



1111 19th Street NW > Suite 402 > Washington, DC 20036
t 202.872.5955 f 202.872.9354 www.aham.org

August 17, 2012

Via E-Mail

Ms. Ashley Armstrong
U.S. Department of Energy
Office of the Building Technologies Program, Mailstop EE-2J
1000 Independence Avenue, SW
Washington, DC 20585-0121

Ashley.Armstrong@EE.Doe.Gov

Re: ENERGY STAR Draft Test Method to Validate Demand Response, Rev. Feb-2012

Dear Ms. Armstrong:

On behalf of the Association of Home Appliance Manufacturers (AHAM), I would like to provide to the Department of Energy (DOE) supplemental comments on the ENERGY STAR Draft Test Method to Validate Demand Response, Rev. Feb-2012. Our supplemental comments, which relate to measurement of network mode, are presented in the form of a redline to the Draft Test Method, attached at Attachment A, and for clarity, the sections on which we are not commenting today are “grayed out,” and the non-gray sections contain AHAM’s supplemental comments.

AHAM represents manufacturers of major, portable and floor care home appliances, and suppliers to the industry. AHAM’s membership includes over 150 companies throughout the world. In the U.S., AHAM members employ tens of thousands of people and produce more than 95% of the household appliances shipped for sale. The factory shipment value of these products is more than \$30 billion annually. The home appliance industry, through its products and innovation, is essential to U.S. consumer lifestyle, health, safety and convenience. Through its technology, employees and productivity, the industry contributes significantly to U.S. jobs and economic security. Home appliances also are a success story in terms of energy efficiency and environmental protection. New appliances often represent the most effective choice a consumer can make to reduce home energy use and costs.

AHAM supports DOE and the Environmental Protection Agency (EPA) in their efforts to provide incentives to manufacturers, retailers, and consumers for continual energy efficiency improvement, as long as product performance can be maintained for the consumer. The ENERGY STAR program will be a stronger and better program going into the future as it recognizes the benefits of smart appliances and implements efforts to jump start the development of the Smart Grid. Were network mode to be included in the active mode measurement and

overall energy rating, even if only for purposes of meeting ENERGY STAR criteria, however, it would penalize manufacturers that are offering innovative energy savings solutions by enabling system level energy efficiencies defined in the ENERGY STAR specification, where the allowances are already too low to give proper incentive for participation.

AHAM continues to believe that network mode and its associated energy usage in smart appliances should be treated as a distinctive energy user that enhances electrical grid system efficiencies through energy management and thus resulting in reduced carbon emissions. This position applies across product categories and is consistent with IEC Standard 62301, Second Edition. It is also consistent with DOE's positions in rulemakings that have addressed the measurement of standby and off mode, and examined whether to include network mode. For example, in the clothes washer test procedure rulemaking, DOE stated that it "is unaware . . . of any clothes washers currently on the market with network mode capabilities. . . . Consequently, DOE can not [sic] thoroughly evaluate these network mode provisions, as would be required to justify their incorporation into DOE's test procedures at this time. DOE notes that although an individual appliance may consume some small amount of power in network mode, the potential exists for energy-related benefits that more than offset this additional power consumption if the appliance can be controlled by the 'smart grid' to consume power during non-peak periods. Although DOE is supportive of efforts to develop smart-grid and other network-enabled technologies in clothes washers, today's final rule does not incorporate network mode provisions due to the lack of available data that would be required to justify their inclusion." 77 Fed. Reg. at 13888, 13900 (Mar. 7, 2012).¹

Furthermore, the energy consumed by "all connected and network modes" is not completely in the manufacturer's control. The energy consumption in network mode will vary depending on transmission range, networking technology deployed (especially when not specified by the manufacturer), and the size and frequency of the data transmissions, all of which may be influenced by devices outside the refrigerator or by parties other than the manufacturer. Not only is the energy consumption from network mode not entirely within the manufacturer's control, thereby making it impossible to predict for testing purposes, but there is also no data to suggest what the energy consumption would be from consistent or typical consumer use such that these factors could appropriately be incorporated in the test procedure to represent typical consumer use. Accordingly, network mode energy consumption should not be measured during the ENERGY STAR test method baseline test until such time as more products are available and consumer use can be adequately studied.

AHAM appreciates the opportunity to submit comments on the ENERGY STAR Draft Test Method to Validate Demand Response, Rev. Feb-2012 and would be glad to further discuss these matters.

