



ENERGY STAR® Program Requirements Product Specification for Residential Clothes Washers

Draft 1 Test Method for Determining Residential Clothes Washer Cleaning Performance October 2016

1. OVERVIEW

The following test method shall be used for determining the cleaning performance of residential clothes washers that meet the ENERGY STAR Eligibility Criteria for Clothes Washers. Cleaning performance shall be determined on the same test units immediately following the energy and water consumption tests for ENERGY STAR qualification. Cleaning performance is measured under test conditions that are consistent with the test conditions used to determine the energy and water performance.

Note: DOE recognizes that it is desirable to measure clothes washer cleaning performance under the same test conditions as specified in the DOE clothes washer test procedure (10 CFR 430, Subpart B, Appendix J2, referred to here as "Appendix J2") to minimize test burden and ensure that performance metrics are relevant to certified energy and water use.

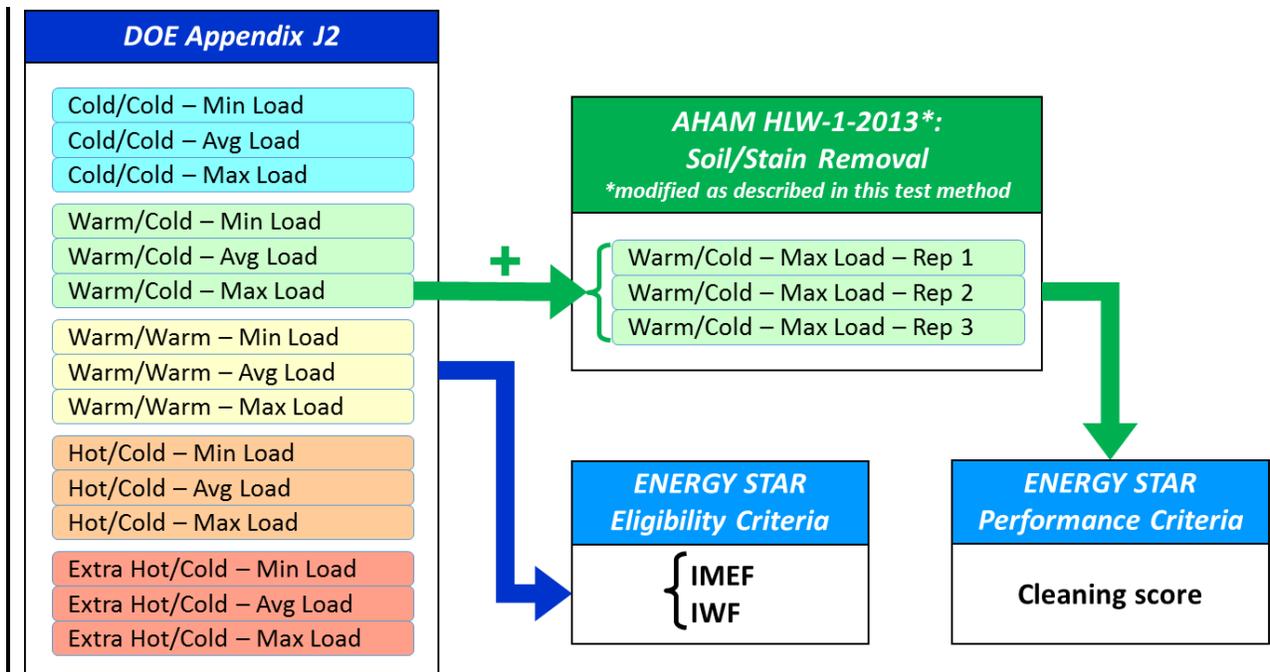
Appendix J2 does not contain a procedure for measuring cleaning performance; therefore, this proposed ENERGY STAR test method incorporates modified procedures from the Association of Home Appliance Manufacturers (AHAM) test method HLW-1-2013, "Performance Evaluation Procedures for Household Clothes Washers" (referred to here as "AHAM HLW-1-2013"). Specifically, the proposed test method incorporates the Soil/Stain Removal Test from AHAM HLW-1-2013, performed using DOE test cloth rather than the 100% cotton load specified in AHAM HLW-1-2013, and with detergent as specified in AHAM HLW-1-2013.

