

ENERGY STAR Appliance Verification Testing – Pilot Program Summary Report

February 3, 2012



Foreword

ENERGY STAR® is a joint program of the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA) with a dual focus on energy and cost savings. These goals are reached through a combination of increasing customer awareness, partnering with over 15,000 private and public sector organizations and driving widespread technological advances in energy efficiency. ENERGY STAR recognizes three paths to increased daily energy efficiency: bringing to market new energy-efficient products, constructing efficient new homes and commercial buildings, and improving the efficiency of existing homes, commercial buildings and industrial facilities.

In 2010, DOE launched a pilot program to verify the energy efficiency and water-use characteristics of selected ENERGY STAR products through laboratory testing.¹ The pilot verification program helped ensure that ENERGY STAR products deliver the efficient use of energy and water that consumers expect, while minimizing costs and inconvenience to product manufacturers.

This report summarizes the findings and lessons learned from the pilot program.

¹ See FAQ for: ENERGY STAR Verification Testing Pilot Program, available at:
http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/faqfinal.pdf

Table of Contents

- 1 Scope..... 1
- 2 Process 2
 - 2.1 Stage 1..... 2
 - 2.2 Stage 2..... 2
- 3 Testing..... 3
- 4 Summary of Results 4
- 5 Product-Specific Results..... 6
 - 5.1 Refrigerators and Refrigerator-Freezers..... 6
 - 5.2 Freezers..... 8
 - 5.3 Residential Clothes Washer 10
 - 5.4 Dishwashers 12
 - 5.5 Tankless Water Heaters 14
 - 5.6 Storage Water Heaters 16
 - 5.7 Room Air Conditioners..... 18
- 6 Lessons Learned..... 20
 - 6.1 Product Selection and Procurement..... 20
 - 6.2 Test Report Templates..... 20
 - 6.3 Manufacturer Notification 20
 - 6.4 Sample Size 21
 - 6.5 Third Party Certification Bodies 21
- Appendix A: Statistics Details..... 22

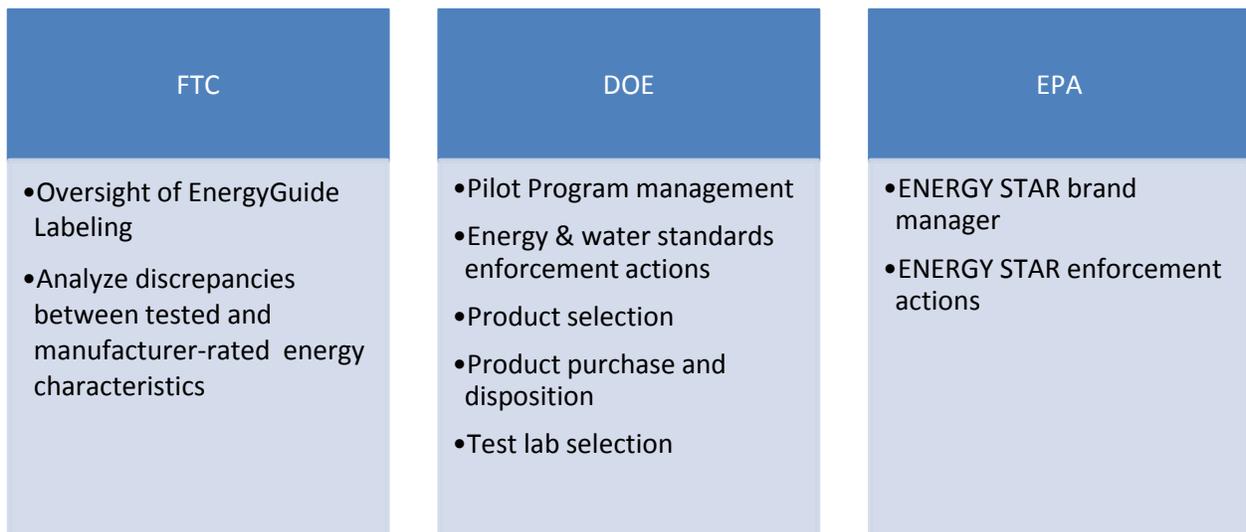
1 Scope

ENERGY STAR is a joint program of the U.S. Department of Energy (DOE) and the U.S. Environmental Protection Agency (EPA), with a dual focus on energy and cost savings. In 2010, DOE launched a Pilot Program to verify the energy efficiency and water-use characteristics of selected ENERGY STAR products through laboratory testing.² A complete list of ENERGY STAR products is available on the ENERGY STAR website; however, not all products covered by ENERGY STAR specifications were tested during the Pilot Program.³ The ENERGY STAR products included in the Pilot Program were:

- Residential refrigerators and refrigerator-freezers;
- Residential freezers;
- Residential clothes washers;
- Residential dishwashers;
- Residential gas tankless water heaters;
- Residential gas storage water heaters; and
- Room air conditioners.

The Pilot Program’s primary objective was to verify product performance consistent with ENERGY STAR specifications; however, because these products are covered by Federal conservation standards and Federal Trade Commission information disclosure requirements, a secondary function of the program was to identify products that do not meet these standards. Figure 1-1 outlines the roles for the various organizations involved in the Pilot Program.

Figure 1-1: Roles of Contributing Organizations in the ENERGY STAR Pilot Program



² See FAQ for: ENERGY STAR Verification Testing Pilot Program, available at: http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/faqfinal.pdf

³ The ENERGY STAR product listing is available at: http://www.energystar.gov/index.cfm?c=products.pr_find_es_products

2 Process

The process used to determine if a model met an ENERGY STAR specification was based on DOE's enforcement sampling plan⁴; however, several modifications were made to minimize test cost while providing sufficient data to make a determination. The online document, "FAQ for ENERGY STAR Verification Testing Pilot Program" provides additional details on the testing process.⁵

2.1 Stage 1

In Stage 1, DOE conducted a "spot-check" of a single unit of a specified model. DOE took no further testing action if the unit performed no more than 5% worse than the ENERGY STAR specification. If the product tested more than 5% worse than the ENERGY STAR specification, DOE initiated Stage 2 testing. In addition, if a unit tested worse than the applicable DOE energy or water conservation standard, the basic model was referred to the DOE Office of General Counsel for possible enforcement action.

2.2 Stage 2

In Stage 2, DOE tested additional units of the original basic model in accordance with the Code of Federal Regulations' sampling plan (Appendix A to Subpart C of Part 429).^{6, 7} Testing was limited to an additional seven units. Details on the statistical calculations are summarized in Appendix A: Statistics Details. If, following Stage 2 testing, a model was determined to not meet the ENERGY STAR specification, the model was referred to EPA for further action.

⁴ Appendix A to Subpart C of Part 429: <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=aa402eb4a7c7bb27caf7e5119d410eeb&rgn=div9&view=text&node=10:3.0.1.4.17.3.9.16.3&idno=10>

⁵ "FAQ for: ENERGY STAR Verification Testing Pilot Program," U.S. Department of Energy, December 2010, Available at: http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/faq_final_december-2010.pdf.

⁶ As per 10 CFR 430.2, a basic model means "all units of a given type of covered product (or class thereof) manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency"

⁷ Appendix A to Subpart C of Part 429: <http://ecfr.gpoaccess.gov/cgi/t/text/text-idx?c=ecfr&sid=aa402eb4a7c7bb27caf7e5119d410eeb&rgn=div9&view=text&node=10:3.0.1.4.17.3.9.16.3&idno=10>

3 Testing

Pilot Program testing was conducted at five independent third-party test laboratories, using the relevant DOE test procedures in 10 CFR Part 430 Subpart B, and listed in Table 3-1. If any test procedure guidance had been issued by DOE on DOE’s website⁸, this guidance was used during testing.