¹ Consequently, DOE also did not consider network mode in the direct final rule on energy conservation standards for residential clothes washers. 77 Fed. Reg. 32308, 32328 (May 31, 2012) ("DOE is unaware at this time of any such clothes washers available on the U.S. market for evaluation in terms of energy and water savings. Therefore, DOE did not consider smart-grid or other network-enabled technology options in this rulemaking.").

Best Regards,

A handwritten signature in black ink, reading "Jennifer Cleary". The signature is written in a cursive style with a large, looping initial "J".

Jennifer Cleary
Director, Regulatory Affairs

cc: Amanda Stevens, EPA

ATTACHMENT A



ENERGY STAR[®] Program Requirements Product Specification for Residential Refrigerators and Freezers

Draft Test Method to Validate Demand Response Rev. Feb-2012

1 OVERVIEW

The following test method shall be used for determining product compliance with requirements for Demand Response (DR) functionality in the ENERGY STAR Eligibility Criteria for Connected Refrigerators, Freezers, and Refrigerator-Freezers (herein referred to as Connected R/F).

Note: In September 2011, the Association of Home Appliance Manufacturers (AHAM) shared a draft test procedure for Connected R/F with DOE and EPA titled, "AHAM Smart Refrigerator, Refrigerator-Freezer, and Freezer Test Procedure (AHAM SRF-0.5-2011)". DOE utilized the AHAM test procedure as a starting point for this proposed Connected R/F Draft 1 Test Method.

DOE performed a market evaluation to better understand the Connected R/F market. DOE found that no units exist on the commercial market, but meetings with manufacturers and AHAM provided insights into connected feature applications, including consumer controls, notifications, and energy management. DOE used this information to better inform its testing and validation process.

Throughout 2011, DOE requested pre-market Connected R/F units from manufacturers in an effort to validate the proposed Connected R/F test method; however, only one manufacturer provided DOE with a Connected R/F for testing. While DOE is seeking input on this draft test method, DOE does not plan to finalize the test method until it can obtain additional Connected R/F products for testing. DOE wants to ensure that the Connected R/F test method is applicable to a wide cross-section of the market.

Throughout this test method, DOE references the current DOE Test Procedure in 10 CFR Part 430 Subpart B Appendix A1 and Appendix B1 (DOE Test Procedure). DOE notes that this method and all references within will continue to be valid when the amended DOE Test Procedure in 10 CFR Part 430 Subpart B Appendix A and Appendix B are required to be used in 2014.

Please send comments via email to appliances@energystar.gov no later than March 23, 2012.

2 APPLICABILITY

This test method is applicable to refrigerators, refrigerator-freezers, and freezers intending to meet the Connected appliance requirements in the ENERGY STAR Version 5.0 Program Requirements.

3 DEFINITIONS

Unless otherwise specified, all terms used in this document are consistent with the definitions in the ENERGY STAR Eligibility Criteria for Residential Refrigerators and Freezers Version 5.0 and in the DOE Test Procedure in 10 CFR Part 430 Subpart B Appendix A1 and Appendix B1 (DOE Test Procedure).

30 **Note:** The acronyms, definitions, and discussion below are included in the test method for initial
31 discussion. Most definitions are reproduced from the AHAM Smart Refrigerator, Refrigerator-Freezer,
32 and Freezer Test Procedure (AHAM SRF-0.5-2011). All definitions and acronyms will eventually be
33 moved to the specification document when ENERGY STAR Residential Refrigerators and Freezers
34 Version 5.0 is published.

- 35 A) Utility Equivalent Communication Device: Device capable of communicating with the connected
36 appliance and emulating signals sent from a utility. It will be controlled by the technician and will allow
37 the technician to deliver the Delay Appliance Load and Temporary Appliance Load Reduction signals.
- 38 B) Communication Module (Appliance): A built-in or external device that enables appliance bi-directional
39 communication with a utility or equivalent communication device.

40 **Note:** There are currently no universally accepted standards for connected appliance communication and
41 network architecture, although many efforts are underway including those by the National Institute of
42 Standards and Technology (NIST) Smart Grid Interoperability Panel.

43 The above definitions broadly outline the requirements for testing a connected device for the ENERGY
44 STAR specification. EPA has proposed new “connected” criteria in the Version 5.0 ENERGY STAR
45 Program Requirements for Residential Refrigerators and Freezers currently under development.