Structure of the Proposed Test Method

Cleaning performance would be measured using the hottest Warm Wash/Cold Rinse temperature selection and maximum load size test cycle defined in Section 3.5.1 of Appendix J2 (hereafter referred to as the "Warm/Cold Max Load cycle"). As proposed, cleaning performance would be measured separately from energy and water consumption, immediately after performing all test cycles required for Appendix J2. DOE recognizes that measuring cleaning performance concurrently with energy and water consumption would provide the strongest linkage between cleaning performance results and certified energy and water use. However, the energy and water use of residential clothes washers must be certified using the existing version of Appendix J2, which does not incorporate any aspects of cleaning performance. DOE invites comment on an alternative proposal presented below that would provide a more direct link between energy, water, and cleaning performance.

Justification for proposing the use of the Warm/Cold Max Load cycle to measure cleaning performance is provided later in this document.

Figure 1 below illustrates the structure of the proposed test method in terms of the test cycles that would be performed for each purpose. The diagram shows how the resulting cleaning performance score relates to the existing Integrated Modified Energy Factor (IMEF) and Integrated Water Factor (IWF).



34
35 **Figure 1. Structure of Proposed Test Method**

36 AHAM HLW-1-2013 requires performing three replications of any given load condition; therefore, three
37 replications of the Warm/Cold Max Load cycle would be performed.

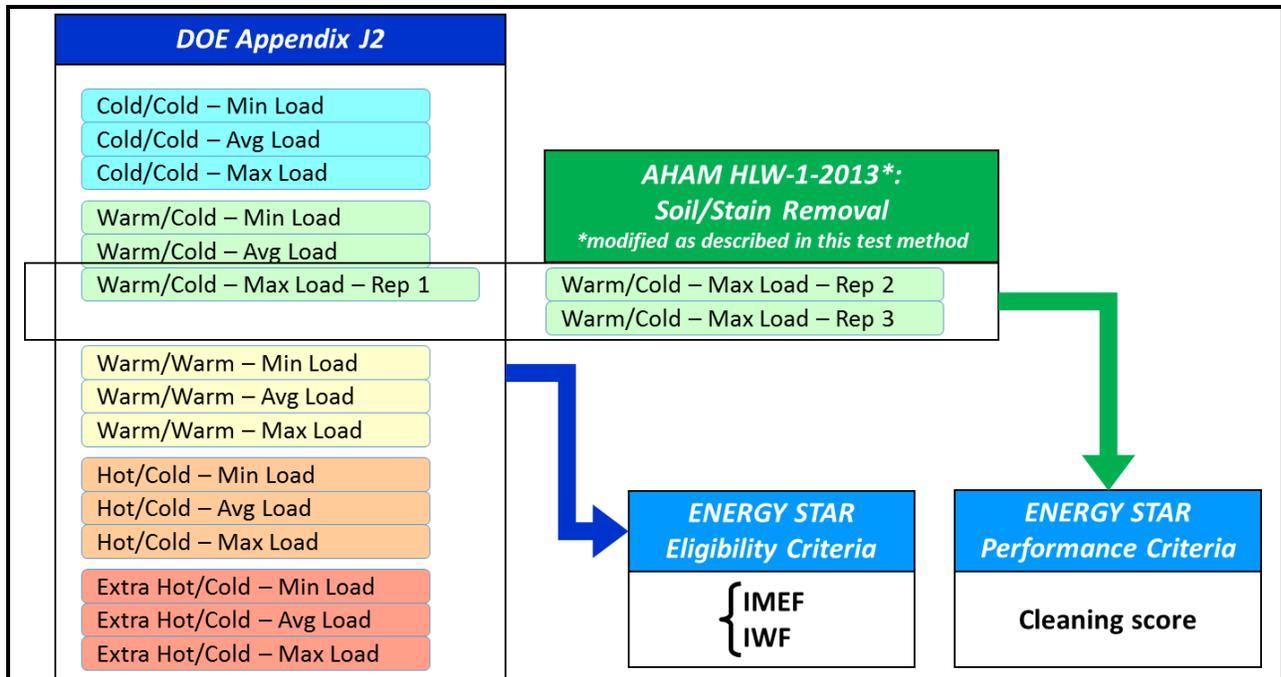
38 As proposed, this test method would require three additional wash cycle runs beyond those required for
39 measuring energy and water use in accordance with Appendix J2.

