



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

Eligibility Criteria Version 5.0

California Energy Commission

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Following is the **Version 5.0** product specification for ENERGY STAR qualified residential refrigerators and freezers. A product shall meet all of the identified criteria to earn the ENERGY STAR.

- 1) **Definitions:** Below are the definitions of the relevant terms in this document. Unless otherwise specified, these definitions are harmonized with definitions in the DOE test procedures at 10 CFR 430, Subpart B, Appendix A or in 10 CFR Subpart A, Section 430.2.
- A. **Electric Refrigerator:** A cabinet designed for the refrigerated storage of food, designed to be capable of achieving storage temperatures above 32 °F (0 °C) and below 39 °F (3.9 °C), and having a source of refrigeration requiring single phase, alternating current electric energy input only. An electric refrigerator may include a compartment for the freezing and storage of food at temperatures below 32 °F (0 °C), but does not provide a separate low temperature compartment designed for the freezing and storage of food at temperatures below 8 °F (-13.3 °C).
 - B. **Freezer:** A cabinet designed as a unit for the freezing and storage of food at temperatures of 0 °F (-17.8 °C) or below, and having a source of refrigeration requiring single phase, alternating current electric energy input only.
 - C. **Electric Refrigerator-Freezer:** A cabinet which consists of two or more compartments with at least one of the compartments designed for the refrigerated storage of food and designed to be capable of achieving storage temperatures above 32 °F (0 °C) and below 39°F (3.9 °C), and with at least one of the compartments designed for the freezing and storage of food at temperatures below 8 °F (-13.3 °C) which may be adjusted by the user to a temperature of 0 °F (-17.8 °C) or below. The source of refrigeration requires single phase, alternating current electric energy input only.
 - D. **Adjusted Volume (AV):** The sum of the fresh food compartment volume in cubic feet, and the product of an adjustment factor and the net freezer compartment volume. Volumes shall be calculated as described in 10 CFR 430 Appendix A. Volume adjustment factors shall be as prescribed in 10 CFR 430 Appendix A § 6.1.
 - E. **Compact refrigerator/refrigerator-freezer/freezer:** Any refrigerator, refrigerator-freezer or freezer with total volume less than 7.75 cubic feet (220 liters) (rated volume as determined in Appendix A and B of 10 CFR 430 subpart B).
 - F. **Built-in refrigerator/refrigerator-freezer/freezer:** Any refrigerator, refrigerator-freezer, or freezer with 7.75 cubic feet or greater total volume and 24 inches or less depth not including doors, handles, and custom front panels; with sides which are not finished and not designed to be visible after installation; and that is designed, intended, and marketed exclusively (1) to be installed totally encased by cabinetry or panels that are attached during installation, (2) to be securely fastened to adjacent cabinetry, walls or floor, and (3) to either be equipped with an integral factory-finished face or accept a custom front panel.
 - G. **Basic Model:** All units of a given type of 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.

2) Scope:

- A. Included Products: Products that meet the definition of (i) an Electric Refrigerator, Electric Refrigerator-Freezer, or Freezer, including compact and built-in products, as specified herein and (ii) the definition of a consumer product as specified in 10 CFR § 430.2 are eligible for ENERGY STAR qualification.
- B. Excluded Products: Commercial refrigeration equipment (as defined in 10 CFR § 431.62), Freezers, and Refrigerators, and Refrigerator-Freezers with a total refrigerated volume exceeding 39 cubic feet are not eligible for ENERGY STAR. Products that are covered under other ENERGY STAR product specifications (e.g. Commercial Refrigerators) are not eligible for qualification under this specification. Wine refrigerators or other products that do not meet the definition of an Electric Refrigerator or Electric Refrigerator-Freezer are not eligible for qualification under this specification.

3) Qualification Criteria:

A. Energy Use Requirements

- 1. Annual Energy Consumption (AEC) shall be less than or equal to Maximum Annual Energy Consumption (AEC_{MAX}), as calculated per Equation 1.