Table 3-1: Test Procedures and ENERGY STAR Metrics by Product Type

Product Type	Applicable DOE Test Procedure from 10 CFR part 430 Subpart B	ENERGY STAR Performance Metrics
Refrigerators and Refrigerator-Freezers	Appendix A1, Uniform Test Method for Measuring the Energy Consumption of Electric Refrigerators and Electric Refrigerator-Freezers	Annual Energy Use (AEU, kWh/year)
Freezers	Appendix B1, Uniform test Method for Measuring the Energy Consumption of Freezers	Annual Energy Use (AEU, kWh/year)
Residential Clothes Washers	Appendix J1, Uniform Test Method for Measuring the Energy Consumption of Automatic and Semi-Automatic Clothes Washers	Modified Energy Factor (MEF, ft ³ /kWh/cycle) Water Factor (WF, gallons/cycle-ft ³) Estimated Annual Energy Use (EAEU, kWh/year)
Residential Dishwashers	Appendix C, Uniform Test Method for Measuring the Energy Consumption of Dishwashers	Water Consumption (WC, gallons/cycle)
Tankless Natural-Gas Water Heaters (Whole House)	Appendix E, Uniform Test Method for Measuring the Energy Consumption of Water Heaters	Energy Factor (EF) GPM (gallons/minute @ 77°F rise)
Storage Water Heaters	Appendix E, Uniform Test Method for Measuring the Energy Consumption of Water Heaters	Energy Factor (EF) First-Hour-Rating (FHR, gallons/hour)
Room Air Conditioners	Appendix F, Uniform Test Method for Measuring the Energy Consumption of Room Air Conditioners	Energy Efficiency Ratio (EER)

⁸ <http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1>

4 Summary of Results

This section summarizes overall Pilot Program test results. Product-specific results are summarized in Section 5.

DOE selected seven product types for the Pilot Program: refrigerators, freezers, residential clothes washers, tankless and storage water heaters, dishwashers, and room air conditioners. Refrigerators and room air conditioners represented the greatest number of models selected, both with 32% of the total 239 models. Table 4-1 summarizes test results, including the number of products that required further action after Stage 1 and the outcomes of the Stage 2 tests.

Table 4-1: Pilot Program Results Summary

Product Type	Total Units Tested in Stage 1	Required Further Action (Percent of Product Type)			
		Total	Met ESTAR Specification in Stage 2	Referred to EPA ^a	Other ^b
Refrigerators and Refrigerator-Freezers	76	11 (14%)	3 (4%)	4 (5%)	4 (5%)
Freezers	18	5 (28%)	1 (6%)	4 (22%)	0 (0%)
Residential Clothes Washers	39	6 (15%)	3 (8%)	2 (5%)	1 (3%)
Residential Dishwashers	10	2 (20%)	1 (10%)	1 (10%)	0 (0%)
Tankless Water Heaters	11	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Storage Water Heaters	8	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Room Air Conditioners	77	20 (26%)	4 (5%)	13 (17%)	3 (4%)
Total	239	44 (18%)	12 (5%)	24 (10%)	8 (3%)

a. Includes models referred directly to EPA without further testing.

b. DOE conducted no further testing on these units because they were either no longer available in the market or they were referred directly to EPA for potential enforcement action.

Freezers showed the worst Stage 1 (i.e., spot-check) performance compared to the ENERGY STAR specification, with 28% of the models performing more than 5% worse than the ENERGY STAR specification. Room air conditioners and residential dishwashers also showed relatively poor Stage 1 performance, with 26% and 20% of models, respectively, performing more than 5% worse than the ENERGY STAR specifications. Of the 19 tankless and storage water heaters tested, none performed more than 5% worse than the ENERGY STAR specification and therefore did not require Stage 2 analysis.

Of all products tested, 44 models (18%) required additional testing. Research on compliance programs run by other countries indicate that spot-check compliance generally results in approximately a 15% “failure”

rate.^{9,10} While many of these programs are not directly comparable to the DOE Pilot Program because they rely on field data to determine compliance, it suggests that the resulting failure rate from the Pilot Program is reasonably aligned with other studies. As shown in Table 4-1, 12 models (5%) were found to meet ENERGY STAR specifications after Stage 2 testing; however, 24 models (10%) were ultimately referred to EPA. The fact that two-thirds of the models tested in Stage 2 did not meet ENERGY STAR specifications implies that the screening process used in Stage 1 is appropriate, and that the sampling and statistics in Stage 2 can differentiate between models that do and do not meet the ENERGY STAR specification.

Consistent with Stage 1 results, room air conditioners and freezers also had the worst Stage 2 performance relative to the ENERGY STAR specifications, with 13 room air conditioners (17%) and four freezers (22%) referred to EPA.

⁹ Frank Kilnkenberg, Experiences with Verification and Enforcement of the EU Energy Label, 8 April 2008.

¹⁰ George Wilkenfeld and Associates, "National Legislation for Appliance and Equipment Minimum Energy Performance Standards (MEPS) and Energy Labeling."

5 Product-Specific Results

5.1 Refrigerators and Refrigerator-Freezers

Figure 5-1 summarizes Stage 1 refrigerator and refrigerator-freezer tests for Annual Energy Use (AEU, in kWh/yr). Seventy-six models were tested in Stage 1, with 65 models (86%) requiring no additional testing, and 11 models (14%) requiring Stage 2 testing. Two models (3%) tested more than 150% worse than the ENERGY STAR specification; these models also performed worse than the federal energy conservation standard and were referred to DOE General Counsel for potential enforcement testing.

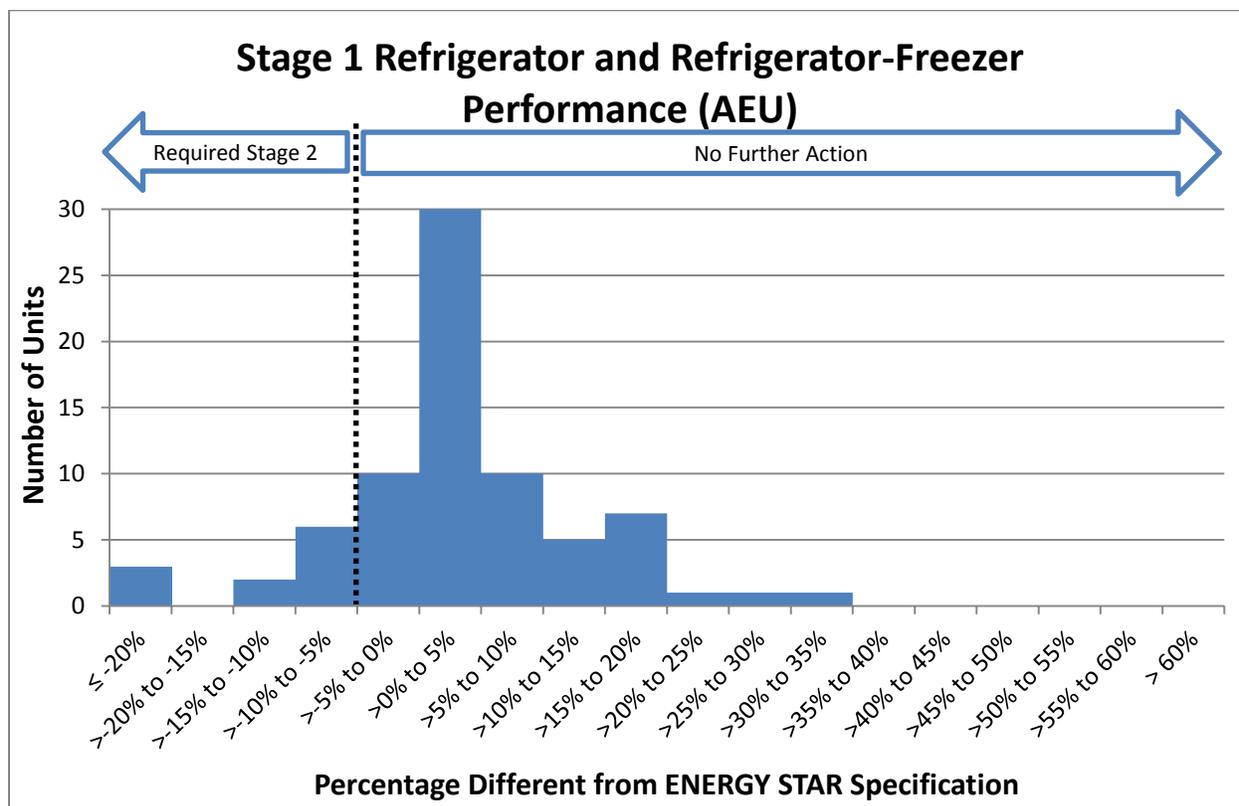


Figure 5-1: Stage 1 Refrigerator and Refrigerator-Freezer Annual Energy Use (AEU) Data

Table 5-1 summarizes Stage 1 and Stage 2 results for refrigerators and refrigerator-freezers. Over half of the selected models fall into either the side-freezer or top-freezer product classes (28% and 37%, respectively); bottom-freezer units, all-refrigerators and compact refrigerators make up the remaining product classes selected for testing.