40 **Note:**

41 *Structure of Alternative Test Method*

42 DOE invites comment on an alternative structure for the cleaning performance test method, which would
43 further integrate energy and water use with cleaning performance. In this alternative method, energy and
44 water consumption would be measured concurrently with cleaning performance on the first replication of
45 the Warm/Cold Max Load cycle. Figure 2 below illustrates the structure of this alternative test method in
46 terms of the test cycles that would be performed for each purpose.

47



48 **Figure 2. Structure of Alternative Test Method**

49 For this alternative method, cold water, hot water, and electrical energy use would be measured during
 50 the first cleaning performance replication and the values would be used to represent the Warm/Cold Max
 51 Load cycle in Section 3.5.1 of Appendix J2 and subsequent calculations. This alternative test method
 52 would require two additional wash cycle runs beyond those required for measuring energy and water use
 53 in accordance with Appendix J2.

54
 55 DOE recognizes that the presence of detergent and the added weight of the test strips in the Warm/Cold
 56 Max Load cycle may impact the energy and water consumption results for that cycle, and subsequently
 57 the overall calculations of IMEF and IWF. However, DOE believes that any such impact on the results of
 58 the Warm/Cold Max Load cycle would be minor, and the subsequent impact on the overall IMEF and IWF
 59 calculations would be insignificant.

60 DOE invites input on how the presence of detergent and test strips in the Warm/Cold Max Load cycle
 61 might impact the energy and water results of that cycle and the overall IMEF and IWF calculations.

62 DOE invites comment on the suitability of using the water and electrical energy consumption
 63 measurements obtained during the first replication of the cleaning performance test to represent the
 64 hottest Warm/Cold Max Load cycle in Section 3.5.1 of Appendix J2.

65
 66 **Note:** DOE also invites comment on whether the Rinsing Effectiveness Test, as identified in AHAM HLW-
 67 1-2013, should be included in this test method to evaluate rinsing performance.

68 2. APPLICABILITY

69 The proposed test method shall be used to determine the cleaning performance of residential clothes
 70 washers within the ENERGY STAR program.

71 3. DEFINITIONS

72 Unless otherwise specified, all terms used in this document are consistent with the definitions in:

- 73 (1) ENERGY STAR Program Requirements, Product Specification for Clothes Washers, Eligibility
74 Criteria Version 8.0
- 75 (2) U.S. Department of Energy (DOE) test procedure at 10 CFR 430, Subpart B, Appendix J2,
76 "Uniform Test Method for Measuring the Energy Consumption of Automatic and Semi-Automatic
77 Clothes Washers." ("Appendix J2")
- 78 (3) Association of Home Appliance Manufacturers (AHAM) HLW-1-2013, "Performance Evaluation
79 Procedures for Household Clothes Washers." ("AHAM HLW-1-2013")

80 **Note:** This ENERGY STAR test method incorporates definitions from the multiple sources listed above.
81 DOE has evaluated the definitions contained within the referenced publications and did not find any
82 contradictions between the sources.

83 A) Acronyms and Units:

- 84 1) AHAM: Association of Home Appliance Manufacturers
- 85 2) CFR: Code of Federal Regulations
- 86 3) DOE: U.S. Department of Energy
- 87 4) IMEF: Integrated Modified Energy Factor
- 88 5) IWF: Integrated Water Factor
- 89 6) UUT: Unit under test

90 B) Definitions:

- 91 1) Performance Test Load: The maximum load size of energy test cloth as defined in Table 5.1
92 of Appendix J2, based on the UUT's capacity as measured in Section 3.1 of Appendix J2,
93 plus the required amount of soil/stain removal test strips, as determined in Section 4.D of this
94 test method.
- 95 2) Total Cleaning Score: A measure of soil/stain removal that represents an average of
96 individual cleaning scores from soil/stain removal test strip swatches of different stain types.
97 An individual cleaning score represents the ratio of the cleaning performance of the UUT to a
98 calibrated reference level. A higher Total Cleaning Score represents better soil/stain removal
99 (*i.e.*, better cleaning performance).

