



ENERGY STAR® Program Requirements Product Specification for Residential Clothes Washers

Final Draft Test Method for Determining Residential Clothes Washer Cleaning Performance February 2017

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.

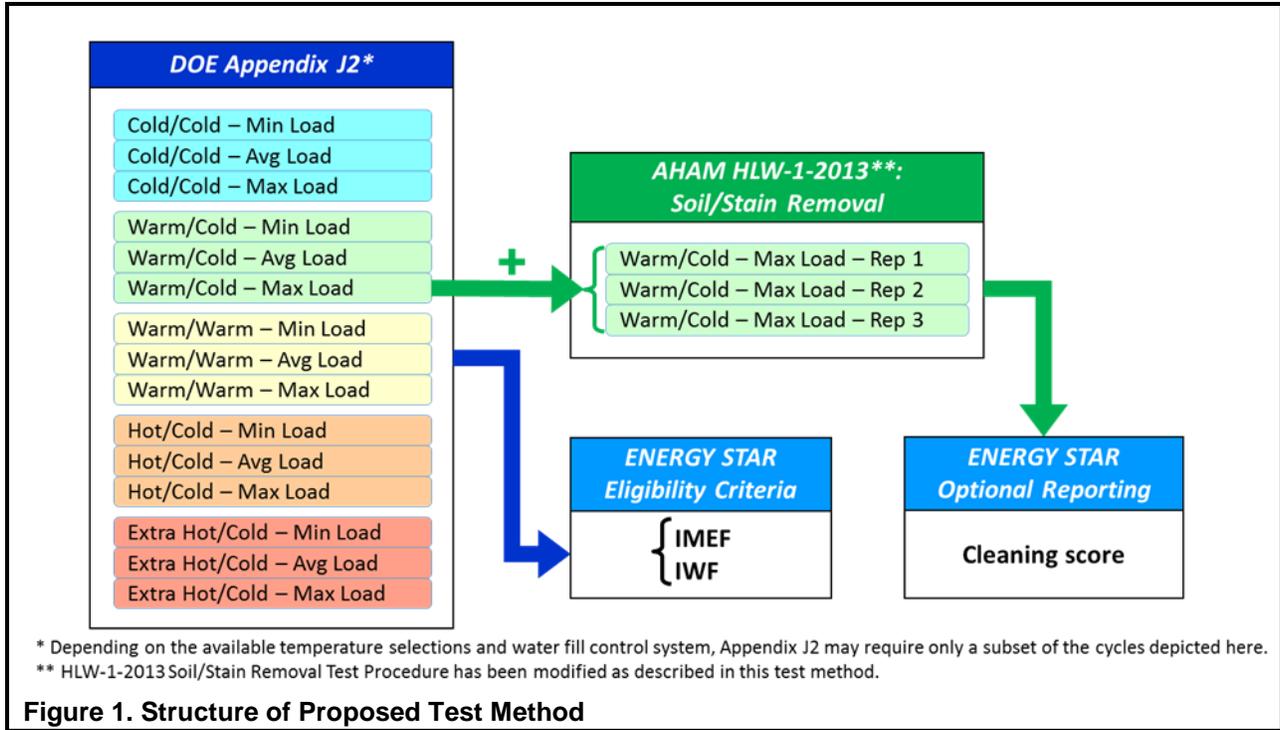
Note: DOE maintains its proposal from Draft 1 to incorporate the Soil/Stain Removal Test from the Association of Home Appliance Manufacturers (AHAM) test method HLW-1-2013, "Performance Evaluation Procedures for Household Clothes Washers" (referred to here as "AHAM HLW-1-2013"), performed using the same test conditions as specified in the DOE clothes washer test procedure (10 CFR 430, Subpart B, Appendix J2, referred to here as "Appendix J2"), and DOE test cloth.

The overall structure of this Test Method has not changed since Draft 1. DOE has, however, incorporated some minor changes to the test method based on stakeholder comments received during the Draft 1 webinar and subsequent written comments.

In this Final Draft version, DOE maintains its proposal to measure cleaning performance 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"). Cleaning performance will be measured over three replications, separately from energy and water consumption, immediately after performing all test cycles required for Appendix J2. This approach represents the primary approach proposed in Draft 1. In this Final Draft version, DOE is no longer considering the alternative method proposed in Draft 1, in which energy and water consumption for the Warm/Cold Max Load cycle would have been measured simultaneously with cleaning performance during the first cleaning performance replication.