- 46 C) Connected Signal Simulation Hardware: Self-contained or Power Computer (PC) based hardware
47 that will allow the operator to execute necessary communication and commands and receive
48 necessary feedback from the Unit Under Test (UUT).
- 49 D) Consumer Override: The capability for an end-user to cancel a product’s response to a demand
50 response (DR) signal.
- 51 E) Signals: Communications to a connected product indicating that it should modify its operation or
52 providing information. Signals include, but are not limited to, delay appliance load, time-based pricing,
53 and notifications for load-shedding to meet temporary energy reduction requirements.
- 54 F) Signal Type - Delay Appliance Load: Capability of an appliance to reduce its average energy input
55 over a specified time period. The delay load command provides the start time and duration of the
56 delay load time period.
- 57 G) Signal Type - Temporary Appliance Load Reduction: Capability of an appliance to reduce its average
58 energy input over a short specified time period. The temporary load reduction command provides the
59 start time and duration of the temporary load reduction time period.
- 60 H) Acronyms:
- 61 • DR: Demand Response
 - 62 • DAL: Delay Appliance Load
 - 63 • TALR: Temporary Appliance Load Reduction
 - 64 • Hz: Hertz
 - 65 • Wh: Watt Hours
 - 66 • W: Watts
 - 67 • UUT: Unit Under Test
 - 68 • F: Fahrenheit
 - 69 • C: Celsius
 - 70 • R/F: Refrigerators, Freezers, and Refrigerator-Freezers

71 **4 TEST REQUIREMENTS**

72 Unless otherwise specified, all test conditions and requirements shall be identical to 10 CFR Part 430,
73 Subpart B, Appendices A1 and B1, Section 2.

74 A) Input Power: Products intended to be powered from an ac mains power source shall be connected to
75 a voltage source appropriate for the intended market, as specified in Table .

76 **Table 1: Input Power Requirements for Products with Nameplate Rated Power Less Than or**
77 **Equal to 1500 watts (W)**

Market	Voltage	Voltage Tolerance	Maximum Total Harmonic Distortion	Frequency	Frequency Tolerance
North America, Taiwan	115 volts (V) ac	+/- 1.0 %	2.00%	60 Hertz (Hz)	+/- 1.0 %
Europe, Australia, New Zealand	230 V ac	+/- 1.0 %	2.00%	50 Hz	+/- 1.0 %
Japan	100 V ac	+/- 1.0 %	2.00%	50 Hz/60 Hz	+/- 1.0 %

78 B) Ambient Temperature: Ambient temperature shall be 90 °F ± 1 °F (32.2°C ± 0.6°C).

79 C) Relative Humidity: Relative humidity shall be from 40-60% and shall be measured at a location three
80 feet above the floor and approximately 10 inches from the front of the UUT.

81 D) Radiation Shield: Shields shall be provided to prevent direct radiation from or to any heated or cooled
82 surfaces whose temperature differs from the air temperature by more than 10 °F.

83 E) Watt Hour Meter: Watt hour meters shall comply with parameters described in 10 CFR Part 430,
84 Subpart B, Appendices A1 and B1, Section 2.

85 **5 PRE-TEST UUT CONFIGURATION**

86 **5.1 General Configuration**

87 A) The UUT shall be setup as described in 10 CFR Part 430, Subpart B, Appendices A1 or B1, Section
88 3.

89 **5.2 Communication Setup**

90 A) Connect the UUT to the utility equivalent communication device via wired or wireless connection
91 depending on the unit's capability. A wireless connection is preferred if both are available.

92 B) Ensure that the unit is properly connected and can both receive and send data to a utility equivalent
93 communication device.

94 **Note:** The utility equivalent communication device used during testing was provided with the UUT.
95 Connection and data transfer were verified using the communication equipment's data monitoring
96 capability. This equipment is necessary for connectivity and data monitoring and is vital for
97 troubleshooting and verifying connectivity.

98 **5.3 UUT Steady State Stabilization**

99 A) All compartment temperature controls shall be set at their median position, midway between their
100 warmest and coldest setting for the entirety of the test.

101 B) Prior to the start of testing, the UUT shall be stabilized according to 10 CFR Part 430, Subpart B,
102 Appendix A1 Section 2.9 or Appendix B1 Section 2.7.

