



ENERGY STAR® Program Requirements Product Specification for Residential Refrigerators, Freezers, and Refrigerator-Freezers

Final Draft Test Method to Validate Demand Response Rev. March-2013

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.

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 A and Appendix B (DOE Test Procedure).

- A) Utility Equivalent Communication Device: Device capable of communicating with the connected appliance and emulating signals sent from a utility. It will be controlled by the technician and will allow the technician to deliver the Delay Appliance Load and Temporary Appliance Load Reduction signals.
- B) Communication Module (Appliance): A built-in or external device that enables appliance bi-directional communication with the Utility Equivalent Communication Device.
- C) Connected Signal Simulation Hardware: Self-contained or Power Computer (PC) based hardware that will allow the operator to execute necessary communications and commands and receive necessary feedback from the Unit Under Test (UUT).
- D) Consumer Override: The capability for an end-user to cancel a product's response to a DR signal.
- E) Signals: Communications to a connected product that provide information or indicate that it should modify its operation. Signals include, but are not limited to, Delay Appliance Load (DAL), Temporary Appliance Load Reduction (TALR), and time-based pricing.
- F) Delay Appliance Load Capability: Capability of an appliance to reduce its average energy input over a specified time period. The delay load command provides the start time and duration of the delay load time period.
- G) Temporary Appliance Load Reduction Capability: Capability of an appliance to reduce its average energy input over a short specified time period. The temporary load reduction command provides the start time and duration of the temporary load reduction time period.
- H) Acronyms:
 - DR: Demand Response
 - DAL: Delay Appliance Load

- 33 • TALR: Temporary Appliance Load Reduction
- 34 • Wh: Watt Hours
- 35 • W: Watts
- 36 • UUT: Unit Under Test

37 **4 TEST REQUIREMENTS**

38 Unless otherwise specified, all test conditions and requirements shall be identical to 10 CFR Part 430,
39 Subpart B, Appendices A or B, Section 2.

40 **5 PRE-TEST UUT CONFIGURATION**

41 **5.1 General Configuration**

42 The UUT shall be set up as described in 10 CFR Part 430, Subpart B, Appendices A or B, Section 3.

43 **5.2 Communication Setup**

44 The communication device shall be set up in accordance with manufacturer installation instructions. The
45 communication device setup described below applies only to the Demand Response tests in Sections 7
46 and 8.

- 47 A) Connect the Communication Module to the Utility Equivalent Communication Device via wired or
48 wireless connection depending on the module's capability. A wireless connection is preferred if both
49 are available.
- 50 B) Ensure that the module is properly connected, secured according to manufacturer instructions, and
51 can both receive and send data to the Utility Equivalent Communication Device.

52 **5.3 UUT Steady State Stabilization**

- 53 A) All compartment temperature controls shall be set at their median position, as described for the "first
54 test" in 10 CFR 430, Subpart B, Appendix A or Appendix B, Section 3.2.1.
- 55 B) Prior to the start of testing, the UUT shall be stabilized according to 10 CFR Part 430, Subpart B,
56 Appendix A Section 2.9 or Appendix B Section 2.7.
- 57 C) The ice maker shall be on with harvesting inoperative, as described in Section 2.2 of the DOE Test
58 Procedure. The ice maker shall remain in this inoperative state throughout testing unless otherwise
59 specified.
- 60 D) If the UUT is equipped with an automatic ice maker, water line installation is required in accordance
61 with the printed instructions supplied with the cabinet or water line for the Ice Maker Deferral test.

62 **6 BASELINE ENERGY CONSUMPTION**

63 **6.1 DOE Baseline**

- 64 A) Measure the energy consumption, EP_1 , in Wh, and length of time, T_1 , in minutes, as described in
65 Section 4.1 of the DOE Test Procedure. Conduct the test at the median temperature set point, as
66 described in Section 3.2.1 of the DOE Test Procedure, with the anti-sweat heater switch, if present, in
67 the "off" position. EP_1 and T_1 shall be represented in the DR calculations by EP_{BL} and T_{BL} .
- 68 B) If the UUT has automatic defrost as specified in Section 4.2 of the DOE Test Procedure, and does not
69 require the use of the two part test described in Sections 4.2.1 through 4.2.3:

- 70 1) Select a stable test period consistent with that of the first part test of a Long-time Automatic
71 Defrost unit as described in Section 4.2.1 of the DOE Test Procedure.
- 72 2) Identify the energy consumed during the selected test period, EP_{AD} , in Wh, and the duration of
73 the selected test period, T_{AD} , in minutes. EP_{AD} and T_{AD} shall be represented in the DR calculations
74 by EP_{BL} and T_{BL} .

75 **7 DELAY APPLIANCE LOAD (DAL) TEST**

76 All connected features and network modes must be setup and enabled per Section 5.2, and the anti-
77 sweat heater switch, if present, must be in the “off” position, during the Delay Appliance Load Test. As
78 specified in the ENERGY STAR Program Requirements for Residential Refrigerators and Freezers
79 Version 5.0, only one of the following tests in Section 7 are required for complying with Delay Appliance
80 Load requirements.

