\text{max extraction} + 0.25 \times \text{RMC}_\text{min extraction}
\]

3.4 Data recording. Record for each test cycle in sections 3.2.1 through 3.3.5.

3.4.1 For non-water-heating clothes washers, record the kilowatt-hours of electrical energy, \(E_h\), consumed during the test to operate the clothes washer in section 3.2.3.1.2. For water-heating clothes washers record the kilowatt-hours of electrical energy, \(E_h\), consumed at maximum fill in section 3.2.3.2.

3.4.2 Record the individual gallons (or liters) of hot and cold water, \(V_{h_i}\), and \(V_{c_i}\), measured at maximum fill level for each wash/rinse temperature combination setting tested in section 3.2.3, or in both 3.2.3 and 3.2.4, excluding any fresh make-up water required to complete the fill during a suds-return cycle.

3.4.3 Record the individual gallons (or liters) of hot and cold water consumption, \(V_{h_i}\), and \(V_{c_i}\), measured at minimum fill level for each wash/rinse temperature combination, as provided in section 3.2.3.2.

3.4.4 Record the individual gallons (or liters) of hot and cold water, \(S_{h_i}\) and \(S_{c_i}\), measured at maximum fill for the suds-return cycle.

3.4.5 Record the individual gallons (or liters) of hot and cold water, \(S_{h_i}\) and \(S_{c_i}\), measured at minimum fill for the suds-return cycle.

3.4.6 Data recording requirements for RMC tests are listed in sections 3.3.3 through 3.3.5.

4. Calculation of Derived Results From Test Measurements

4.1 Energy consumption.

4.1.1 Per-cycle temperature-weighted hot water consumption for maximum and minimum water fill levels. Calculate for the cycle under test the per-cycle temperature weighted hot water consumption for the maximum water fill level, \(V_{\text{max}}\), and for the minimum water fill level, \(V_{\text{min}}\), expressed in gallons per cycle (or liters per cycle) and defined as:

\[
V_{\text{max}} = X_1 \sum_{i=1}^{n} [(V_{h_i} \times L) \times TUF_i] + X_2 \sum_{i=1}^{n} [TUF_W \times S_{h_i}]
\]

\[
V_{\text{min}} = X_1 \sum_{i=1}^{n} [(V_{h_i} \times L) \times TUF_i] + X_2 \sum_{i=1}^{n} [TUF_W \times S_{h_i}]
\]

where:

- \(V_{h_i}\) = reported hot water consumption in gallons per cycle (or liters per cycle) at maximum fill for each wash/rinse temperature combination setting, as provided in section 3.4.2. If a clothes washer is equipped with two or more different wash/rinse temperature selections that have the same basic temperature combination selection label (for example, one of them has its water temperature controlled by thermostatically controlled valves and the other does not), then the largest \(V_{h_i}\) shall be used for this calculation. If a clothes washer has lockouts, there will be “\(V_{h_i}\)’s” for wash/rinse temperature combination settings available in the normal cycle and “\(V_{h_i}\)’s” for wash/rinse temperature combination settings in the most energy intensive cycle.

- \(V_{h_i}\) = reported hot water consumption in gallons per cycle (or liters per cycle) at minimum fill for each wash/rinse temperature combination setting, as provided in section 3.4.3. If a clothes washer is equipped with two or more different wash/rinse temperature combination settings that have the same basic temperature combination selection label (for example, one of them has its water temperature controlled by thermostatically controlled valves and the other one does not), then the largest \(V_{h_i}\) shall be used for the calculation. If a clothes washer has lockouts, there will be “\(V_{h_i}\)’s” for wash/rinse temperature combination settings available in the normal cycle and “\(V_{h_i}\)’s” for wash/rinse temperature combination settings in the most energy intensive cycle.