Equation 1. Calculation of Maximum Annual Energy Consumption Requirement

$$AEC_{MAX} = AEC_{BASE} + \sum_{i=1}^n AEC_{ADD_i}$$

where,

AEC_{BASE} is the annual energy consumption base allowance, per Table 1; and

AEC_{ADD_i} is an annual energy functional adder, per Table 2

Table 1: Annual Energy Consumption Base Allowances

Product Class	Annual Energy Consumption Base Allowance, AEC _{BASE} (kWh/year)	% Less Energy than Measured Energy Use
Full-Size Refrigerators and Refrigerator-freezers		
1. Refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost.	$7.19 * AV + 202.5$	10%
1A. All-refrigerators—manual defrost.	$6.11 * AV + 174.2$	10%
2. Refrigerator-freezers—partial automatic defrost.	$7.19 * AV + 202.5$	10%
3. Refrigerator-freezers—automatic defrost with top-mounted freezer without an automatic icemaker.	$7.26 * AV + 210.3$	10%
3–BI. Built-in refrigerator-freezer—automatic defrost with top-mounted freezer without an automatic icemaker.	$8.24 * AV + 238.4$	10%
3I. Refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	$7.26 * AV + 294.3$	10%
3I–BI. Built-in refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker without through-the-door ice service.	$8.24 * AV + 322.4$	10%
3A. All-refrigerators—automatic defrost.	$6.36 * AV + 181.4$	10%
3A–BI. Built-in All-refrigerators—automatic defrost.	$7.22 * AV + 205.7$	10%
4. Refrigerator-freezers—automatic defrost with side-mounted freezer without through-the-door ice service.	$7.66 * AV + 268.0$	10%
4–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer without an automatic icemaker.	$9.20 * AV + 321.7$	10%
4I. Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	$7.66 * AV + 352.0$	10%
4I–BI. Built-In Refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker without through-the-door ice service.	$9.20 * AV + 405.7$	10%
5. Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	$7.97 * AV + 285.3$	10%
5–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer without an automatic icemaker.	$8.46 * AV + 303.2$	10%
5I. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	$7.97 * AV + 369.3$	10%
5I–BI. Built-In Refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker without through-the-door ice service.	$8.46 * AV + 387.2$	10%
5A. Refrigerator-freezers—automatic defrost with bottom-mounted freezer with through-the-door ice service.	$8.33 * AV + 436.3$	10%
5A–BI. Built-in refrigerator-freezer—automatic defrost with bottom-mounted freezer with through-the-door ice service.	$8.85 * AV + 458.3$	10%
6. Refrigerator-freezers—automatic defrost with top-mounted freezer with through-the-door ice service.	$7.56 * AV + 355.3$	10%
7. Refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	$7.69 * AV + 397.9$	10%