Of the 11 basic models that required further action, three (27%) were found to meet the ENERGY STAR specification after additional testing and four (36%) were referred to EPA.

Table 5-1: Refrigerator and Refrigerator-Freezer Detailed Test Results by Product Class

Refrigerator and Refrigerator-Freezer Product Classes	Total Units Tested in Stage 1	Required Further Action			
		Total	Met ESTAR Specification in Stage 2	Referred to EPA ^a	Other ^b
Compact	6	1 (17%)	0	0	1
All Refrigerator	9	2 (22%)	0	0	2
Bottom Freezer	12	0 (0%)	0	0	0
Side Freezer	21	5 (24%)	1	3	1
Top Freezer	28	3 (11%)	2	1	0
Total	76	11 (14%)	3 (27% of Stage 2)	4 (36% of Stage 2)	4 (36% of Stage 2)

a. Includes models referred directly to EPA without further testing.

b. DOE conducted no further testing on these units because they were either no longer available in the market or they were referred directly to EPA for potential enforcement action.

5.2 Freezers

Figure 5-2 summarizes Stage 1 freezer tests for Annual Energy Use (AEU, in kWh/yr). Of the 18 models tested for Stage 1, 12 (67%) required no additional testing and five models (28%) tested required Stage 2 testing. One model tested worse than the Federal conservation standard for AEU and was referred to DOE General Counsel for potential enforcement testing.

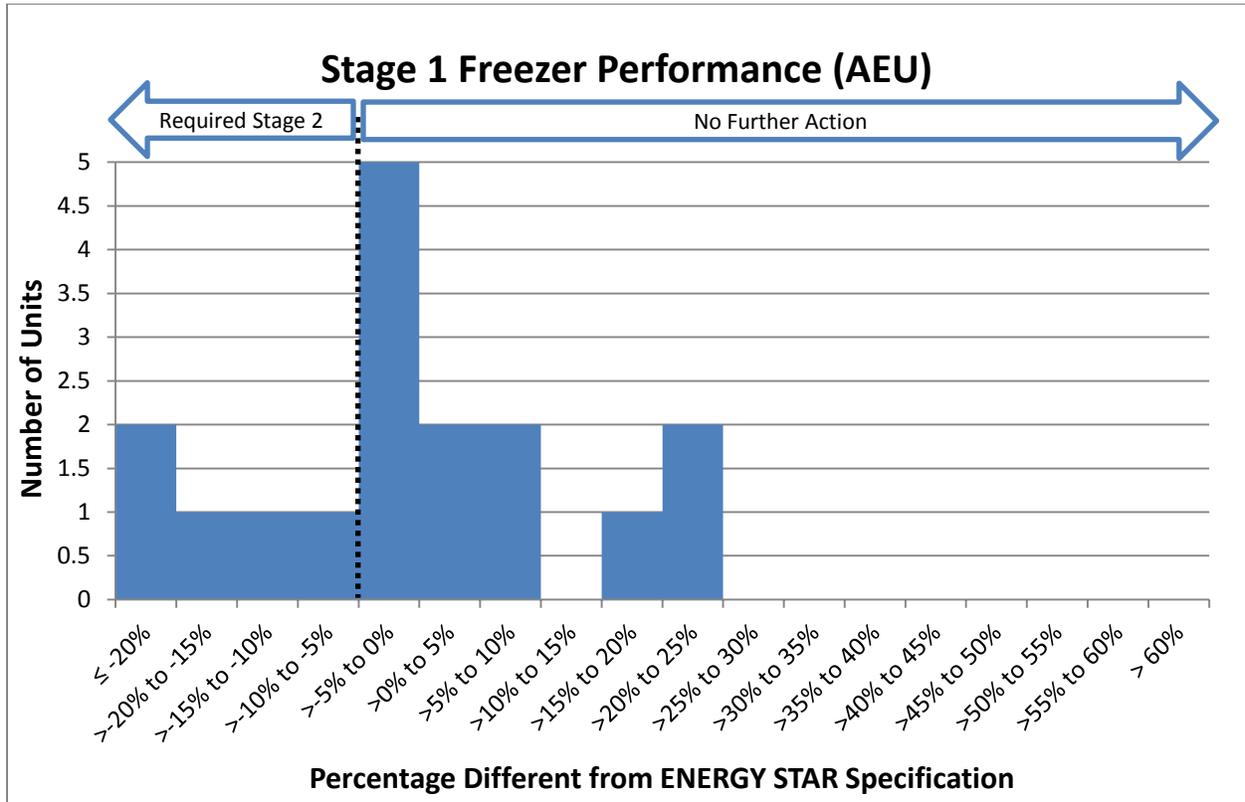


Figure 5-2: Stage 1 Freezer Annual Energy Use (AEU) Data

Table 5-2 summarizes Stage 1 and Stage 2 results by freezer product class. Chest freezers and upright freezers each represented 39% of the selected models, while the remaining units were compact units.

Of the five basic models that required further action, one model (20%) was found to meet the ENERGY STAR specification after additional testing and four models (80%) were referred to EPA. The majority of freezers that required further action were chest freezers (80%).

Table 5-2: Freezer Detailed Test Results by Product Class

Freezer Product Classes	Total Units Tested in Stage 1	Required Further Action			
		Total	Met ESTAR Specification in Stage 2	Referred to EPA ^a	Other ^b
Compact	4	1 (25%)	0	1	0
Upright	7	0 (0%)	0	0	0
Chest	7	4 (57%)	1	3	0
Total	18	5 (28%)	1 (20% of Stage 2)	4 (80% of Stage 2)	0

a. Includes models referred directly to EPA without further testing.

b. DOE conducted no further testing on these units because they were either no longer available in the market or they were referred directly to EPA for potential enforcement action.

5.3 Residential Clothes Washer

Figure 5-3 and Figure 5-4 summarize Stage 1 residential clothes washer tests for Modified Energy Factor (MEF, in ft³/kWh-cycle) and Water Factor (WF, in gallons/cycle/ft³), respectively. Thirty-nine models were tested for Stage 1; 38 models (97%) required no additional testing for MEF and 34 models (87%) required no additional testing for WF. One model (3%) required Stage 2 testing for both WF and MEF, one model (3%) required Stage 2 testing for MEF only and four models (10%) required Stage 2 testing for WF.