- \(L\) = lockout factor to be applied to the reported hot water consumption. For wash/rinse temperature combination settings that are not locked out in the normal...
4.1.2 Total per-cycle hot water energy consumption for maximum and minimum water fill levels. Calculate the total per-cycle hot water energy consumption for the maximum water fill level, $E_{\text{max}}$, and for the minimum water fill level, $E_{\text{min}}$, expressed in kilowatt-hours per cycle and defined as:

$$E_{\text{max}} = [V_{h_{\text{max}}} \times T \times K \times MF]$$

$$E_{\text{min}} = [V_{h_{\text{min}}} \times T \times K \times MF]$$

where:
- $T$ = temperature rise = 90 °F (50 °C).
- $K$ = water specific heat = 0.00240 kWh/(gal–°F) [0.00114 kWh/(L–°C)].
- $V_{h_{\text{max}}}$ = as defined in section 4.1.1.
- $V_{h_{\text{min}}}$ = as defined in section 4.1.1.
- $MF$ = multiplying factor to account for absence of test load = 0.94 for top-loader vertical axis clothes washers that are sensor filled, 1.0 for all other clothes washers.

4.1.3 Total weighted per-cycle hot water energy consumption expressed in kilowatt-hours. Calculate the total weighted per cycle hot water energy consumption, $E_T$, expressed in kilowatt-hours per cycle and defined as:

$$E_T = [E_{\text{max}} \times F_{\text{max}}] + [E_{\text{min}} \times F_{\text{min}}]$$

where:
- $F_{\text{max}}$ = usage fill factor = 0.72.
- $F_{\text{min}}$ = usage fill factor = 0.28.
- $E_{\text{max}}$ = as defined in section 4.1.2.
- $E_{\text{min}}$ = as defined in section 4.1.2.

4.1.4 Per-cycle water energy consumption using gas-heated or oil-heated water. Calculate for the normal cycle the per-cycle energy consumption, $E_{T_G}$, using gas-heated or oil-heated water, expressed in Btu per cycle (or megajoules per cycle) and defined as:

$$E_{T_G} = E_T \times \frac{1}{e} \times \left[ \frac{3412 \text{ Btu}}{\text{kWh}} \right]$$

or

$$E_{T_G} = E_T \times \frac{1}{e} \times \left[ \frac{3.6 \text{ MJ}}{\text{kWh}} \right]$$

where:
- $e$ = nominal gas or oil water heater efficiency = 0.75.
- $E_T$ = as defined in section 4.1.3.

4.1.5 Per-cycle machine electrical energy consumption.

4.1.5.1 Non-water-heating clothes washers. The electrical energy value recorded for the maximum fill in section 3.4.1 is the per-cycle machine electrical energy consumption, $M_e$, expressed in kilowatt-hours per cycle.

4.1.5.2 Water-heating clothes washers.

4.1.5.2.1 Calculate for the cycle under test the per-cycle temperature weighted electrical energy consumption for the maximum water fill level, $E_{h_{\text{max}}}$, and for the minimum water fill level, $E_{h_{\text{min}}}$, expressed in kilowatt-hours per cycle and defined as:

$$E_{h_{\text{max}}} = \sum_{i=1}^{n} \left[ E_{h_i} \times TUF_i \right]$$

where:
- $E_{h_i}$ = reported electrical energy consumption in kilowatt-hours per cycle at maximum fill for each wash/cycle temperature combination setting, as provided in section 3.4.1.
- $TUF_i$ = applicable temperature use factor in section 5 or 6.
- $n$ = number of wash/rinse temperature combination settings available to the user for the clothes washer under test.
and

$$E_{h_{\text{max}}} = \sum_{j=1}^{n} \left[ E_{h_{j}} \times TUF_{j} \right]$$

where:

- $E_{h_{\text{min}}}$ is reported electrical energy consumption in kilowatt-hours per cycle at minimum fill for each wash/rinse temperature combination setting, as provided in section 3.4.1.
- $TUF_{j}$ is applicable temperature use factor in section 5 or 6.
- $n$ is as defined above in this section.