Table 1 (cont.): Annual Energy Consumption Base Allowances

Product Class	Annual Energy Consumption Base Allowance, AEC_{BASE} (kWh/year)	% Less Energy than Measured Energy Use¹
7-BI. Built-in refrigerator-freezers—automatic defrost with side-mounted freezer with through-the-door ice service.	$9.23 * AV + 460.7$	10%
Full-Size Freezers		
8. Upright freezers with manual defrost.	$5.01 * AV + 174.3$	10%
9. Upright freezers with automatic defrost without an automatic icemaker.	$7.76 * AV + 205.5$	10%
9I. Upright freezers with automatic defrost with an automatic icemaker.	$7.76 * AV + 289.5$	10%
9-BI. Built-In Upright freezers with automatic defrost without an automatic icemaker.	$8.87 * AV + 234.8$	10%
9I-BI. Built-in upright freezers with automatic defrost with an automatic icemaker.	$8.87 * AV + 318.8$	10%
10. Chest freezers and all other freezers except compact freezers.	$6.56 * AV + 97.0$	10%
10A. Chest freezers with automatic defrost.	$9.22 * AV + 133.3$	10%
Compact Refrigerators and Refrigerator-Freezers		
11. Compact refrigerator-freezers and refrigerators other than all-refrigerators with manual defrost.	$8.13 * AV + 227.1$	10%
11A. Compact all-refrigerators—manual defrost.	$7.06 * AV + 197.2$	10%
12. Compact refrigerator-freezer—partial automatic defrost.	$5.32 * AV + 302.2$	10%
13. Compact refrigerator-freezers—automatic defrost with top-mounted freezer.	$10.62 * AV + 305.3$	10%
13I. Compact refrigerator-freezers—automatic defrost with top-mounted freezer with an automatic icemaker.	$10.62 * AV + 389.3$	10%
13A. Compact all-refrigerators—automatic defrost.	$8.25 * AV + 233.4$	10%
14. Compact refrigerator-freezers—automatic defrost with side-mounted freezer.	$6.14 * AV + 411.2$	10%
14I. Compact refrigerator-freezers—automatic defrost with side-mounted freezer with an automatic icemaker.	$6.14 * AV + 495.2$	10%
15. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer.	$10.62 * AV + 305.3$	10%
15I. Compact refrigerator-freezers—automatic defrost with bottom-mounted freezer with an automatic icemaker.	$10.62 * AV + 389.3$	10%
16. Compact upright freezers with manual defrost.	$7.79 * AV + 203.1$	10%
17. Compact upright freezers with automatic defrost.	$9.15 * AV + 316.7$	10%
18. Compact chest freezers.	$8.33 * AV + 123.1$	10%

Table 2: Annual Energy Functional Adders

Description	Product Class	Annual Energy Consumption Allowance, AEC_{ADD_i} (kWh/year) ²
Connected	All product classes in Table 1 ¹	$0.05 \times AEC_{BASE}$

¹ To be eligible for the allowance, the product must be qualified using the final and validated ENERGY STAR Program Requirements Product Specification for Residential Refrigerators and Freezers Test Method to Validate Demand Response.

² Calculated allowance shall be rounded down to the nearest tenth before being applied in Equation 1.

- B. **Determination of Adjusted Volume:** Adjusted Volume (AV) shall be calculated in accordance with the DOE test procedure in 10 CFR 430 Subpart B, Appendix A.
- C. **Significant Digits and Rounding:**
 - 1. All calculations shall be carried out as specified in 10 CFR 430 Subpart B, Appendix A and 10 CFR § 430.23(a)(5).
 - 2. The Maximum Annual Energy Consumption specification limit, as determined by Equation 1, shall be rounded off to the nearest kWh per year. If the calculation is halfway between the nearest two kWh per year values, the Maximum Annual Energy Consumption shall be rounded up to the higher of these values.
- D. **Model Numbers:** Model numbers used for ENERGY STAR qualified product submissions shall be consistent with Federal Trade Commission (FTC) and Department of Energy (DOE) submissions.

4) Connected Product Criteria:

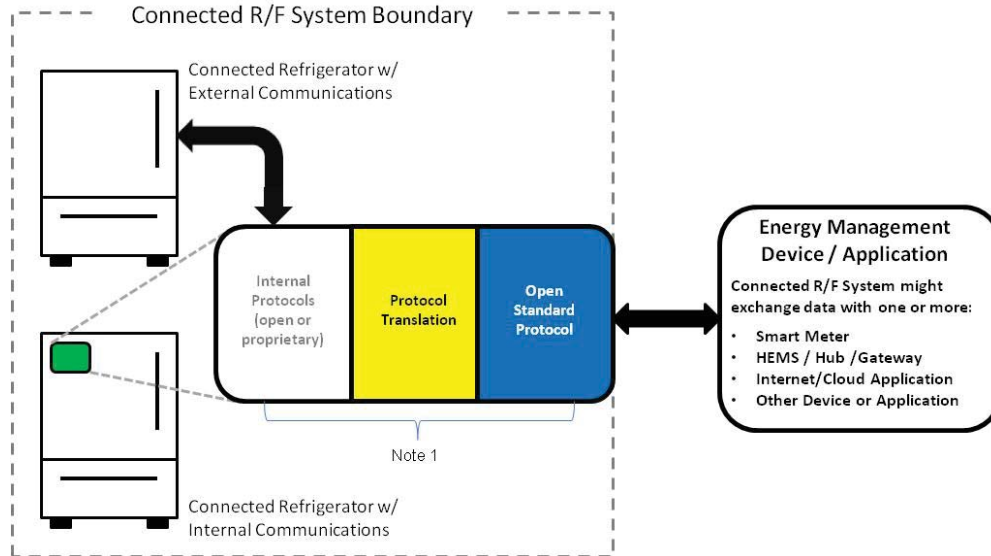
A. Connected Refrigerator, Freezer, or Refrigerator-Freezer System

To be recognized as connected and to be eligible for the connected allowance, a “connected refrigerator, freezer, or refrigerator-freezer system” (Connected R/F System, as shown in Figure 1) shall include the base refrigerator, freezer, or refrigerator-freezer plus all elements (hardware, software) required to enable communication in response to consumer-authorized energy related commands (*not including third-party remote management which may be made available solely at the discretion of the manufacturer*). These elements may be resident inside or outside of the base appliance. This capability shall be supported through one or more means, as identified in section 4B2.

The specific design and implementation of the Connected R/F System is at the manufacturer’s discretion provided it is interoperable with other devices via open communications protocol and enables economical, consumer-authorized third party access to the functionalities provided for in sections 4D, 4F, 4G and 4H. The capabilities shall be supported through one or more means, as identified in section 4B2. A product that enables economical and direct, on-premises, open- standards based interconnection is the preferred option for meeting this requirement, but alternative approaches are also acceptable.

The product must continue to comply with the applicable product safety standards – the addition of the functionality described below shall not override existing safety protections and functions. The appliance must meet manufacturer’s internal minimum performance guidelines, e.g., food preservation.

Figure 1. Connected Refrigerator/Freezer System Boundary – Illustrative Example



Note 1: Communication device(s), link(s) and/or processing that enables open standards-based communication between the Connected R/F System and Energy Management Device/Application(s). These elements could be within the base appliance, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

B. Communications

1. Open Standards – Communication with entities outside the Connected R/F System that enables connected functionality (sections 4D, 4F, 4G and 4H) must use, for all communication layers, standards that are:
 - a. Included in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards,¹ and/or
 - b. Included in the NIST Smart Grid framework Tables 4.1 and 4.2, and/or
 - c. Adopted by the American National Standards Institute (ANSI) or another well-established international standards organization such as the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE), or Internet Engineering Task Force (IETF).
2. Communications Hardware Architecture – Communication with entities outside the Connected R/F System that enables connected functionality (sections 4D through 4H) shall be enabled by any of the following means, according to the manufacturer's preference:
 - a. Built-in communication technology
 - b. Manufacturer-specific external communication module(s) and/or device(s)
 - c. Open standards-based communication port on the appliance combined with open standards-based communications module
 - d. Open standards-based communication port(s) on the appliance in addition to a, b or c, above

If option b or c is used, the communication module/device(s) must be easy for a consumer to install and shipped with the appliance, provided to the consumer at the time of sale, or provided to the consumer in a reasonable amount of time after the sale.

¹ http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PMO#Catalog_of_Standards_Processes

C. Open Access

To enable interconnection with the product, in addition to section 4B1 that requires open-standards, an interface specification, API or similar documentation shall be made available to interested parties that at a minimum, allows transmission, reception, and interpretation of the following information:

1. Energy Consumption Reporting specified in section 4D (must include accuracy, units and measurement interval);
2. Operational Status, User Settings & Messages specified in section 4F (if transmitted via a communication link);
3. Communications required to enable Delay Defrost Capability specified in section 4G; and
4. Demand Response specified in section 4H.