103 **Note:** Although the DOE Test Procedure requires testing at the median, warmest and coldest
104 compartment temperature settings to determine the energy consumption, the tests validating an
105 appliance's connected features are compared to the DOE Test Procedure at the median temperature
106 setting. This provides a comparable baseline setting for comparing average power reduction in response
107 to a demand response signal, while minimizing test burden.

108
109 DOE and EPA request stakeholder feedback on using only the median compartment temperature setting
110 as a baseline for the Connected Test Method.

111 C) The icemaker shall be on with harvesting inoperative, as described in 10 CFR Part 430, Subpart B,
112 Appendices A1 or B1, Section 2.2 No water line installation is required. The UUT shall remain in this
113 configuration throughout testing.

114 **Note:** There is currently no standard method for measuring the energy consumption of automatic
115 icemakers. Although ice-making delay has been suggested as an alternative to a reduction in overall
116 energy consumption, DOE is unable to verify that it is equivalent to a 13% reduction in overall energy
117 consumption. Therefore, all ice-making operations are disabled throughout testing in accordance with the
118 DOE Test Procedure.

119 **6 BASELINE ENERGY CONSUMPTION**

120 **6.1 DOE Baseline**

121 The DOE Test Procedure for Residential Refrigerators and Freezers (10 CFR Part 430, Subpart B,
122 Appendix A1 or B1) shall be performed in its entirety at the median test point with the anti-sweat heater
123 switch, if available, in the "on" position to provide a baseline energy profile for energy reduction from a
124 DR request. All connected features and network modes must be enabled-disabled in accordance with
125 manufacturer instructions during the DOE Baseline Test. If necessary, manufacturers will provide
specific instructions for disabling all connected features and network modes though software, hardware
or other methods, such as through a user interface or by a physical disconnection of an internal module.

126 **Note:** The DOE Test Procedure calls for setting up the test unit in accordance with manufacturer
127 instructions. As the instructions will likely include the installation of connected features, the DOE Baseline
128 Test for verifying DR capability requires enabling all connected features in accordance with manufacturer
129 instructions. This ensures that any steady energy consumption feature is not disabled during testing and
130 that units will reduce energy consumption in accordance with connected criteria based on the intended
131 setup, with no steady energy consumptive feature disabled. The following data shall be obtained to
132 determine the average power reduction from DR compliance.

133 A) The typical compressor duration, D_{comp} , and compressor cycle interval, I_{comp} , shall be determined per
134 Section 4.2 of Appendix A1 or B1 of the DOE Test Procedure. Compressor duration is defined as the
135 typical compressor on-time (in minutes), or time between the compressor turning on and the
136 corresponding compressor turning off. Compressor cycle interval is defined as the typical compressor off
137 time (in minutes), or time between the compressor turning off and the compressor turning on.

138 B) The type of defrost cycle, duration of defrost cycle, $D_{defrost}$, and defrost cycle interval, $I_{defrost}$, shall be
139 determined per Section 4.2 of Appendix A1 or B1 of the DOE Test Procedure. Defrost cycle duration is
140 defined as the typical defrost on time (in minutes), or time between the defrost turning on and the
141 corresponding defrost turning off. Defrost cycle interval is defined as the typical defrost off time (in hours),
142 or time between the defrost turning off and the defrost turning on.

143 C) In accordance with Section 4.2 of Appendices A1 and B1, the energy consumption, EP_{BL} , in Wh, and
144 length of time, T_{BL} , in minutes, shall be recorded based on the first of two parts of the DOE Test
145 Procedure for automatic defrost units.

146 D) Measure the internal refrigerator and freezer compartment temperatures and record the maximum
147 temperatures.

148 **7 DELAY APPLIANCE LOAD TEST**

All connected features and network modes must be enabled with the anti-sweat heater switch, if available, in the “on” position during the Delay Load Appliance Test.

149 **Note:** The current requirements for Delay Appliance Load (DAL) included in the ENERGY STAR
150 Program Requirements for Residential Refrigerators and Freezers Version 5.0 Draft 1 are as follows:
151 *Upon receipt of a delay load signal requesting the delay of a load for a time duration not exceeding four*
152 *hours, the product shall:*

- 153 A) *shift defrost cycles beyond the delay period, and*
- 154 B) *either, shift ice maker cycles beyond the delay period, or reduce average wattage during the delay*
155 *period by at least 13% relative to the baseline average wattage as defined by the DOE Test*
156 *Procedure (10 CFR Part 430 Subpart B, Appendix A1 and/or B1), and may shift this energy*
157 *consumption beyond the delay period.*

158 DOE’s current test procedure does not include a test method for estimating the actual ice maker energy
159 consumption of each individual model. While DOE is currently conducting a rulemaking to address this
160 issue, DOE is not proposing a method of validating the ice maker delay as a substitution for a 13%
161 reduction in energy consumption. Consequently, any response to a delay load signal must be confirmed
162 based on a reduction in energy consumption. This approach is consistent with EPA’s Draft 2 specification
163 (published February 23, 2012), where EPA is proposing to remove the separate pathway for shifting ice
164 maker cycles beyond the delay period.