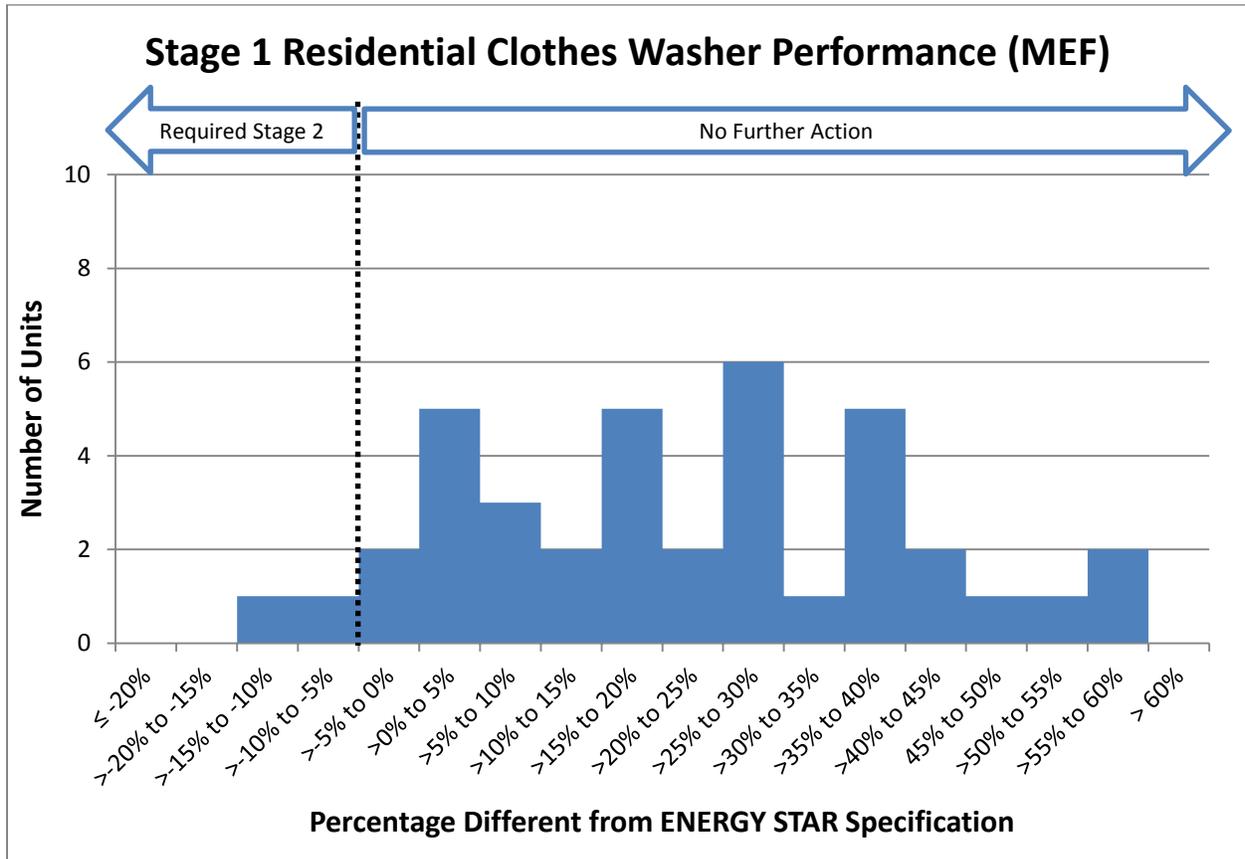


Figure 5-3: Stage 1 Residential Clothes Washer Modified Energy Factor (MEF) Data

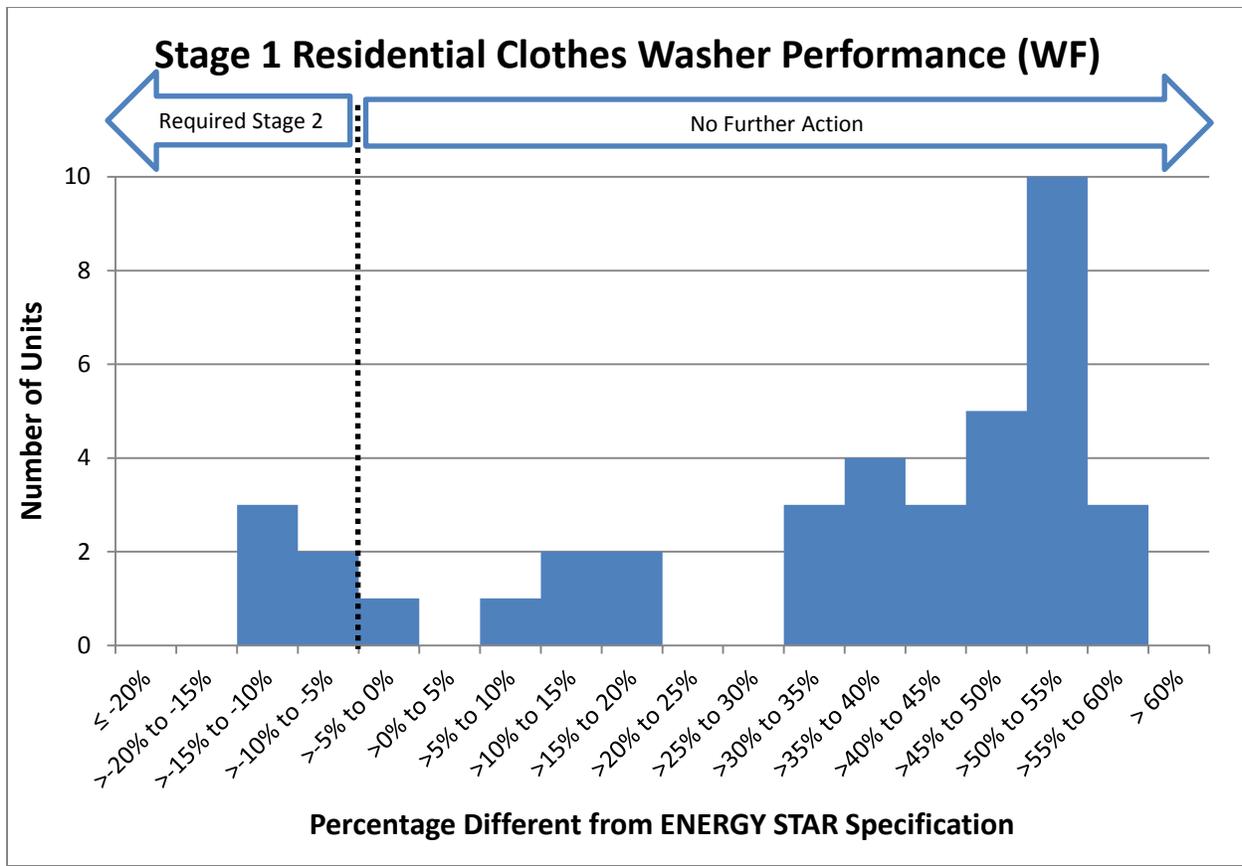


Figure 5-4: Stage 1 Residential Clothes Washer Water Factor (WF) Data

Table 5-3 summarizes Stage 1 and Stage 2 results by the type of residential clothes washer. Of the 39 basic models, 30 models (77%) were front-loading and the remaining nine were top-loading.

Six basic models required further action; three (50%) were found to meet the ENERGY STAR specification and two (33%) were referred to EPA.

Table 5-3: Residential Clothes Washer Test Results by Product Class

Residential Clothes Washer Product Classes	Total Units Tested in Stage 1	Required Further Action			
		Total	Met ESTAR Specification in Stage 2	Referred to EPA ^a	Other ^b
Top-Load	9	4 (44%)	3	1	0
Front-Load	30	2 (7%)	0	0	2
Total	39	6 (15%)	3 (50% of Stage 2)	1 (18% of Stage 2)	2 (33% of Stage 2)

a. Includes models referred directly to EPA without further testing.

b. DOE conducted no further testing on these units because they were either no longer available in the market or they were referred directly to EPA for potential enforcement action.

5.4 Dishwashers

Figure 5-5 and Figure 5-6 summarize Stage 1 dishwasher tests for Estimated Annual Energy Use (EAEU, in kWh/yr) and Water Consumption (WC, in gallons/cycle), respectively. Of the 10 models tested for Stage 1, two models (20%) required additional testing for EAEU. One of these models was found to meet the ENERGY STAR specifications for both EAEU and WC after Stage 2 testing. The second model was directly referred to EPA without additional testing.