D. Energy Consumption Reporting

In order to enable simple, actionable energy use feedback to consumers and consumer authorized energy use reporting to 3rd parties, the product shall be capable of transmitting energy consumption data via a communication link to energy management systems and other consumer authorized devices, services, or applications. This data shall be representative of the product's interval energy consumption. It is recommended that data be reported in watt-hours for intervals of 15 minutes or less, however, representative data may also be reported in alternate units and intervals as specified in the product manufacturer's interface specification or API detailed in section 4C.

The product may also provide energy use feedback to the consumer on the product itself. On-product feedback, if provided, may be in units and format chosen by the manufacturer (e.g., \$/month).

E. Remote Management

The product shall be capable of receiving and responding to consumer authorized remote requests (*not including third-party remote management which may be made available solely at the discretion of the manufacturer*), via a communication link, similar to consumer controllable functions on the product. The product is not required to respond to remote requests that would compromise performance and/or product safety as determined by the product manufacturer.

F. Operational Status, User Settings & Messages

1. The product shall be capable of providing the following information to energy management systems and other consumer authorized devices, services, or applications via a communication link:
 - Demand Response (DR) status (e.g., normal operation, delay appliance load, temporary appliance load reduction).
2. The product shall be capable of providing the following information on the product and/or to energy management systems and other consumer authorized devices, services, or applications via a communication link:
 - At least two types of messages relevant to the energy consumption of the product. For example, messages for refrigerators, refrigerator-freezers and freezers, might address: door left open notification, a notification that product lost power, a reminder to clean refrigerator coils, or report of energy consumption that is outside the product's normal range.

G. Delay Defrost Capability

When interconnected with an energy management system or other consumer authorized device, service, or application via a communication link, products with automatic defrost shall have a delay defrost capability active by default, where the consumer can input or the product itself shall identify, the time of day, and the product shall automatically move the defrost function outside of a 4-hour deferral period. The default deferral period is seasonal and has been defined to align with both summer and winter peak energy demand periods, as follows:

- 6am to 10am – November 1 through April 30
- 3pm to 7pm – May 1 through October 31

The product shall provide an option for the consumer and/or consumer authorized 3rd party to modify scheduling and functional status of this capability in order to, for example: respond to a short term request from the utility, align defrost avoidance periods with on-peak periods for their utility, or enable/disable the capability.

In the event of a power outage, after power is restored the product shall not require any interaction from the consumer to maintain this defrost deferral feature with the same settings as prior to the power outage.

Exceptions:

- Once the consumer enrolls in a program that sends consumer-authorized signals to the R/F System, the Delay Defrost capability, as defined in this section, shall be disabled. The product may include an optional transition period of up to 24-hours after enrollment, during which the R/F System is not required to provide either Delay Defrost capability or DR capability as defined in Section 4H.
- A refrigerator, refrigerator-freezer or freezer with manual defrost or partial automatic defrost is not required to provide Delay Defrost Capability.

H. Demand Response

A connected refrigerator, freezer or refrigerator-freezer shall have the capability to receive, interpret and act upon consumer-authorized signals by automatically adjusting its operation depending on both the signal's contents and settings from consumers. At a minimum, the product shall be capable of providing the following:

1. *Delay Appliance Load Capability:* The capability of the product to respond to a signal by providing a moderate load reduction for the duration of a delay period.
 - a. Upon receipt of signal and in accordance with consumer settings, except as permitted below, the product shall:
 - i. Shift its defrost cycle(s) beyond the delay period, and
 - ii. Either shift ice maker cycles beyond the delay period or reduce its average power draw during the delay period by at least 13% relative to the average power draw drawn during an average load over a 24-hour period as defined by the DOE Baseline in the Test Method to Validate Demand Response.
 - b. Exceptions:
 - i. The product is not required to provide a response in accordance with 4H1(a) if the signal requests the delay load period to begin while a defrost heater is engaged. That defrost cycle may finish, however, no additional defrost cycle(s) shall occur during the delay period, and/or
 - ii. The product is not required to provide a response in accordance with 4H1(a)(ii) if the delay appliance load signal requests the delay load period to begin while the product is in an ice-maker harvest/refill cycle. The product must however, continue to provide a response in accordance with 4H1(a)(i).