165 DOE and EPA also request feedback on the interchangeability of ice making and overall energy
166 reduction.

167

168 7.1 Delay Appliance Load Test

- 169 A) Initiate a 4-hour DAL signal 15 minutes before the start of a predicted defrost cycle. For products with
170 manual defrost or off-cycle defrost (in which evaporator surfaces are defrosted during the compressor
171 off-cycle without energizing a heater), send the DAL signal at any time and skip to step C.
- 172 B) If no reliable prediction for the defrost cycle can be determined, follow the steps below to initiate a
173 defrost cycle.
- 174 1) Based on the energy consumption profile obtained during the DOE Test Procedure, determine
175 when the next defrost may occur;
- 176 2) Within two hours of the predicted defrost cycle, open the refrigerator or freezer door to a 90
177 degree angle for a total of 15 seconds;
- 178 3) Shut the door;
- 179 4) Wait five minutes;
- 180 5) Repeat steps 2 – 4 above four times, for a total of five door openings;
- 181 6) Send delay signal.

182 **Note:** The requirements for a Connected R/F in Section 4C of the ENERGY STAR Program
183 Requirements for Residential Refrigerators and Freezers Version 5.0 Draft 1 include “*the product*
184 *shall...shift defrost cycles beyond the delay period.*” To verify that a defrost cycle has been delayed it is
185 important to reliably predict the occurrence of a defrost cycle. A delay signal can then be sent and the DR
186 capabilities of the Connected R/F can be confirmed. Manual and off-cycle defrost units are predictable
187 and a delay can easily be verified; however, defrost occurrence is not easily predicted for units that utilize
188 an automatic defrost. In these cases, it is necessary to manually induce a defrost cycle to verify the
189 Connected R/F requirements.

190 The proposal for triggering a defrost is based on DOE testing of a single UUT using approaches found in
191 10 CFR Part 431, Subpart C, “Uniform Test Method for the Measurement of Energy Consumption of
192 Commercial Refrigerators, Freezers, and Refrigerator-Freezers (70 FR 60414). Unlike the DOE 431
193 Subpart C Test Procedure, the process above is performed at the point when a defrost would likely occur
194 instead of immediately following a defrost cycle.

195 DOE conducted extensive testing to induce defrost on the UUT, including: combinations of door
196 openings, signal timing, and increasing the chamber ambient humidity. However, it was not possible to
197 consistently initiate defrost on the UUT.

198 To verify that defrost is delayed with a DR signal, there must be a reliable method that predicts the
199 defrost cycle. The final method must minimize test burden and the potential for circumvention, while
200 clearly identifying and predicting defrost cycles at independent test labs.

201 DOE and EPA request feedback from stakeholders on the proposed defrost initiation method and on
202 alternate methods for determining and predicting defrost cycles for variable defrost units.

- 203 C) Measure and record the energy consumption, EP_{DL} , and internal temperatures during the four-hour
204 defrost delay test period.
- 205 D) Verify no defrost cycle occurs four hours after the initiation of the delay load signal.

206

8 TEMPORARY APPLIANCE LOAD REDUCTION TEST

All connected features and network modes must be enabled with the anti-sweat heater switch, if available, in the “on” position during the Temporary Appliance Load Reduction Test.