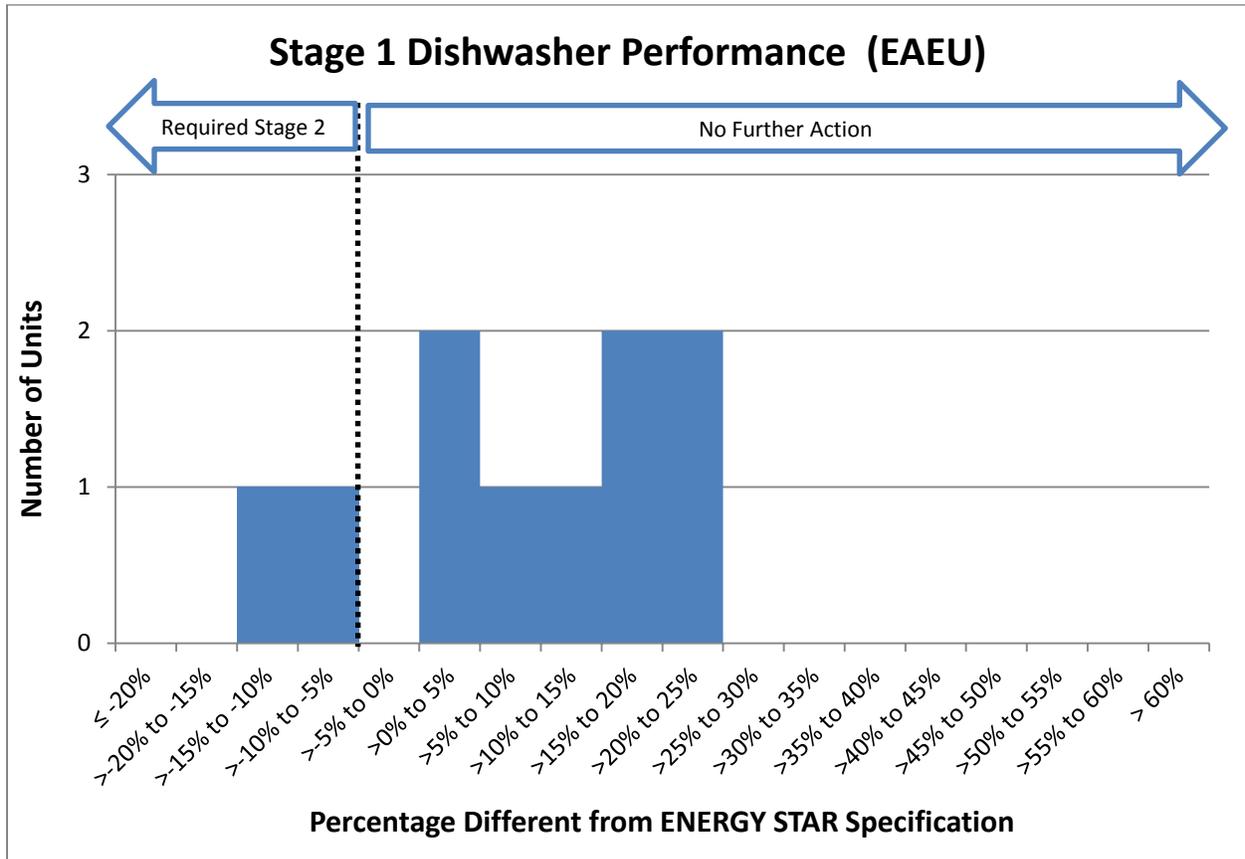


Figure 5-5: Stage 1 Dishwasher Estimated Annual Energy Usage (EAEU) Data

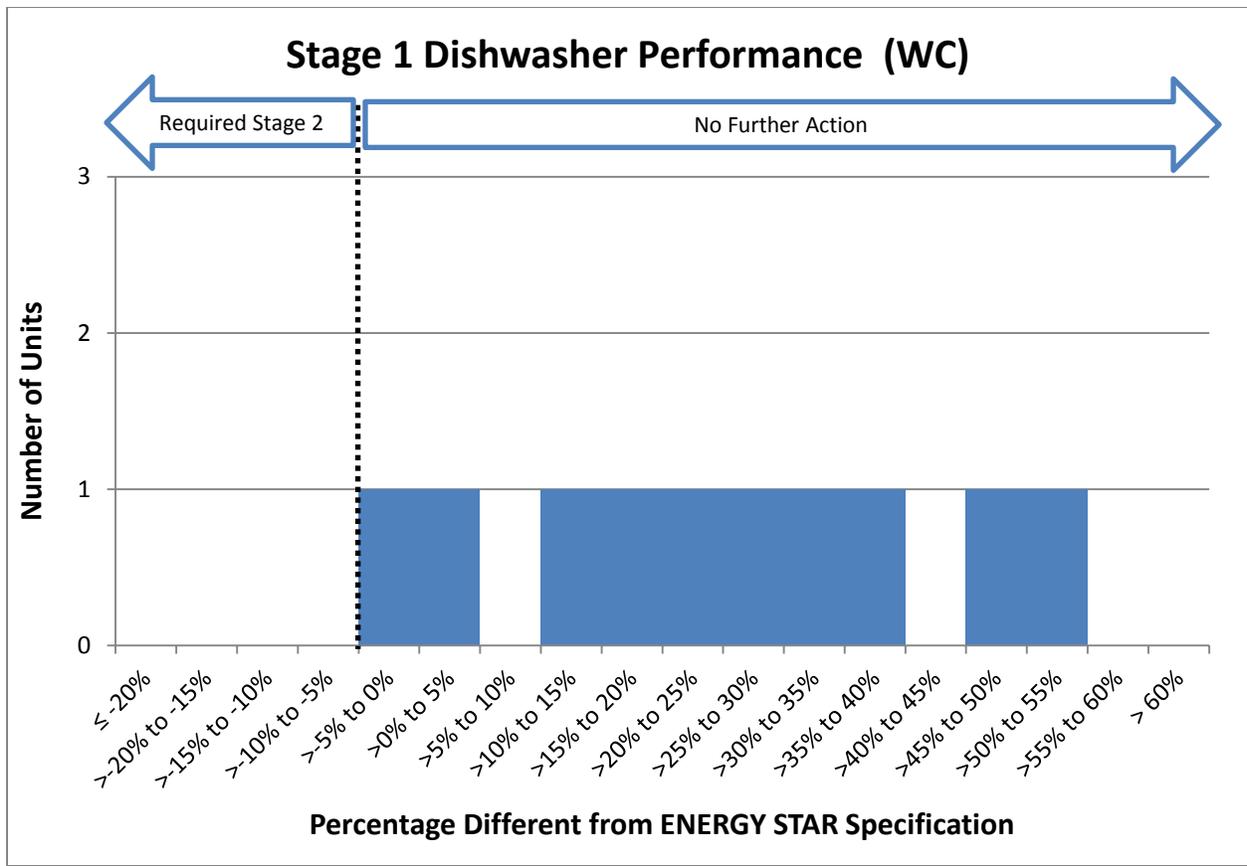


Figure 5-6: Stage 1 Dishwasher Water Consumption (WC) Data

5.5 Tankless Water Heaters

Error! Reference source not found. and **Error! Reference source not found.** summarize Stage 1 tankless water heater tests for Energy Factor (EF) and Gallons Per Minute (GPM, @ 77°F rise), respectively. Eleven models were tested in Stage 1; no models required additional Stage 2 testing for either EF or GPM and therefore tankless water heaters were referred to EPA or DOE for action.