Figure 1 below, which represents the same information presented in Draft 1, 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). DOE is also including this diagram at the end of this test method, in a new Appendix A section, to provide added clarity in the final version of the test method.

29



30
31

32

Note: This Final Draft version maintains the proposal from Draft 1 for measuring soil and stain removal; *i.e.*, “cleaning performance.” DOE received comments from stakeholders regarding other important performance metrics such as rinsing effectiveness, mechanical action, and cycle time. DOE addresses these comments in the accompanying Stakeholder Comment Matrix.

37 2. APPLICABILITY

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

40 3. DEFINITIONS

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

- 42 (1) ENERGY STAR Program Requirements, Product Specification for Clothes Washers, Eligibility
43 Criteria Version 8.0
- 44 (2) U.S. Department of Energy (DOE) test procedure at 10 CFR 430, Subpart B, Appendix J2,
45 “Uniform Test Method for Measuring the Energy Consumption of Automatic and Semi-Automatic
46 Clothes Washers.” (“Appendix J2”)
- 47 (3) Association of Home Appliance Manufacturers (AHAM) HLW-1-2013, “Performance Evaluation
48 Procedures for Household Clothes Washers.” (“AHAM HLW-1-2013”)

49 A) Acronyms and Units:

- 50 1) AHAM: Association of Home Appliance Manufacturers
- 51 2) CFR: Code of Federal Regulations
- 52 3) DOE: U.S. Department of Energy
- 53 4) IMEF: Integrated Modified Energy Factor

54 5) IWF: Integrated Water Factor

55 6) UUT: Unit under test

56 B) Definitions:

57 1) Performance Test Load: The maximum load size of energy test cloth as defined in Table 5.1
58 of Appendix J2, based on the UUT's capacity as measured in Section 3.1 of Appendix J2,
59 plus the required amount of soil/stain removal test strips, as determined in Section 4.E of this
60 test method.

61 2) Total Cleaning Score: A measure of soil/stain removal that represents an average of
62 individual cleaning scores from soil/stain removal test strip swatches of different stain types.
63 An individual cleaning score represents the ratio of the cleaning performance of the UUT to a
64 calibrated reference level. A higher Total Cleaning Score represents better soil/stain removal
65 (*i.e.*, better cleaning performance).

66 4. TEST SETUP

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

69 A) Test Conditions

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

71 **Note:** This Final Draft version maintains the proposal from Draft 1 to use the water hardness limit
72 specified in HLW-1-2013. DOE received comments from stakeholders regarding the water hardness
73 requirement and addresses these comments in the accompanying Stakeholder Comment Matrix.

74 B) Instrumentation and Equipment

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

77 2) The scale used for weighing detergent must be in accordance with the specifications in
78 Section 6.2.d of AHAM HLW-1-2013.

79 3) The Tristimulus Colorimeter/Spectrocolorimeter used to measure post-wash reflectance must
80 be in accordance with the specifications in Annex A, Section A.10 of AHAM HLW-1-2013.

81 4) The sewing machine or stapling equipment for attaching soil/stain removal test strips to load
82 items must be in accordance with the specifications in Section 6.2.c of AHAM HLW-1-2013.

83 C) Test Materials: Test Cloth

84 1) The test cloth must be in accordance with the specifications in Sections 2.7 and 2.8 of
85 Appendix J2.

86 **Note:** DOE added the above section C in response to comments made by stakeholders during the Draft 1
87 webinar that the conditions of use of the test cloth were ambiguous. DOE notes that this newly added
88 specification is consistent with Draft 1, which included the introductory statement after the Section 4
89 heading above, specifying that all materials must follow Section 2 of Appendix J2. This newly added
90 section C provides added clarity that the test cloth specifications in Sections 2.7 and 2.8 of Appendix J2
91 apply here.

92 D) Test Materials: Detergent

93 1) Detergent formulation, concentration and storage specifications must be in accordance with
94 Section 4.7 of AHAM HLW-1-2013.

95 2) When loading the detergent into the clothes washer, follow Section 6.6.4.1 of AHAM HLW-1-
 96 2013 for a clothes washer with a detergent dispenser or Section 6.6.4.2 of AHAM HLW-1-
 97 2013 for a clothes washer without a detergent dispenser.

98 E) Test Materials: Soil/Stain Removal Test Strips

99 1) Soil/stain removal test strips (hereafter referred to as “test strips”) must be in accordance with
 100 Annex A, Sections A.6 and A.7 of AHAM HLW-1-2013.