100 **4. TEST SETUP**

101 Testing conditions, instrumentation, and materials for all portions of this method shall follow Section 2 of
102 Appendix J2, with the following additions.

103 A) Test Conditions

- 104 1) Maintain the supply water hardness as specified in Section 4.5.3 of AHAM HLW-1-2013.

105 **Note:** AHAM HLW-1-2013 specifies a water hardness limit of 50 parts per million (ppm) or less. Appendix
106 J2 does not provide water hardness specifications for the wash cycles performed as part of the energy
107 test cycle; however, Section 2.7.3 of Appendix J2 specifies a water hardness limit of 17 ppm or less for
108 pre-conditioning DOE energy test cloth.

109 B) Instrumentation and Equipment

- 110 1) The scale used for weighing test cloth must have a resolution of no larger than 0.2 oz. (5.7 g)
111 and a maximum error no greater than 0.1 percent of the measured value.

112 **Note:** Appendix J2 requires the test load weighing equipment to provide accuracy to within $\pm 0.3\%$;
113 whereas AHAM HLW-1-2013 requires a greater level of accuracy, to within $\pm 0.1\%$. DOE believes that
114 specifying a greater accuracy for the load-weighing equipment may produce more accurate and

115 repeatable results for cleaning performance testing, and invites stakeholder comment on the benefits and
 116 test burden of requiring such equipment.

- 117 2) The scale used for weighing detergent must be in accordance with the specifications in
 118 Section 6.2.d of AHAM HLW-1-2013.
- 119 3) The Tristimulus Colorimeter/Spectrocolorimeter used to measure post-wash reflectance must
 120 be in accordance with the specifications in Annex A, Section A.10 of AHAM HLW-1-2013.
- 121 4) The sewing machine or stapling equipment for attaching soil/stain removal test strips to load
 122 items must be in accordance with the specifications in Section 6.2.c of AHAM HLW-1-2013.

123 C) Test Materials: Detergent

- 124 1) Detergent formulation, concentration and storage specifications must be in accordance with
 125 Section 4.7 of AHAM HLW-1-2013.
- 126 2) When loading the detergent into the clothes washer, follow Section 6.6.4.1 of AHAM HLW-1-
 127 2013 for a clothes washer with a detergent dispenser or Section 6.6.4.2 of AHAM HLW-1-
 128 2013 for a clothes washer without a detergent dispenser.

129 D) Test Materials: Soil/Stain Removal Test Strips

- 130 1) Soil/stain removal test strips (hereafter referred to as “test strips”) must be in accordance with
 131 Annex A, Sections A.6 and A.7 of AHAM HLW-1-2013.
- 132 2) Mark each test strip with a unique identifying reference in accordance with Section 6.5.6 of
 133 AHAM HLW-1-2013.
- 134 3) Table 1 of this test method indicates the quantity of test strips to use based on the capacity of
 135 the UUT, as measured in Section 3.1 of Appendix J2, and the associated maximum load size.

136 **Table 1: Number of test strips based on clothes washer capacity**

Container volume		Maximum load	Number of test strips
<i>cu. ft.</i>		<i>lb.</i>	
≥	<		
0	0.80	3.00	2
0.80	0.90	3.50	
0.90	1.00	3.90	
1.00	1.10	4.30	
1.10	1.20	4.70	
1.20	1.30	5.10	3
1.30	1.40	5.50	
1.40	1.50	5.90	
1.50	1.60	6.40	
1.60	1.70	6.80	
1.70	1.80	7.20	4
1.80	1.90	7.60	
1.90	2.00	8.00	
2.00	2.10	8.40	
2.10	2.20	8.80	
2.20	2.30	9.20	5
2.30	2.40	9.60	
2.40	2.50	10.00	
2.50	2.60	10.50	
2.60	2.70	10.90	
2.70	2.80	11.30	6
2.80	2.90	11.70	
2.90	3.00	12.10	
3.00	3.10	12.50	