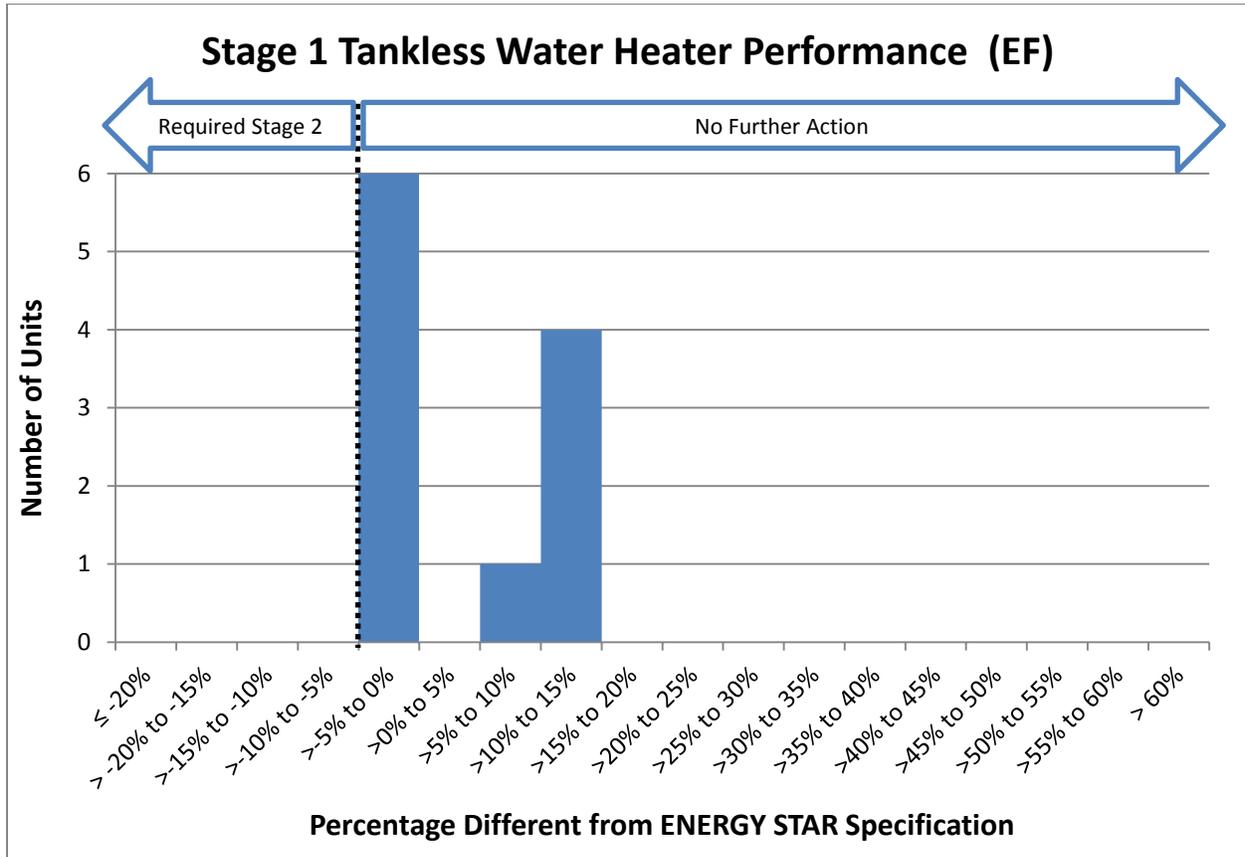


Figure 5-7: Stage 1 Tankless Water Heater Energy Factor (EF) Data

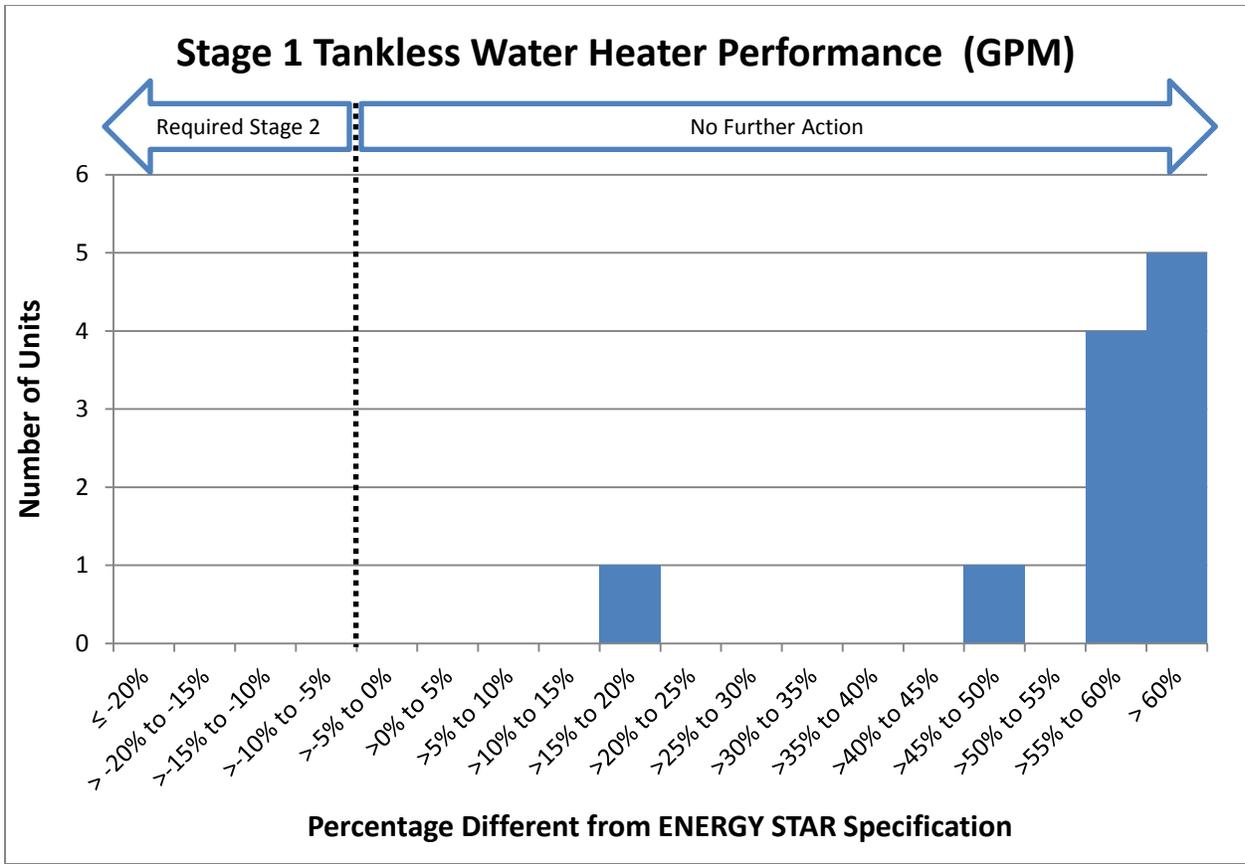


Figure 5-8: Stage 1 Tankless Water Heater Gallons Per Minute (GPM) Data

5.6 Storage Water Heaters

Figure 5-9 and Figure 5-10 summarize Stage 1 storage water heater test results for Energy Factor (EF) and First Hour Rating (FHR, in gallons), respectively. Eight models were tested in Stage 1. No models required further action for either EF or FHR and therefore no storage water heaters were referred to EPA or DOE for action.