4.1.5.2.2 Weighted per-cycle machine electrical energy consumption. Calculate the weighted per cycle machine energy consumption, $M_{E}$, expressed in kilowatt-hours per cycle and defined as:

$$M_{E} = [E_{h_{\text{max}}} \times F_{\text{max}}] + [E_{h_{\text{min}}} \times F_{\text{min}}]$$

where:

- $F_{\text{max}}$ is as defined in section 4.1.3.
- $F_{\text{min}}$ is as defined in section 4.1.3.
- $E_{h_{\text{max}}}$ is as defined in section 4.1.5.2.1.
- $E_{h_{\text{min}}}$ is as defined in section 4.1.5.2.1.

4.1.6 Total per-cycle energy consumption when electrically heated water is used. Calculate for the normal cycle the total per-cycle energy consumption, $E_{TE}$, using electrically heated water, expressed in kilowatt-hours per cycle and defined as:

$$E_{TE} = E_{T} + M_{E}$$

where:

- $E_{T}$ is as defined in section 4.1.3.
- $M_{E}$ is as defined in section 4.1.5.1 or 4.1.5.2.2.

4.2 Per-cycle energy consumption for removal of RMC. Calculate the amount of energy per cycle required to remove RMC. Such amount is $D_{E}$, expressed in kilowatt-hours per cycle and defined as:

$$D_{E} = [(LAF) \times (\text{test load weight}) \times (\text{RMC} - 4\%) \times (\text{DEF}) \times (DUF)]$$

where:

- $LAF$ is load adjustment factor = 0.52.
- Test load weight is as shown in test load table in 3.3.2 expressed in lbs/cycle.
- $RMC$ is as defined in 3.3.3.5, 3.3.4.3, or 3.3.5.
- $DEF$ is nominal energy required for a clothes dryer to remove moisture from clothes = 0.5 kWh/lb (1.1 kWh/kg).
- $DUF$ is dryer usage factor, percentage of washer loads dried in a clothes dryer = 0.84.

4.3 Water consumption.

4.3.1 Per-cycle temperature-weighted water consumption for maximum and minimum water fill levels. To determine these amounts, calculate for the cycle under test the per-cycle temperature-weighted total water consumption for the maximum water fill level, $Q_{\text{max}}$, and for the minimum water fill level, $Q_{\text{min}}$, expressed in gallons per cycle (or liters per cycle) and defined as:

$$Q_{\text{max}} = X \sum_{i=1}^{n} \left[ (V_{h_{i}} + V_{c_{i}}) \times TUF_{i} \right] + X_{2} \left[ TUF_{w} \times (S_{H} + S_{c} + H) \right]$$

where:

- $V_{h_{i}}$ is hot water consumption in gallons per-cycle at maximum fill for each wash/rinse temperature combination setting, as provided in section 3.4.2.
- $V_{c_{i}}$ is total cold water consumption in gallons per-cycle at maximum fill for each wash/rinse temperature combination setting, cold wash/cold rinse cycle, as provided in section 3.4.2.
- $TUF_{i}$ is applicable temperature use factor in section 5 or 6.
- $TUF_{w}$ is temperature use factor for warm wash setting.

For clothes washers equipped with suds-saver feature:

- $X_{1}$ is frequency of use without suds-saver feature = 0.86
- $X_{2}$ is frequency of use with suds-saver feature = 0.14
- $S_{H}$ is fresh hot water make-up measured during suds-return cycle at maximum water fill level.
- $S_{c}$ is fresh cold water make-up measured during suds-return cycle at maximum water fill level.