3.10	3.20	12.90	
3.20	3.30	13.30	
3.30	3.40	13.70	
3.40	3.50	14.10	7
3.50	3.60	14.60	
3.60	3.70	15.00	
3.70	3.80	15.40	
3.80	3.90	15.80	8
3.90	4.00	16.20	
4.00	4.10	16.60	
4.10	4.20	17.00	
4.20	4.30	17.40	
4.30	4.40	17.80	9
4.40	4.50	18.20	
4.50	4.60	18.70	
4.60	4.70	19.10	
4.70	4.80	19.50	
4.80	4.90	19.90	10
4.90	5.00	20.30	
5.00	5.10	20.70	
5.10	5.20	21.10	
5.20	5.30	21.50	
5.30	5.40	21.90	11
5.40	5.50	22.30	
5.50	5.60	22.80	
5.60	5.70	23.20	
5.70	5.80	23.60	
5.80	5.90	24.00	12
5.90	6.00	24.40	

137

138 **Note:** The number of test strips is based on the maximum load size in Table 5.1 of Appendix J2 and is
139 consistent with the number of test strips per pound of load provided in Table 2 of AHAM HLW-1-2013.
140 DOE linearly extrapolated Table 2 of AHAM HLW-1-2013 beyond 20lb. loads to include quantities for all
141 capacities currently included in Table 5.1 of Appendix J2. See Section 5 of this test method for a
142 discussion on use of the maximum load size.

143 E) Loading the Performance Test Load

- 144 1) Attach each test strip to an energy test cloth from the maximum test load, as defined in Table
145 5.1 of Appendix J2, in accordance with Section 6.5.7 of AHAM HLW-1-2013, substituting
146 “energy test cloth” for “towel.”
- 147 2) Fold the energy test cloths with attached test strips in accordance with Figure 1 of AHAM
148 HLW-1-2013, substituting “energy test cloth” for “towel.”
- 149 3) Load the test cloths as follows:
- 150 a) Top-loading clothes washer: Load 7 test cloths without test strips followed by 1 test cloth
151 with an attached test strip, ensuring an even distribution of test cloths without test strips,
152 and that test cloths with attached test strips are not placed on top of each other. Repeat
153 this sequence until the final test cloth with an attached test strip is loaded; the last
154 sequence may include fewer than 7 test cloths without test strips. Load any remaining
155 test cloths without test strips, including any energy stuffer cloths, on top.
- 156 i) To load test cloths without test strips, follow the instructions provided in Section
157 2.9.2.1 of Appendix J2.

- 158 ii) To load test cloths with attached test strips, follow the instructions provided in
 159 Sections 5.3.2.2 and 5.3.2.2.2 of AHAM HLW-1-2013. Test cloths with attached test
 160 strips must be placed in one of the 4 quadrants around the vertical axis, shown in
 161 Figure 11 of AHAM HLW-1-2013. Place the first test cloth with an attached test strip
 162 in the left quadrant; the second test cloth with an attached test strip in the back
 163 quadrant; and so forth, placing each subsequent test cloth with an attached test strip
 164 in the next quadrant in the clockwise direction.
- 165 b) Front-loading clothes washer: Load 14 test cloths without test strips followed by 2 test
 166 cloths with attached test strips, ensuring an even distribution of test cloths without test
 167 strips. Repeat this sequence until the final test cloths with attached test strips are loaded;
 168 the last sequence may include fewer than 14 test cloths without test strips, or only one
 169 test cloth with an attached test strip. Load any remaining test cloths without test strips,
 170 including any energy stuffer cloths, on top.
- 171 i) To load test cloths without test strips, use alternating orientations according to the
 172 “towels” illustration in Figure 9 of AHAM HLW-1-2013.
- 173 ii) To load test cloths with attached test strips, follow the instructions provided in
 174 Sections 5.3.2.2 and 5.3.2.2.1 of AHAM HLW-1-2013. Test cloths with attached test
 175 strips must be placed into the UUT according to Figure 10 of AHAM HLW-1-2013. If
 176 an odd number of test strips are required, position the last test cloth with an attached
 177 test strip midway between the front and back of the wash drum.