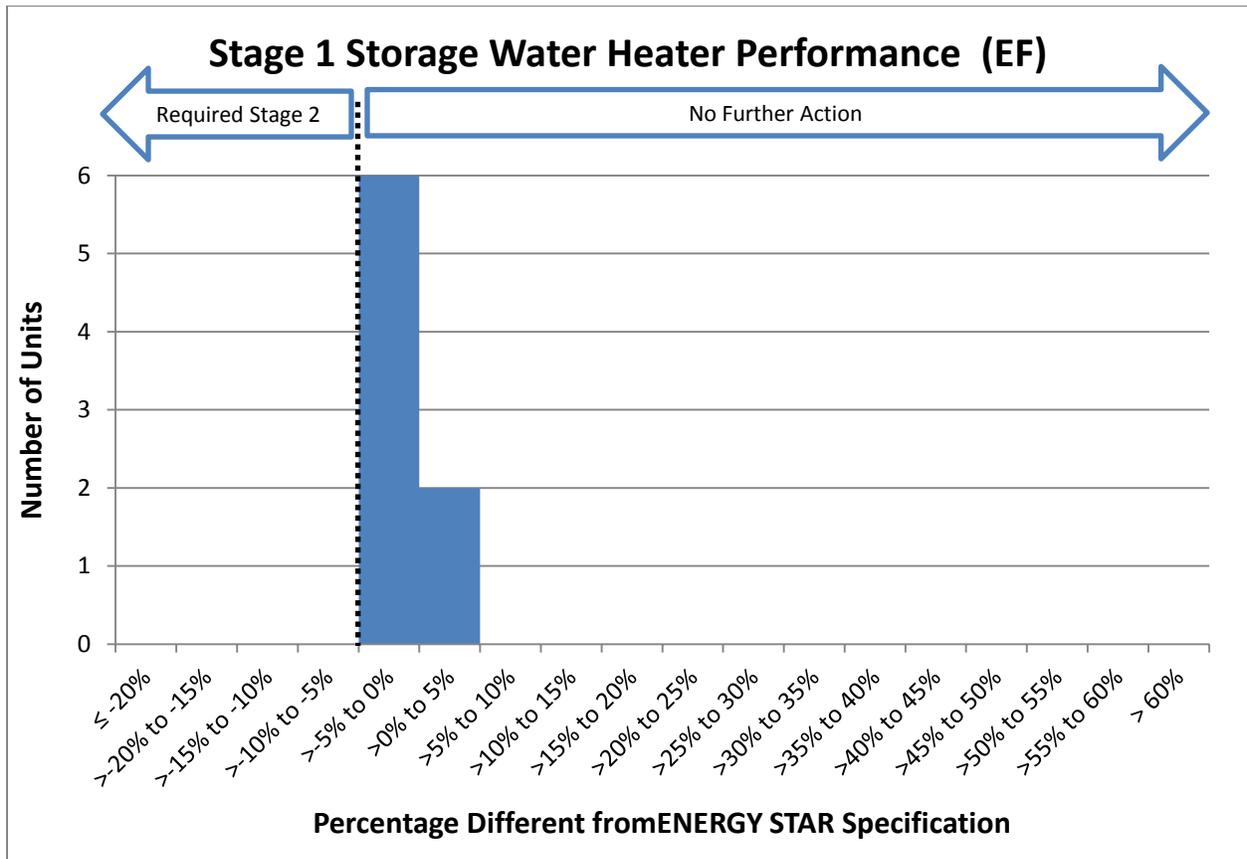


Figure 5-9: Stage 1 Storage Water Heater Energy Factor (EF) Data

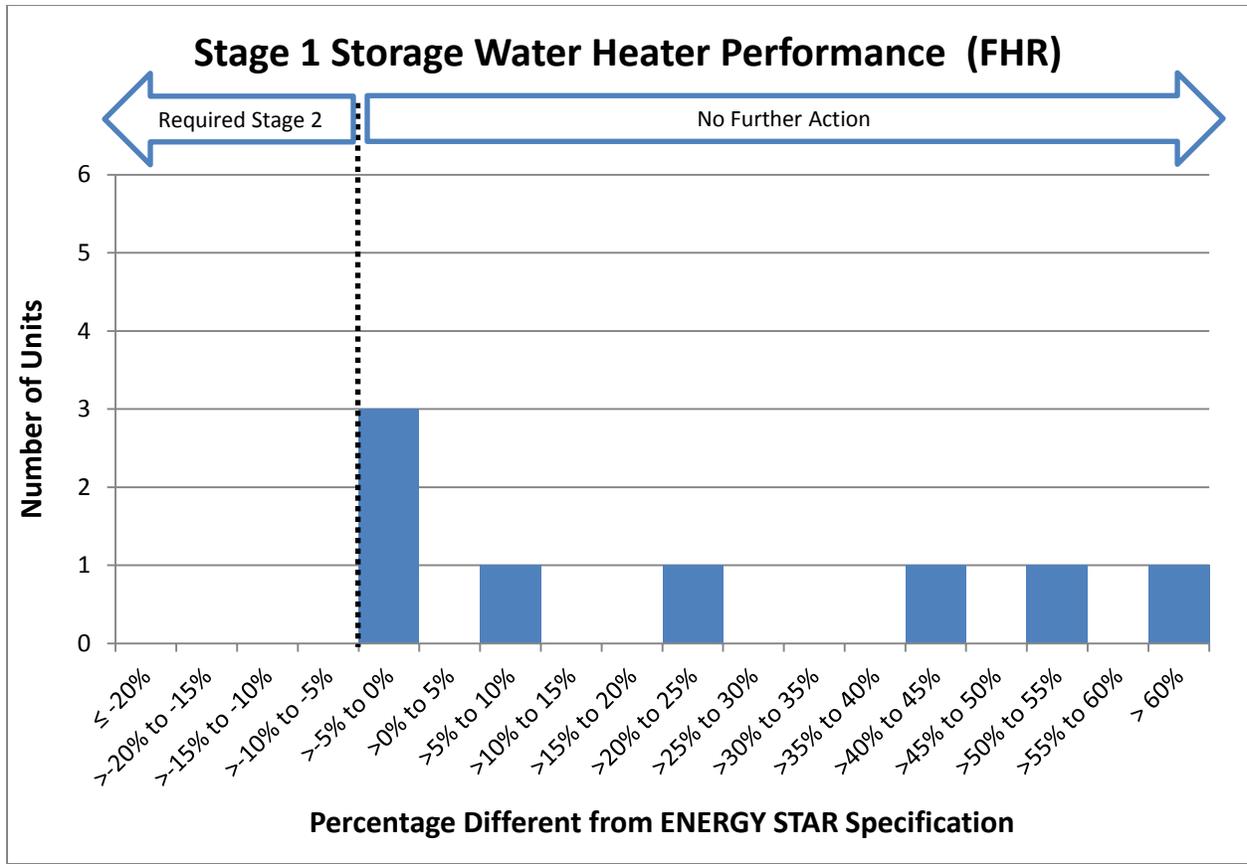


Figure 5-10: Stage 1 Storage Water Heater First Hour Rating (FHR) Data

5.7 Room Air Conditioners

Figure 5-11 summarizes Stage 1 room air conditioner test results for Energy Efficiency Ratio (EER). Seventy-seven models were tested in Stage 1. Fifty-seven models (74%) did not require additional testing. Twenty of the models (26%) tested in Stage 1 required Stage 2 testing.

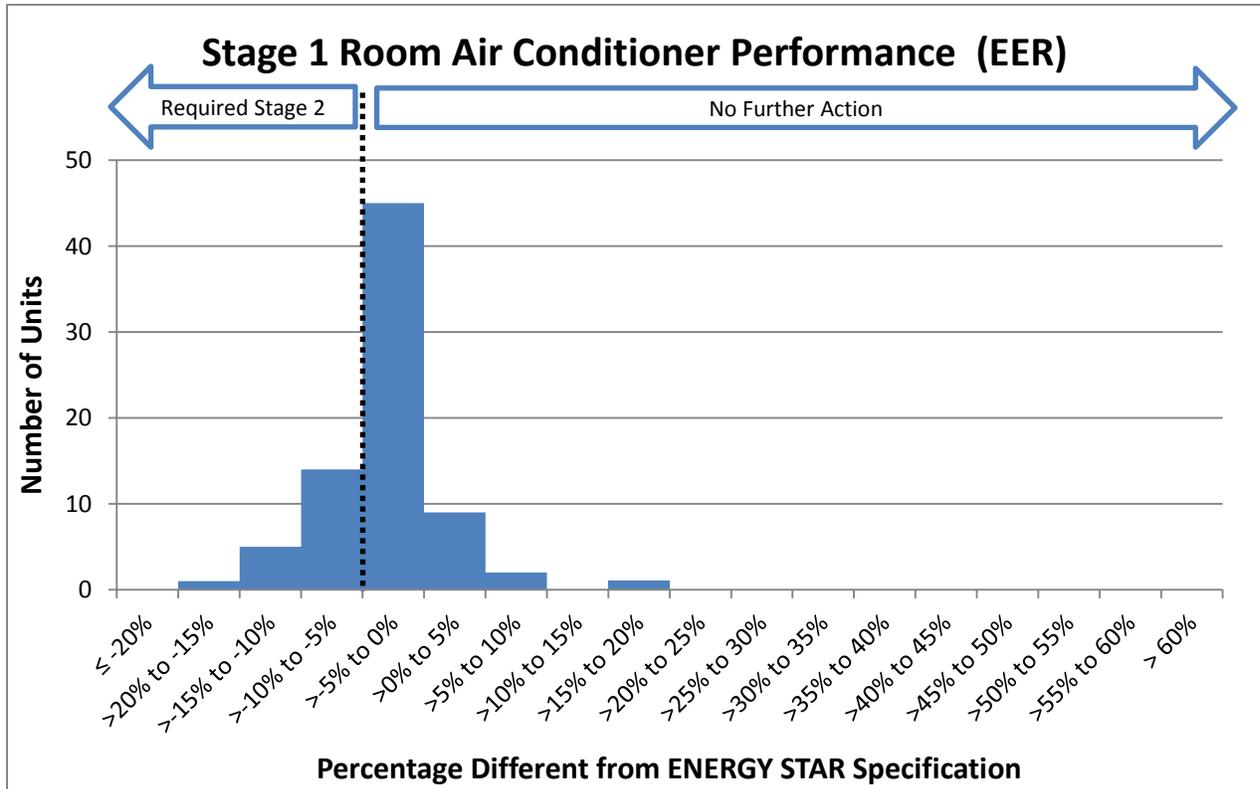


Figure 5-11: Stage 1 Room Air Conditioner Energy Efficiency Ratio (EER) Data

Table 5-4 summarizes Stage 1 and Stage 2 results by room air conditioner cooling output capacity range. Over half of the models tested had capacities between 8,000 and 13,999 Btu/hr; 13% had capacities between 6,000 and 7,999 Btu/hr and 17% had capacities between 14,000 and 19,999 Btu/hr. The remaining models were split between the lowest capacity range (four units at <6,000 Btu/hr) and the highest capacity range (nine units at > 20,000 Btu/hr).

Of the 20 basic models that required further action, four (20%) were found to meet the ENERGY STAR specification and nine (45%) were referred to EPA. Twenty models required additional testing; however, only 13 models were ultimately tested and acted on. During the pilot program, many R-22 units were discontinued; seven of the units that required additional testing could not be procured for Stage 2 testing.

