



ENERGY STAR® Program Requirements

Product Specification for Residential Dishwashers

Eligibility Criteria

Draft 1 Version 7.0

1 Following is the **Draft 1 Version 7.0** ENERGY STAR Product Specification for Residential Dishwashers. A
2 product shall meet all of the identified required criteria if it is to earn the ENERGY STAR.

3 **1) Definitions:**

4 Below are the definitions of the relevant terms in this document. Where noted below, definitions are identical
5 to the definitions in the U.S Department of Energy (DOE) test procedure at 10 Code of Federal Regulations
6 (CFR) 430, Subpart B, Appendix C1 or in 10 CFR 430.2. When in conflict, the definitions in the CFR take
7 precedence.

- 8 A. Dishwasher¹: A cabinet-like appliance which with the aid of water and detergent, washes, rinses, and
9 dries (when a drying process is included) dishware, glassware, eating utensils, and most cooking
10 utensils by chemical, mechanical and/or electrical means and discharges to the plumbing drainage
11 system.
- 12 1. Compact Dishwasher²: A dishwasher that has a capacity of less than eight place settings plus six
13 serving pieces as specified in ANSI/AHAM DW-1-2010 (incorporated by reference; see §430.3),
14 using the test load specified in section 2.7 of 10 CFR 430, Subpart B, Appendix C1.
- 15 2. Standard Dishwasher²: A dishwasher that has a capacity equal to or greater than eight place
16 settings plus six serving pieces as specified in ANSI/AHAM DW-1-2010 (incorporated by reference;
17 see §430.3), using the test load specified in section 2.7 of 10 CFR 430, Subpart B, Appendix C1.
- 18 B. Basic Model¹: All units of a given type of covered product (or class thereof) manufactured by one
19 manufacturer, having the same primary energy source, and which have essentially identical electrical,
20 physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency,
21 water consumption, or water efficiency.
- 22 C. Consumer Product¹: Any product (other than an automobile, as defined in Section 501(1) of the Motor
23 Vehicle Information Cost Savings Act) which: (1) in operation consumes, or is designed to consume,
24 energy and (2) to any significant extent, is distributed in commerce for personal use or consumption by
25 individuals.
- 26 D. Consumer Override: The product shall be capable of supporting Demand Response (DR) event override
27 ability by consumers. If the appliance, Smart Home Energy Management Systems (SHEMS) or owner
28 concludes that the dishwasher needs to take an action for safety or user service, it is welcome to decline
29 the DR request or override any current or scheduled events.

¹ 10 CFR 430, Subpart A, Section 430.2 Note: Definition of consumer product has been abbreviated to be specific to residential dishwashers by omitting the regulatory definition's references to lighting and water.

² 10 CFR 430, Subpart B, Appendix C1

- 30 E. Delay Appliance Load (DAL) Capability: The capability of the product to respond to a signal in
31 accordance with consumer settings, except as permitted below, by delaying the start of an operating
32 cycle beyond the delay period.
- 33 F. Communications Link: The product shall include a communication link that is capable of bidirectional
34 data transfer between the dishwasher and or more external applications, devices or systems. This link
35 shall use open standards, as defined in the specification, for all communication layers.
- 36 G. Demand Response (DR): A Connected Dishwasher System shall have the capability to receive, interpret
37 and act upon consumer-authorized signals by automatically adjusting its operation depending on both
38 the signal's contents and settings from consumers.
- 39 H. Open Standards: To enable interconnection with the product over the communication link, an interface
40 specification, application programming interface (API) or similar documentation that is intended to enable
41 DR functionality shall be made readily available.
- 42 I. Temporary Appliance Load Reduction (TALR) Capability: The capability of the product to respond to a
43 signal by providing load reduction for a short time period, typically 10 minutes.

44 **Note:** For Version 7.0, EPA is proposing to move the key terms with their definitions from the connected criteria
45 section to the definitions section.

46 2) Scope

- 47 A. Included Products: Products that meet the definition of a dishwasher, demonstrate a minimum per-cycle
48 Cleaning Index score of 70³, and are a consumer product as specified herein are eligible for ENERGY
49 STAR certification, with the exception of products listed in Section 2.B.
- 50 B. Excluded Products: Product types not specifically identified in Section 2.A are not eligible for ENERGY
51 STAR certification under this specification. Products that are covered under other ENERGY STAR
52 product specifications (e.g., Commercial Dishwashers) are not eligible for certification under this
53 specification.

54 **Note:** EPA has amended the ENERGY STAR certification scope to exclude products that fail to demonstrate a
55 minimum cleaning performance score. Consistent with the ENERGY STAR Guiding Principles, EPA is committed
56 to ensuring that the label is associated with products that deliver energy efficiency without compromise in
57 performance. Guarding against performance trade-offs becomes more important as efficiency requirements
58 become more stringent. Manufacturers have cautioned that if product performance does not meet consumer
59 expectations, efficiency savings will be negated by the use of more intensive energy and water cycles or the
60 increased instances of handwashing.

61 Cleaning performance in dishwashers has been a part of the ENERGY STAR program through the ENERGY
62 STAR Most Efficient criteria since 2015 which has given stakeholders time to learn and gain experience with the
63 requirement and test method. Since the publication of the ENERGY STAR cleaning performance test procedure
64 in February 2014, manufacturers have submitted 110 models to ENERGY STAR that included cleaning
65 performance data with their certification. EPA has not and will continue to neither post or make public the cleaning
66 performance data that can be identified to a specific model, nor will it be subject to verification testing.