Note: DOE has included loading instructions for the performance test load because no test strip loading instructions are available in Appendix J2. Where possible, DOE has referenced loading instructions from Appendix J2, which are generally applicable to loading DOE test cloth into clothes washers. Test cloths with attached test strips are to be loaded in accordance with AHAM HLW-1-2013.

As noted above, AHAM HLW-1-2013 specifies the use of 1 test strip for every 2 lb. of test load. Based on the fabric weight specifications for DOE energy test cloth in Section 2.7.4.3 of Appendix J2, 2 lb. of test load corresponds to approximately 8 energy test cloths. Therefore, each test strip is accompanied by 8 energy test cloths.

DOE has proposed loading sequences for test loads that would ensure a) even loading of test cloths without test strips, b) even distribution of test cloths with attached test strips throughout the test load, and c) consistent and repeatable loading conditions. DOE is aware that the loading sequence can influence performance results and requests stakeholder comments on specific experience regarding the impacts of the loading sequence on the repeatability and reproducibility of cleaning performance results.

5. TEST METHOD

The hottest Warm Wash/Cold Rinse (“Warm/Cold”) temperature selection used for Section 3.5.1 of Appendix J2 shall be performed 3 times immediately after performing all test cycles required for Appendix J2, as follows:

- A) Use the performance test load and detergent, as specified in Sections 3.B.1 and 4.C of this test method.
- B) After completion of each wash cycle separate the test strips from the test cloth and dry them according to Sections 6.6.6 and 6.6.7 of AHAM HLW-1-2013.
 - 1) Measure the post-wash reflectance of each soiled swatch on each test strip according to Section 6.6.8 of AHAM HLW-1-2013.

Note: DOE proposes testing only the Warm/Cold temperature selection for cleaning performance because this temperature selection has the highest consumer usage factor according to Table 4.1.1 in Appendix J2. DOE believes that this will provide an appropriate tradeoff between minimizing test burden and maintaining test conditions that are most representative of consumer usage.

205 DOE invites comment on whether the cleaning test results obtained from the Warm/Cold cycle would
206 sufficiently distinguish performance among clothes washer models at different efficiency levels.

207 DOE also invites comment on whether requiring testing of only the Warm/Cold temperature selection
208 represents an appropriate tradeoff between minimizing test burden while maintaining test conditions
209 representative of consumer usage.

210 **Note:** DOE proposes testing cleaning performance using the maximum test load size. DOE recognizes
211 that for clothes washers with automatic water fill control systems, the average test load size has the
212 highest consumer usage factor according to Table 4.1.3 in Appendix J2. However, DOE believes that a
213 number of other factors support using the maximum test load size, including the following:

214 1. For clothes washers with manual water fill control systems, the maximum load size has the highest
215 consumer usage factor. By testing with the maximum load size for all clothes washers, the cleaning
216 performance results will be comparable regardless of which type of water fill control system is used.

217 2. The maximum load size represents the most challenging cleaning burden that a clothes washer
218 would experience under the test conditions of AHAM HLW-1-2013.

219 3. The maximum load size is based on the maximum capacity of the clothes container, which is used
220 to calculate IMEF and IWF.

221 4. The maximum capacity of the clothes container is a key feature of a clothes washer that is
222 advertised to the consumer.

223 DOE invites comment on the appropriateness of using the maximum load size for measuring cleaning
224 performance.

225 6. CALCULATIONS AND SCORING

226 Calculation of results shall be as follows:

227 A) Total Cleaning Score: Calculate a Total Cleaning Score for the UUT in accordance with Section
228 6.7 and Figure 14 of AHAM HLW-1-2013, using the post-wash reflectance values obtained in
229 Section 5.B.1 of this test method.

230 7. REFERENCES

231 A) AHAM HLW-1-2013. "Performance Evaluation Procedures for Household Clothes Washers"

232 B) DOE Appendix J2 to Subpart B of 10 CFR 430, "Uniform Test Method for Measuring the Energy
233 Consumption of Automatic and Semi-Automatic Clothes Washers"