Table 5-4: Room Air Conditioner Test Results by Output Capacity

Room Air Conditioners by Output Capacity	Total Units Tested in Stage 1	Required Further Action			
		Total	Met ESTAR Specification in Stage 2	Referred to EPA ^a	Other ^b
Less than 6,000	4	0 (0%)	0	0	0
6,000 to 7,999	9	2 (20%)	1	0	1
8,000 to 13,999	42	11 (26%)	2	5	4
14,000 to 19,999	13	4 (31%)	0	3	1
20,000 or More	9	3 (33%)	1	1	1
Total	76	20 (26%)	4 (20% of Stage 2)	9 (45% of Stage 2)	7 (25% of Stage 2)

a. Includes models referred directly to EPA without further testing.

b. DOE conducted no further testing on these units because they were either no longer available in the market or they were referred directly to EPA for potential enforcement action.

6 Lessons Learned

Process evaluation was conducted throughout the Pilot Program and DOE used this evaluation to develop an improved process for continued DOE testing in support of ENERGY STAR.¹¹ The following sections outline issues that were identified during the Pilot Program, and changes that DOE intends to make in future ENERGY STAR verification testing.

6.1 Product Selection and Procurement

Implementation of the Pilot Program helped DOE identify several issues with product selection and procurement that the Department has remedied in the revised verification program process.

Lack of information regarding manufacturer's basic model identification caused difficulty in selecting individual models and may have led to multiple models within the same basic model being tested under the Pilot Program. DOE has recently published revised certification reporting requirements for products covered by Federal energy conservation standards¹². Following the compliance date for these requirements, which varies by product, DOE will have access to manufacturer-supplied basic models for all ENERGY STAR products that are also covered by the Department under its Energy Conservation Standards Program. This information, cross-referenced with the ENERGY STAR database, should provide sufficient information to identify ENERGY STAR qualified basic models and their derivative models and prevent the Department from conducting testing of multiple models within a single basic model.

Once models were identified, procurement was often difficult because models were no longer available for sale on the market. To remedy this issue, the Department will target products that have more recently entered the market, based on certification dates provided to the Department as part of the certification reporting outlined above. Additionally, the Department has identified statistical deficiencies inherent in procuring multiple units of the same model from one vendor and has remedied this by specifying that units should be purchased from multiple vendors, where possible.

6.2 Test Report Templates

To provide reporting accuracy and consistency between laboratories and to help minimize additional test report completion time, test report templates were initially developed during the Pilot Program. Deficiencies in the templates that were used during the Pilot Program have been identified and template development is ongoing to ensure uniform reporting and reduced burden for test labs and DOE.

DOE version-controlled templates are now available on the DOE website at:

http://www1.eere.energy.gov/buildings/appliance_standards/standardized_templates_for_reporting.html

6.3 Manufacturer Notification

At the beginning of the Pilot Program, the Department notified manufacturers of failed tests after the initial "spot-check". This approach caused unnecessary delay during testing and often resulted in

¹¹ http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/estar_verification_process.pdf

¹² http://www1.eere.energy.gov/buildings/appliance_standards/pdfs/cce_finalrule_notice.pdf

manufacturers discontinuing production of models before DOE could procure additional units. As a result, DOE eliminated the practice in favor of informing manufacturers of failures only upon a determination of the model not meeting the ENERGY STAR specification after testing of four to eight units. The Department will continue to inform manufacturers and accept feedback after testing of four units and anticipates that this practice will ensure that DOE is able to quickly determine a model's conformity with ENERGY STAR specifications.

6.4 Sample Size

Pilot Program results indicate that 43 models (18%) tested in Stage 1 required additional testing (Stage 2). Additionally, of those 43 models, eight models (20%) required a second Stage 2 sample (e.g., selection of a total of 5 to 8 units). In only one case was a model found to not meet ENERGY STAR specifications after a second Stage 2 sample. This suggests that the second Stage 2 sample is of little value to the Department, making it an unnecessary burden. As a result, the Department has eliminated the second Stage 2 sample, and will determine compliance following the testing of three additional units.

6.5 Third Party Certification Bodies

In January 2011, EPA introduced requirements for Certification Bodies. A substantial requirement for Certification Bodies is that they operate a partner-funded verification testing program that fulfills a number of requirements, including:

- Ensure products meet product-specific ENERGY STAR performance parameters; and
- Annually select and test at least 10% of all ENERGY STAR-qualified models, with half the models randomly selected and the remaining half selected based on EPA referrals.

The pilot program was initiated prior to the EPA's Certification Body requirement, and has provided helpful information to aid DOE and EPA in the development of requirements and expectations for third party-run verification programs. DOE and EPA expect the third-party programs to provide substantial value for consumers, manufacturers and the government. While DOE has no interest in duplicating verification efforts, DOE recognizes that these programs are currently under development and may continue to supplement developing third-party programs with DOE conducted verification testing. DOE may also focus on ENERGY STAR products that do not yet have a verification program in place.

Appendix A: Statistics Details

1	Mean (\bar{x})	$\bar{x} = \frac{1}{n} \left(\sum_{i=1}^n x_i \right)$	n = number of units tested X_i = measured energy efficiency or consumption from test i
2	Standard Deviation (s)	$s = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n - 1}}$	
3	Standard Error (s_x)	$s_x = \frac{s}{\sqrt{n}}$	
4	Lower Confidence Limit (LCL)	$LCL = EPS - t_1 s_x$	EPS* = energy performance specification t_1 – Stage 1 97.5% one-sided student's t statistic at n - 1
5	Upper Confidence Limit (UCL)	$UCL = EPS + t_1 s_x$	
6	Second Sample	$n_2 = \left(\frac{t_2 s_x}{0.05 EPS} \right)^2 - n_1$	t_2 = Stage 1 t value (t_1) If n_2 is greater than zero, a second sample of not more than 4 units is necessary
7	Second Sample Mean (\bar{x}_2)	$\bar{x}_2 = \frac{1}{n_1 + n_2} \left(\sum_{i=1}^{n_1+n_2} x_i \right)$	
8	Second Sample Standard Error (s_{x_2})	$s_{x_2} = \frac{s}{\sqrt{n_1 + n_2}}$	
9	Second Sample LCL	$LCL = EPS - t_2 s_{x_2}$	
10	Second Sample UCL	$UCL = EPS + t_2 s_{x_2}$	
11	5% tolerance on LCL	$LCL(0.05) = 0.95 * EPS$	
12	5% tolerance on UCL	$UCL(0.05) = 1.05 * EPS$	

*An energy performance specification (EPS) is used to indicate either an energy efficiency specification or an energy consumption specification depending on product type.

A single unit was tested in Stage 1 and the result was compared to the applicable ENERGY STAR specification with a 5% screening tolerance. Stage 2 testing was initiated on a given model if the Stage 1 test result was more than 5% worse than the applicable ENERGY STAR specification.

Stage 2 testing had the potential for two separate samples. A second sample was necessary only if the model calculations were indeterminate after the first sample, and was calculated based on the standard deviation of the first sample.

For an energy efficiency specification:

The model met the ENERGY STAR specification after the first sample if the sample mean was equal to or greater than the upper confidence limit (UCL) calculated in row 5; the model was indeterminate if the sample mean was equal to or greater than the lower confidence limit (LCL) calculated in row 4 and less than the UCL; and the model did not meet the ENERGY STAR specification if the sample mean was less than the LCL.

If the model was indeterminate, a second sample of up to four units was tested, determined based on the standard deviation of the first sample (row 6). The larger value of the Second Sample LCL (row 9) and the LCL(.05) (row 11) was compared to the sample mean for all eight samples. The model was determined to meet the ENERGY STAR specification if the sample mean was equal to or greater than the selected control limit.

For an energy consumption specification:

The model met the ENERGY STAR specification after the first sample if the sample mean was less than or equal to the lower confidence limit (LCL); the model was indeterminate if the sample mean was less than or equal to the upper confidence limit (UCL) and greater than the LCL; and the model was not compliant with the ENERGY STAR specification if the sample mean was greater than the UCL.

If the model was indeterminate, a second sample of four units was tested. The smaller value of the Second Sample UCL (row 10) and the UCL (.05) (row 12) was compared to the mean for all eight samples. The model was determined to meet the ENERGY STAR specification if the sample mean was less than or equal to the selected control limit.