207 **Note:** The current requirements for Temporary Appliance Load Reduction (TALR) included in the
208 ENERGY STAR Program Requirements for Residential Refrigerators and Freezers Version 5.0 Draft 1
209 are as follows:

210 *Upon receipt of this signal, except as permitted below, the product shall restrict its average energy*
211 *consumption during the load reduction period to no more than 50 percent of that consumed during an*
212 *average load over a 24-hour period as defined by the DOE Test Procedure.*

213 *Exceptions - under the following conditions, the product is not required to restrict its average energy*
214 *consumption in response to a temporary appliance load reduction signal.*

215 *1. If the temporary appliance load reduction signal is received during a defrost cycle, that defrost cycle*
216 *may finish. However, no additional defrost cycles shall occur during the time period.*

217 *2. If there is a consumer initiated function such as a door opening or ice/water dispensing during the load*
218 *reduction period.*

219 *The product shall be able to respond to at least one TALR signal in a 24-hour period.*

220 The requirements above state that no additional defrost cycles shall occur during the time period. The
221 method for initiating a defrost proposed in section 7.1.B may be effective for predicting a defrost within a
222 few hours, but it cannot estimate a defrost cycle occurrence in 10 minutes. Additionally, testing did not
223 produce a situation where a defrost would occur within 10 minutes of a previous defrost cycle. For these
224 reasons, DOE does not propose a test to verify that a defrost does not occur during the TALR signal
225 duration; however, the test lab shall record and verify that no defrost cycles occur during TALR signals.

226 8.1 Temporary Appliance Load Reduction Test

227 A) Initiate a 10-minute TALR signal within five minutes after the start of a compressor On cycle.

228 **Note:** In an effort to minimize test burden and reproduce a worst-case scenario, the TALR signal is sent
229 shortly after the start of a compressor cycle. At this time, compartment temperatures have risen and the
230 compressor is necessary. If the unit is able to operate according to TALR requirements in this case, then
231 it is assumed to satisfy all other TALR situations (compressor off, the end of a compressor “on” cycle).

232 B) Verify no defrost cycle occurs during the TALR signal test period.

233 C) Measure and record the energy consumption, EP_{TALR} , and average internal temperatures during the
234 10-minute TALR test period.

235 9 CONSUMER OVERRIDE

236 **Note:** The requirements for a Connected R/F in Section 4C of the ENERGY STAR Program
237 Requirements for Residential Refrigerators and Freezers Version 5.0 Draft 1 include: “The consumer
238 shall be allowed to override the product’s response to the Delay Appliance Load and Temporary
239 Appliance Load signals.” EPA and DOE are sensitive to the needs and satisfaction of the consumer.
240 Although not directly related to energy consumption, the consumer override is an integral feature that
241 consumers will find highly valuable and necessary. Therefore, DOE has investigated several approaches
242 for verifying the consumer override functionality of Connected R/Fs.

243
244 The following steps outline a method for verifying consumer override effectiveness. These steps are
245 written for a TALR signal but are adjustable for Delay Loads.

- 246 1. Send a 10-minute TALR signal within XX minutes after the start of a compressor On cycle, as
247 determined in 6.1.A.
- 248 2. Following the initiation of the TALR signal, activate the consumer override.
- 249 3. Verify the override is activated and the UUT returns to normal compressor cycle operation for the
250 duration of the TALR signal.

251 Although the consumer override is an important feature, DOE is hesitant to include it as a feature
252 required for testing as it will increase test burden. Consumer override is a feature, which DOE believes
253 manufacturers will address during the development process. DOE and EPA request feedback from
254 stakeholders on the importance and possible inclusion of consumer override testing.

255 10 CALCULATIONS

256 10.1 **DOE** Baseline Average Power

257 Calculate the average **DOE** baseline power, AP_{BL} .

258 **Equation 1: Baseline Average Power**

$$AP_{BL} = \frac{(EP_{BL} \times 1000)}{\left(\frac{T_{BL}}{60}\right)}$$

259 *Where:*

- 260 • AP_{BL} is the average baseline power in W, [as described in Section 6.1](#)
- 261 • EP_{BL} is the baseline energy consumption in kWh
- 262 • 1000 is the conversion factor from kWh to Wh
- 263 • T_{BL} is the baseline time period in minutes
- 264 • 60 is the conversion factor from minutes to hours

265 10.2 Delay Load Period Average Power

266 Calculate the average baseline power, AP_{DL} .

267 **Equation 2: Delay Load Average Power**

$$AP_{DL} = \frac{(EP_{DL} \times 1000)}{\left(\frac{T_{DL}}{60}\right)}$$

268 *Where:*

- 269 • AP_{DL} is the average delay load power in W
- 270 • EP_{DL} is the delay load energy consumption in kWh

- 271 • 1000 is the conversion factor from kWh to Wh
- 272 • T_{DL} is the delay load duration in minutes
- 273 • 60 is the conversion factor from minutes to hours