For clothes washers not equipped with suds-saver feature:

- $X_{1} = 1.0$
- $X_{2} = 0.0$

and
\[
Q_{\text{min}} = \sum_{j=1}^{n} \left( (V_{hj} + V_{cj}) \times TUF_j \right) + X_2 \left[ TUF_w \times (S_{hL} + S_{cL}) \right]
\]

where:
- \(V_{hj}\): hot water consumption in gallons per cycle (or liters per cycle) at minimum fill for each wash/rinse temperature combination setting, as provided in section 3.4.3.
- \(V_{cj}\): cold water consumption in gallons per cycle (or liters per cycle) at minimum fill for each wash/rinse temperature combination setting, cold wash/cold rinse cycle, as provided in section 3.4.3.
- \(TUF_j\): applicable temperature use factor in section 5 or 6.
- \(S_{hL}\): fresh hot make-up water measured during suds-return cycle at minimum water fill level.
- \(S_{cL}\): fresh cold make-up water measured during suds-return cycle at minimum water fill level.

4.3.2 Total weighted per-cycle water consumption. To determine this amount, calculate the total weighted per cycle water consumption, \(Q_{r}\), expressed in gallons per cycle (or liters per cycle) and defined as:

\[
Q_r = Q_{\text{min}} \times F_{w1} + Q_{\text{max}} \times F_{w2}
\]

where:
- \(F_{w1}\): as defined in section 4.1.3.
- \(F_{w2}\): as defined in section 4.3.1.
- \(Q_{\text{min}}\): as defined in section 3.4.1.
- \(Q_{\text{max}}\): as defined in section 3.4.1.

4.3.3 Water consumption factor. The following calculates the water consumption factor, WCF, expressed in gallon per cycle per cubic foot (or liter per cycle per liter):

\[
\text{WCF} = Q_r / C
\]

where:
- \(C\): as defined in section 3.1.5.
- \(Q_r\): as defined in section 4.3.2.

4.4 Modified energy factor. The following calculates the modified energy factor, MEF, expressed in cubic feet per kilowatt-hours per cycle (or liters per kilowatt-hours per cycle):

\[
\text{MEF} = C / (M_E + E_T + D_E)
\]

where:
- \(C\): as defined in section 3.1.5.
- \(M_E\): as defined in section 4.1.5.1 or 4.1.5.2.2.
- \(E_T\): as defined in section 4.1.3.
- \(D_E\): as defined in section 4.2.

5. Applicable Temperature Use Factors for Determining Hot Water Usage for Various Wash/Rinse Temperature Selections for All Automatic Clothes Washers

5.1 Clothes washers with discrete temperature selections.

5.1.1 Five-temperature selection (n=5).

<table>
<thead>
<tr>
<th>Wash/rinse temperature setting</th>
<th>Temperature Use Factor (TUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot/Warm</td>
<td>0.18</td>
</tr>
<tr>
<td>Hot/Cold</td>
<td>0.12</td>
</tr>
<tr>
<td>Warm/Warm</td>
<td>0.30</td>
</tr>
<tr>
<td>Warm/Cold</td>
<td>0.25</td>
</tr>
<tr>
<td>Cold/Cold</td>
<td>0.15</td>
</tr>
</tbody>
</table>

5.1.2 Four-temperature selection (n=4).

<table>
<thead>
<tr>
<th>Wash/rinse temperature setting</th>
<th>Temperature Use Factor (TUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot/Warm</td>
<td>0.18</td>
</tr>
<tr>
<td>Hot/Cold</td>
<td>0.12</td>
</tr>
<tr>
<td>Warm/Warm</td>
<td>0.30</td>
</tr>
<tr>
<td>Warm/Cold</td>
<td>0.40</td>
</tr>
</tbody>
</table>

5.1.3 Three-temperature selection (n=3).

<table>
<thead>
<tr>
<th>Wash/rinse temperature setting</th>
<th>Temperature Use Factor (TUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot/Cold</td>
<td>0.12</td>
</tr>
<tr>
<td>Warm/Cold</td>
<td>0.55</td>
</tr>
<tr>
<td>Cold/Cold</td>
<td>0.15</td>
</tr>
</tbody>
</table>

4.5 Energy factor. Calculate the energy factor, EF, expressed in cubic feet per kilowatt-hours per cycle (or liters per kilowatt-hours per cycle), as:

\[
EF = \frac{C}{(M_E + E_T)}
\]

where:
- \(C\): as defined in section 3.1.5.
- \(M_E\): as defined in section 4.1.5.1 or 4.1.5.2.2.
- \(E_T\): as defined in section 4.1.3.
### 5.1.4 Two-temperature selection (n=2).