81 **7.1 Delay Appliance Load Test - Ice Maker Deferral**

- 82 A) Activate the ice maker harvest capabilities.
- 83 B) Ensure that the ice maker is properly activated through the successful production of ice.
- 84 C) Once ice making operations are activated, empty the ice bin, if necessary, and initiate a four-hour
85 DAL signal.
- 86 D) Ensure that all ice maker operations are deferred beyond the test period by confirming the ice bin is
87 empty at the end of the four-hour test period.
- 88 E) Verify no precool cycle (as defined in Section 4.2.1.1 of the DOE Test Procedure) occurs and the
89 defrost heater is off during the entire duration of the four-hour DAL test period.
- 90 F) For the remainder of testing, return the ice maker to its inoperative state as described in Section
91 5.3.C and empty the ice bin if ice is present.

92 **7.2 Delay Appliance Load Test - Percent Reduction**

- 93 A) Initiate a four-hour DAL signal within five minutes after the start of a compressor on cycle.
- 94 B) Measure and record the energy consumption, EP_{DL} , during the four-hour DAL test period.
- 95 C) Verify no precool cycle occurs and the defrost heater is off during the entire duration of the four-hour
96 DAL test period.

97 **8 TEMPORARY APPLIANCE LOAD REDUCTION (TALR) TEST**

98 All connected features and network modes must be setup and enabled per Section 5.2, and the anti-
99 sweat heater switch, if present, must be in the “off” position, during the Temporary Appliance Load
100 Reduction Test.

101 **8.1 Temporary Appliance Load Reduction Test**

- 102 A) Initiate a 10-minute TALR signal within five minutes after the start of a compressor on cycle.
- 103 B) Measure and record the energy consumption, EP_{TALR} , during the 10-minute TALR test period.
- 104 C) Verify no precool cycle occurs and the defrost heater is off during the entire duration of the 10-minute
105 TALR test period.

106 **9 CALCULATIONS**

107 **9.1 DR Baseline Average Power**

108 Calculate the average DR baseline power, AP_{BL} .

109 **Equation 1: DR Baseline Average Power**

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

110 *Where:*

- 111 • AP_{BL} is the average baseline power in W
- 112 • EP_{BL} is the baseline energy consumption in kWh, as
- 113 described in section 6.1
- 114 • 1000 is the conversion factor from kWh to Wh
- 115 • T_{BL} is the baseline time period in minutes, as described in
- 116 section 6.1
- 117 • 60 is the conversion factor from minutes to hours

118 **9.2 Delay Load Period Average Power**

119 Calculate the average delay load power, AP_{DL} .

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

$$AP_{DL} = \frac{(EP_{DL} \times 1000)}{4}$$

121 *Where:*

- 122 • AP_{DL} is the average delay load power in W
- 123 • EP_{DL} is the delay load energy consumption in kWh, as
- 124 described in section 7.2
- 125 • 1000 is the conversion factor from kWh to Wh
- 126 • 4 is the delay load duration in hours

127 **9.3 Percent Delay Load Average Power Reduction**

128 Calculate the percent average delay load power reduction compared to the DR Baseline Test.

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

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

130 *Where:*

- 131 • AP_{BL} is the average baseline power in W, as calculated in
- 132 section 9.1
- 133 • AP_{DL} is the average delay load power in W, as calculated
- 134 in section 9.2

135 **9.4 Temporary Appliance Load Reduction Average Power**

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

137 **Equation 4: TALR Average Power**

$$AP_{TALR} = \frac{(EP_{TALR} \times 1000)}{0.1667}$$

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Where:

- AP_{TALR} is the average TALR power in W
- EP_{TALR} is the TALR energy consumption in kWh, as described in section 8.1
- 0.1667 is the time duration of the TALR period in hours

143 9.5 Percent TALR Average Power Consumed

144 Calculate the percent average TALR power consumed compared to the DOE Baseline Test.

145 Equation 5: Percent TALR Average Power Consumed

$$\text{Percent Average Power Consumed} = \frac{AP_{TALR}}{AP_{BL}} \times 100\%$$

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Where:

- AP_{BL} is the average baseline power in W, as calculated in section 9.1
- AP_{TALR} is the average TALR power in W, as calculated in section 9.4

151 10 REFERENCES

- 152 A) 10 CFR Part 430, Subpart B, Appendix A. Uniform Test Method for Measuring the Energy
153 Consumption of Electric Refrigerators and Electric Refrigerator-Freezers.
- 154 B) 10 CFR Part 430, Subpart B, Appendix B. Uniform Test Method for Measuring the Energy
155 Consumption of Freezers.
- 156 C) ENERGY STAR Program Requirements for Residential Refrigerators and Freezers - Eligibility Criteria
157 Version 5.0 Draft 3 published September 2012.