274 **10.3 Percent Delay Load Average Power Reduction**

275 Calculate the percent average delay load power reduction compared to the DOE Baseline Test Procedure.

276 **Equation 3: Percent Delay Load Average Power Reduction**

$$\text{Percent Wattage Reduction} = \frac{(AP_{BL} - AP_{DL})}{AP_{BL}} \times 100\%$$

277 Where:

- 278 • AP_{BL} is the average baseline power, calculated in section 10.1 (W)
- 279
- 280 • AP_{DL} is the average delay load power calculated in section 10.2 (W)
- 281
- 282

283 **10.4 Temporary Appliance Load Reduction Average Power**

284 Calculate the average TALR power, AP_{TALR} .

285 **Equation 4: TALR Average Power**

$$AP_{TALR} = \frac{(EP_{TALR} \times 1000)}{\left(\frac{10}{60}\right)}$$

286 Where:

- 287 • AP_{TALR} is the average TALR power in W
- 288 • EP_{TALR} is the TALR energy consumption in kWh
- 289 • 10/60 is the time duration of the TALR period in hours

290 **10.5 Percent TALR Signal Average Power Reduction Consumed**

291 Calculate the percent average TALR power reduction consumed compared to the DOE Baseline Test Procedure.

292 **Equation 5: Percent TALR Average Power Consumed Reduciton**

$$\text{Percent Wattage ~~Reduction~~Consumed} = \left[1 - \frac{(AP_{BL} - AP_{TALR})}{AP_{BL}} \right] \times 100\%$$

Equation and Descriptive Language Correction Explained: The language and the formula are incorrect in 10.5. According to line 210 of section 8, the limit to be measured is described as;

“[T]he product shall restrict its average energy consumption during the load reduction period to no more than 50 percent of that consumed during an average load over a 24-hour period as defined by the DOE Test Procedure.”

Therefore, this calculation should compare the average TALR power consumed to that of the DOE Baseline Test rather than measure the average power reduced from the DOE Baseline Test. The formula should include a “1-“ within the brackets because if $AP_{TALR} = 0$, then the Percent Wattage Consumed should equal 0%.

However, this is not the case under the original language when setting $AP_{TALR} = 0$, as shown below.

$$\text{Percent Wattage Consumed} = \frac{(AP_{BL} - 0)}{AP_{BL}} \times 100\%$$

$$\text{Percent Wattage Consumed} = \frac{AP_{BL}}{AP_{BL}} \times 100\%$$

$$\text{Percent Wattage Consumed} = 1 \times 100\% = 100\%$$

The proposed correction is the following equation.

$$\text{Percent Wattage Consumed} = \left[1 - \frac{(AP_{BL} - AP_{TALR})}{AP_{BL}} \right] \times 100\%$$

Setting $AP_{TALR} = 0$ in the equation above results in an answer, as shown below, aligned with the language in this Test Procedure and in the Specification.

$$\text{Percent Wattage Consumed} = \left[1 - \frac{(AP_{BL} - 0)}{AP_{BL}} \right] \times 100\%$$

$$\text{Percent Wattage Consumed} = \left[1 - \frac{AP_{BL}}{AP_{BL}} \right] \times 100\% = [1 - 1] \times 100\% = 0\%$$

293
294
295
296
297

Where:

- AP_{BL} is the average baseline power, calculated in section 10.1 (W)
- AP_{TALR} is the average TALR power calculated in section 10.4 (W)

298 11 REFERENCES

- 299 10 CFR Part 430, Subpart B, Appendix A1. Uniform Test Method for Measuring the Energy Consumption
300 of Electric Refrigerators and Electric Refrigerator-Freezers.
- 301 10 CFR Part 430, Subpart B, Appendix B1. Uniform Test Method for Measuring the Energy Consumption
302 of Freezers.
- 303 AHAM SRF-0.5-2011. AHAM Smart Refrigerator, Refrigerator-Freezer, and Freezer Test Procedure.
304 Draft shared with DOE September 2011.
- 305 ENERGY STAR Program Requirements for Residential Refrigerators and Freezers - Eligibility Criteria
306 Draft 1 Version 5.0. Published November 2011.
- 307 10 CFR Part 431, Subpart C. Uniform Test Method for the Measurement of Energy Consumption of
308 Commercial Refrigerators, Freezers, and Refrigerator-Freezers. .