<table>
<thead>
<tr>
<th>Wash/rinse temperature setting</th>
<th>Temperature Use Factor (TUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold/Cold</td>
<td>0.15</td>
</tr>
<tr>
<td>Cold/Warm</td>
<td>0.25</td>
</tr>
<tr>
<td>Warm/Warm</td>
<td>0.55</td>
</tr>
<tr>
<td>Warm/Cold</td>
<td>0.30</td>
</tr>
<tr>
<td>Hot/Cold</td>
<td>0.15</td>
</tr>
<tr>
<td>Hot/Warm</td>
<td>0.09</td>
</tr>
<tr>
<td>Hot/Hot</td>
<td>0.05</td>
</tr>
<tr>
<td>Any</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### 5.1.5 One-temperature selection (n=1).

<table>
<thead>
<tr>
<th>Wash/rinse temperature setting</th>
<th>Temperature Use Factor (TUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cold/Cold</td>
<td>0.15</td>
</tr>
<tr>
<td>Warm/Cold</td>
<td>0.85</td>
</tr>
<tr>
<td>Warm/Warm</td>
<td>0.55</td>
</tr>
<tr>
<td>Any</td>
<td>1.00</td>
</tr>
</tbody>
</table>

### 5.2 Clothes washers with infinite temperature selections.

<table>
<thead>
<tr>
<th>Wash/rinse temperature setting</th>
<th>Temperature Use Factor (TUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extra-hot</td>
<td>0.05</td>
</tr>
<tr>
<td>Hot</td>
<td>0.80</td>
</tr>
<tr>
<td>Warm</td>
<td>0.55</td>
</tr>
<tr>
<td>Cold</td>
<td>0.15</td>
</tr>
</tbody>
</table>

### 6. Applicable Temperature Use Factors for Determining Hot Water Usage for Various Wash/Rinse Temperature Settings for All Semi-Automatic, Non-Water-Heating, Clothes Washers

### 6.1 Six-temperature settings (n=6).

<table>
<thead>
<tr>
<th>Wash/rinse temperature setting</th>
<th>Temperature Use Factor (TUF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot/Hot</td>
<td>0.15</td>
</tr>
<tr>
<td>Hot/Warm</td>
<td>0.09</td>
</tr>
<tr>
<td>Hot/Cold</td>
<td>0.06</td>
</tr>
<tr>
<td>Warm/Cold</td>
<td>0.42</td>
</tr>
<tr>
<td>Warm/Warm</td>
<td>0.13</td>
</tr>
<tr>
<td>Cold/Cold</td>
<td>0.15</td>
</tr>
</tbody>
</table>

### 7. Waivers and Field Testing

#### 7.1 Waivers and Field Testing for Non-conventional Clothes Washers

Manufacturers of non-conventional clothes washers, such as clothes washers with adaptive control systems, must submit a petition for waiver pursuant to 10 CFR 430.27 to establish an acceptable test procedure for that clothes washer. For these and other clothes washers that have controls or systems such that the DOE test procedures yield results that are so unrepresentative of the clothes washer’s true energy consumption characteristics as to provide materially inaccurate comparative data, field testing may be appropriate for establishing an acceptable test procedure. The following are guidelines for field testing which may be used by manufacturers in support of petitions for waiver. These guidelines are not mandatory and the Department may determine that they do not apply to a particular model. Depending upon a manufacturer’s approach for conducting field testing, additional data may be required. Manufacturers are encouraged to communicate with the Department prior to the commencement of field tests which may be used to support a petition for waiver.