101 **Note:** In response to Draft 1, stakeholders commented that the final cleaning score may be impacted by
 102 the manufacturer and/or lot number of the test strips, as well as the detergent batch. Based on these
 103 concerns, EPA/DOE are adding a recommendation that the details of the test strips (e.g. manufacturer
 104 and lot number) and detergent batch must accompany the reported Total Cleaning Score. This
 105 information will provide important context with which to compare cleaning performance scores among
 106 different clothes washer models.

107 2) Mark each test strip with a unique identifying reference in accordance with Section 6.5.6 of
 108 AHAM HLW-1-2013.

109 3) Table 1 of this test method indicates the quantity of test strips to use based on the capacity of
 110 the UUT, as measured in Section 3.1 of Appendix J2, and the associated maximum load size.

111 **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	7
3.30	3.40	13.70	
3.40	3.50	14.10	
3.50	3.60	14.60	
3.60	3.70	15.00	
3.70	3.80	15.40	8
3.80	3.90	15.80	

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	12
5.80	5.90	24.00	
5.90	6.00	24.40	

112

113 F) Loading the Performance Test Load

114 1) Attach each test strip to an energy test cloth from the maximum test load, as defined in Table
 115 5.1 of Appendix J2, in accordance with Section 6.5.7 of AHAM HLW-1-2013, substituting
 116 “energy test cloth” for “towel.”

117 2) Fold the energy test cloths with attached test strips in accordance with Figure 1 of AHAM
 118 HLW-1-2013, substituting “energy test cloth” for “towel.”

119 3) Load the test cloths as follows:

120 a) Top-loading clothes washer: Load 7 test cloths without test strips followed by 1 test cloth
 121 with an attached test strip, ensuring an even distribution of test cloths without test strips,
 122 and that test cloths with attached test strips are not placed on top of each other. Repeat
 123 this sequence until the final test cloth with an attached test strip is loaded; the last
 124 sequence may include fewer than 7 test cloths without test strips. Load any remaining
 125 test cloths without test strips, including any energy stuffer cloths, on top.

126 i) To load test cloths without test strips, follow the instructions provided in Section
 127 2.9.2.1 of Appendix J2.

128 ii) To load test cloths with attached test strips, follow the instructions provided in
 129 Sections 5.3.2.2 and 5.3.2.2.2 of AHAM HLW-1-2013. Test cloths with attached test
 130 strips must be placed in one of the 4 quadrants around the vertical axis, shown in
 131 Figure 11 of AHAM HLW-1-2013. Place the first test cloth with an attached test strip
 132 in the left quadrant; the second test cloth with an attached test strip in the back
 133 quadrant; and so forth, placing each subsequent test cloth with an attached test strip
 134 in the next quadrant in the clockwise direction.

135 b) Front-loading clothes washer: Load 14 test cloths without test strips followed by 2 test
 136 cloths with attached test strips, ensuring an even distribution of test cloths without test
 137 strips. Repeat this sequence until the final test cloths with attached test strips are loaded;
 138 the last sequence may include fewer than 14 test cloths without test strips, or only one
 139 test cloth with an attached test strip. Load any remaining test cloths without test strips,
 140 including any energy stuffer cloths, on top.

- 141 i) To load test cloths without test strips, use alternating orientations according to the
142 “towels” illustration in Figure 9 of AHAM HLW-1-2013.
- 143 ii) To load test cloths with attached test strips, follow the instructions provided in
144 Sections 5.3.2.2 and 5.3.2.2.1 of AHAM HLW-1-2013. Test cloths with attached test
145 strips must be placed into the UUT according to Figure 10 of AHAM HLW-1-2013. If
146 an odd number of test strips are required, position the last test cloth with an attached
147 test strip midway between the front and back of the wash drum.

148 **Note:** This Final Draft version maintains the proposed loading instructions from Draft 1.

149 5. TEST METHOD

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

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

159 **Note:** This Final Draft version maintains the proposal from Draft 1 to measure cleaning performance using
160 the Warm/Cold Max Load cycle. DOE received comments from stakeholders regarding the use of the
161 Warm/Cold Max Load cycle and addresses these comments in the accompanying Stakeholder Comment
162 Matrix.

163 6. CALCULATIONS AND SCORING

164 Calculation of results shall be as follows:

- 165 A) Total Cleaning Score: Calculate a Total Cleaning Score (CS_i) for the UUT in accordance with
166 Section 6.7 and Figure 14 of AHAM HLW-1-2013, using the post-wash reflectance values
167 obtained in Section 5.B.1 of this test method.
- 168 1) Round the Total Cleaning Score to the nearest 0.1.