- c. Default settings –The product shall ship with default settings that enable a response in accordance with 4H1(a) for at least 4 hours.
 - d. Consumer override – The consumer shall be able to override the product’s Delay Appliance Load response before or during a delay period.
 - e. The product shall be able to provide at least one Delay Appliance Load response in a rolling 24-hour period.
2. *Temporary Appliance Load Reduction Capability:* The capability of the product to respond to a signal by providing an aggressive load reduction for a short time period, typically 10 minutes.
- a. Upon receipt of signal and in accordance with consumer settings, except as permitted below, the product shall restrict its average power draw during the load reduction period to no more than 50% of the average power draw during an average load over a 24-hour period as defined by the DOE Baseline in the Test Method to Validate Demand Response.
 - b. Exceptions – Under the following conditions, the product is not required to provide a response in accordance with 4H2(a):
 - i. If a signal is received while a defrost heater is engaged, that defrost cycle may finish. However, no additional defrost cycle(s) shall occur during the time period, and/or
 - ii. If there is a consumer-initiated function such as a door opening or ice/water dispensing during the load reduction period.
 - c. Default settings - The product shall ship with default settings that enable a response in accordance with 4H2(a) for a time period of least 10 minutes.
 - d. Consumer override – The consumer shall be able to override the product’s Temporary Appliance Load Reduction response before or during a load reduction period.
 - e. The product shall be able to provide at least one Temporary Appliance Load Reduction response in a rolling 24-hour period.

I. Information to Consumers

If additional modules, devices, services, and/or infrastructure are part of the configuration required to activate the product’s communications capabilities, prominent labels, or other forms of consumer notifications with instructions shall be displayed at the point of purchase and in the product literature. These shall provide specific information on what consumers must do to activate these capabilities (e.g. *“This product has WiFi capability and requires Internet connectivity and a wireless router to enable interconnection with an Energy Management System, and/or with other external devices, systems or applications.”*).

5) Test Requirements:

- A. One of the following sampling plans shall be used to test energy performance for qualification to ENERGY STAR:
 - 1. A representative unit shall be selected for testing based on the definition for Basic Model provided in Section 1 above; or
 - 2. Units shall be selected for testing per the sampling requirements defined in 10 CFR § 429.14.
- B. When testing energy consumption of residential refrigerators and freezers, the following test methods shall be used to determine ENERGY STAR qualification:

Table 3: Test Methods for ENERGY STAR Qualification

ENERGY STAR Requirement	Test Method Reference
Energy Consumption (kWh/year)	10 CFR 430, Subpart B Appendix A – Residential Refrigerators
	10 CFR 430, Subpart B Appendix B – Residential Freezers

- C. When determining energy performance for purposes of ENERGY STAR certification, the principles of interpretation, contained in 10 CFR § 430.23 (a) (10), should be applied to the test procedure.
- D. Compliance with Connected functionality, as specified in Section 4, shall be through examination of product and/or product documentation. In addition, demand response functionality shall be verified using the ENERGY STAR Test Method to Validate Demand Response (May 2013) in order to be eligible for the connected allowance.
- 6) **Effective Date:** The ENERGY STAR Residential Refrigerator and Freezer specification shall take effect on **September 15, 2014**. To qualify for ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit and is the date (e.g., month and year) on which a unit is considered to be completely assembled.
- 7) **Future Specification Revisions:** EPA reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions. In the event of a specification revision, please note that ENERGY STAR qualification is not automatically granted for the life of a product model.