#### 7.2 Non-conventional Wash System Energy Consumption Test

The field test may consist of a minimum of 10 of the nonconventional clothes washers (“test clothes washers”) and 10 clothes washers already being distributed in commerce (“base clothes washers”). The tests should include a minimum of 50 normal test cycles per clothes washer. The test clothes washers and base clothes washers should be identical in construction except for the controls or systems being tested. Equal numbers of both the test clothes washer and the base clothes washer should be tested simultaneously in comparable settings to minimize seasonal and/or consumer laundering conditions and/or variations. The clothes washers should be monitored in such a way as to accurately record the total energy consumption per cycle. At a minimum, the following should be measured and recorded throughout the test period for each clothes washer: Hot water usage in gallons (or liters), electrical energy usage in kilowatt-hours, and the cycles of usage. The field test results would be used to determine the best method to correlate the rating of the test clothes washer to the rating of the base clothes washer. If the base clothes washer is rated at A kWh per year, but field tests at B kWh per year, and the test clothes washer field tests at D kWh per year, the test unit would be rated as follows:

$$A \times (D/B) = G \text{ kWh per year}$$
### Definitions and Symbols

1. **Adaptive control system** means a clothes washer control system, other than an adaptive water fill control system, which is capable of automatically adjusting washer operation or washing conditions based on characteristics of the clothes load placed in the clothes container, without allowing or requiring consumer intervention or actions. The automatic adjustments may, for example, include automatic selection, modification, or control of any of the following: wash water temperature, agitation or tumble cycle time, number of rinse cycles, and spin speed. The characteristics of the clothes load, which could trigger such adjustments, could, for example, consist of or be indicated by the presence of either soil, soap, suds, or any other additive laundering substitute or complementary product.

2. **Adaptive water fill control system** means a clothes washer water fill control system which is capable of automatically adjusting the water fill level based on the size or weight of the clothes load placed in the clothes container, without allowing or requiring consumer intervention or actions.

3. **Bone-dry** means a condition of a load of test cloth which has been dried in a dryer at maximum temperature for a minimum of 10 minutes, removed and weighed before cool down, and then dried again for 10 minute periods until the final weight change of the load is 1 percent or less.

4. **Clothes container** means the compartment within the clothes washer that holds the clothes during the operation of the machine.

5. **Compact** means a clothes washer which has a clothes container capacity of less than 1.6 ft³ (45 L).

6. **Deep rinse cycle** means a rinse cycle in which the clothes container is filled with water to a selected level and the clothes load is rinsed by agitating it or tumbling it through the water.

7. **Energy test cycle** for a basic model means (A) the cycle recommended by the manufacturer for washing cotton or linen

### Sample Calculation

Calculate:

T_a = The total number of adaptive control normal test cycles run during the field test

T_m = The total number of manual control normal test cycles

The percentage weighting factors:

\[ P_a = \left( \frac{T_a}{T} \right) \times 100 \]

\[ P_m = \left( \frac{T_m}{T} \right) \times 100 \]

Energy consumption values, E_a, E_m, and D_c (if desired) calculated in section 4 for the manual and adaptive modes, should be combined using \( P_a \) and \( P_m \) as the weighting factors.

### Sunset

The provisions of this appendix J expire on December 31, 2003.

---

APPENDIX J1 TO SUBPART B OF PART 430—UNIFORM TEST METHOD FOR MEASURING THE ENERGY CONSUMPTION OF AUTOMATIC AND SEMI-AUTOMATIC CLOTHES WASHERS

The provisions of this appendix J1 shall apply to products manufactured beginning January 1, 2004.

1. **Adaptive control system**

2. **Adaptive water fill control system**

3. **Bone-dry**

4. **Clothes container**

5. **Compact**

6. **Deep rinse cycle**

7. **Energy test cycle**