169 **Note:** This Final Draft version adds a rounding requirement for the Total Cleaning Score, which was
170 inadvertently omitted from Draft 1. DOE is proposing to round the Total Cleaning Score to the nearest
171 0.1, which is consistent with the International Electrotechnical Commission (IEC) Standard: Clothes
172 washing machines for household use (“IEC 60456”), from which much of the AHAM HLW-1-2013
173 procedure is derived. Section 9.2e of IEC 60456 specifies rounding the cleaning performance score
174 “q” to the nearest 0.001. The score “q” in IEC 60456 is conceptually similar (albeit calculated using a
175 slightly different formula) to the Total Cleaning Score CS_i in section 6.7 of AHAM HLW-1-2013. The
176 formula for calculating CS_i includes a multiplication factor of 100% to scale the values up; therefore,
177 rounding to 0.1 in AHAM HLW-1-2013 is equivalent to rounding to 0.001 in IEC 60456.

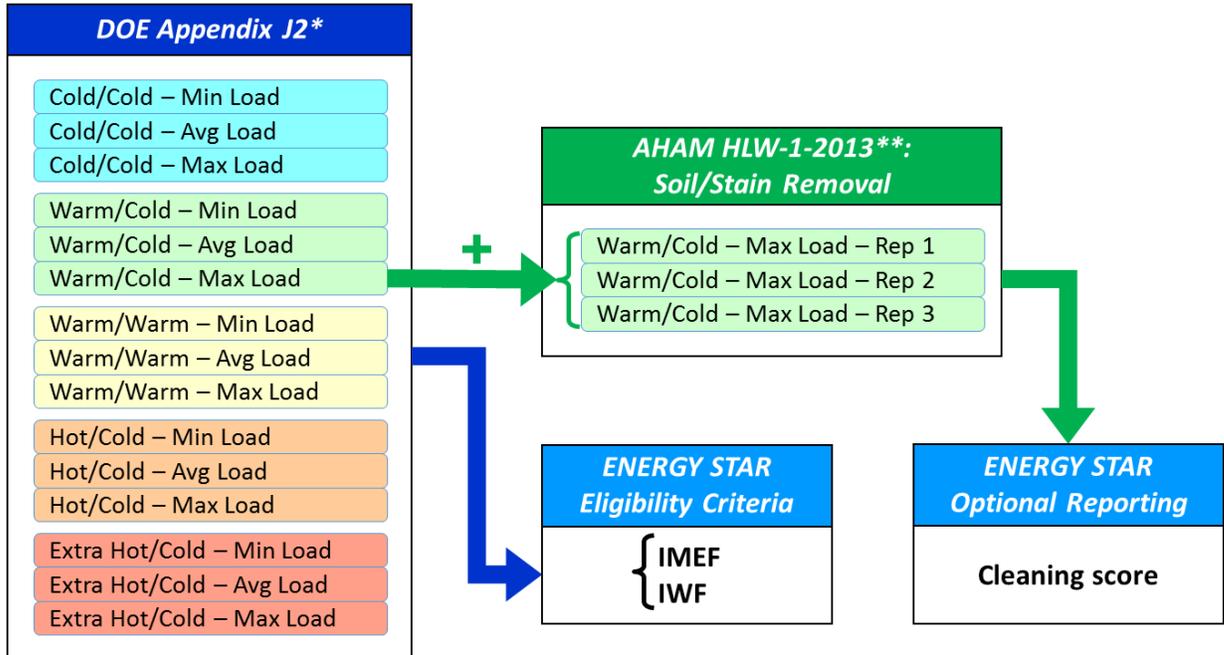
179 7. REFERENCES

- 180 A) AHAM HLW-1-2013. “Performance Evaluation Procedures for Household Clothes Washers”
- 181 B) DOE Appendix J2 to Subpart B of 10 CFR 430, “Uniform Test Method for Measuring the Energy
182 Consumption of Automatic and Semi-Automatic Clothes Washers”

183

184 APPENDIX A: TEST METHOD STRUCTURE

185 The following figure illustrates the structure of the cleaning performance test method, and shows its
186 relationship with Appendix J2 test cycles performed to determine IMEF and IWF scores.



* Depending on the available temperature selections and water fill control system, Appendix J2 may require only a subset of the cycles depicted here.

** HLW-1-2013 Soil/Stain Removal Test Procedure has been modified as described in this test method.

187
188

Figure 1: Overall test method structure

189