³ Using the ENERGY STAR Test Method for Determining Residential Dishwasher Cleaning Performance (Rev. Feb – 2014)
for purposes of determining product eligibility.

67 EPA is also considering alternative approaches that may ensure minimum cleaning performance. An ENERGY
 68 STAR partner recommended that EPA consider requiring dishwashers to have a turbidity sensor (commonly
 69 referred to as a soil sensor) and algorithm to be eligible for certification. Not only does a soil sensor system help
 70 ensure clean dishes, it may also increase a dishwasher’s energy efficiency by terminating the wash cycle early if it
 71 senses that the dishes are clean. EPA is asking partners to provide data or provide comments regarding the
 72 following topics:

- 73 • Soil sensor systems and impacts on cleaning performance. Do stakeholders have data that shows
 74 dishwashers with soil sensor systems achieve or surpass a cleaning performance score of 70? EPA
 75 encourages partners to share any data they have on the relationship between soil sensor systems and
 76 cleaning.
- 77 • Soil sensor system and impacts on energy and/or water use. EPA encourages stakeholders to share data that
 78 demonstrates the relationship between having a soil sensor system and the product’s energy and water
 79 consumption under testing of a variety of soil-levels.
- 80 • Capabilities or components of soil/turbidity sensor systems that are associated with sensor systems that
 81 ensure minimum cleaning performance while achieving higher water and energy efficiency. How could EPA
 82 identify and exclude sensor systems that do not deliver minimum cleaning performance comparable to a
 83 cleaning score of 70?
- 84 • If partners are able to share data with EPA, please include the model number, the name of the cleaning
 85 performance test used (a preference being for the ENERGY STAR cleaning performance test), and
 86 description of the soil sensor system.

87 Additionally, EPA would like feedback from partners and stakeholders on ideas on other criteria or approaches
 88 that ENERGY STAR could explore to help ensure cleaning performance is maintained with higher energy and
 89 water efficiency requirements.

90 3) Certification Criteria

91 A. Energy Performance Requirements

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

94 Equation 1: Calculation of Maximum Annual Energy Consumption

$$95 AEC_{MAX} = AEC_{BASE} + AEC_{AdderConnected}$$

96 where,

97 AEC_{BASE} is the annual energy consumption base allowance (kWh/year), per Table 1

98 $AEC_{AdderConnected}$ is the annual energy connected allowance, per Table 2

99 **Table 1: Annual Energy Consumption Base Allowances**

Product Type	AEC_{BASE} (kWh per year)
Standard Dishwashers	240
Compact Dishwashers	155

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Table 2: Connected Allowance

Product Type	$AEC_{AdderConnected}$
Standard Dishwashers	$0.05 \times AEC_{BASE}$

Note: There is no connected allowance for compact dishwashers. Product must be qualified using the final and validated ENERGY STAR Test Method for Residential Dishwashers to Validate Demand Response (TBD) to use the allowance. Calculated allowance shall be rounded down to the nearest whole number before being applied in Equation 1.

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B. Water Performance Requirements

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Table 3: Maximum Water Consumption

Product Type	Water Consumption (gallons per cycle)
Standard Dishwashers	≤ 3.2
Compact Dishwashers	≤ 2.0

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110 C. Significant Digits and Rounding: All calculations shall be carried out as specified in Appendix C1 to
111 Subpart B of Part 430 and 10 CFR Part 430.23(c).

112 D. Model Numbers: Model numbers used for ENERGY STAR qualified product submissions shall be
113 consistent with Federal Trade Commission (FTC) and Department of Energy (DOE) submissions.

114 **Note:** For Version 7.0, EPA is proposing revisions to the minimum efficiency requirements for residential
115 dishwashers. The current ENERGY STAR criteria for residential dishwashers went into effect on January 29,
116 2016, and ENERGY STAR market share is currently 90%.

117 Moreover, dishwasher technology has made numerous advancements that increase the energy and water
118 efficiency. Some of the technologies that improve washing and efficiency include in-sump heaters, variable-speed
119 motors, new spray-arm geometry, and flow through heating. Advancements in drying technology seen on the
120 market include automatic door releases, fan drying, and desiccant drying among others. Additional improvements
121 in water use have been delivered through better food filters and soil-sensing controls.

122 Considering the high market share and advances in dishwasher efficiency, stronger requirements are necessary
123 to effectively differentiate highly efficient residential dishwashers for consumers. EPA also recognizes that more
124 stringent levels could encourage trade-offs between energy, water, and cleaning and, as such, predicates
125 participation upon delivering a minimum cleaning.

126 In Draft 1 Version 7.0, EPA is proposing that to certify as ENERGY STAR, standard residential dishwashers use
127 less than or equal to 240 kWh/year and 3.2 gallons per cycle and compact residential dishwashers use less than
128 or equal to 155 kWh/year of energy and 2.0 gallons per cycle. Currently, EPA estimates that approximately 15
129 percent of all standard residential dishwashers on the market meet the proposed criteria based on rated values
130 and 28 percent using measured values with a 5 percent engineering factor. These models are produced by 33
131 manufacturers under 36 different brands.

132 To determine the potential qualification rate, EPA used a dataset of residential dishwashers developed by
133 combining the current ENERGY STAR certified product list with the DOE’s Certification Database. EPA estimates
134 that, at these levels, consumers would save on average approximately \$190 over a residential dishwasher’s
135 typical 12-year lifetime in energy and water costs. Further information is available in the Data & Analysis
136 spreadsheet that accompanies this draft specification. EPA welcomes comments on the proposed criteria for
137 residential dishwashers.

138 **4) Connected Criteria:**

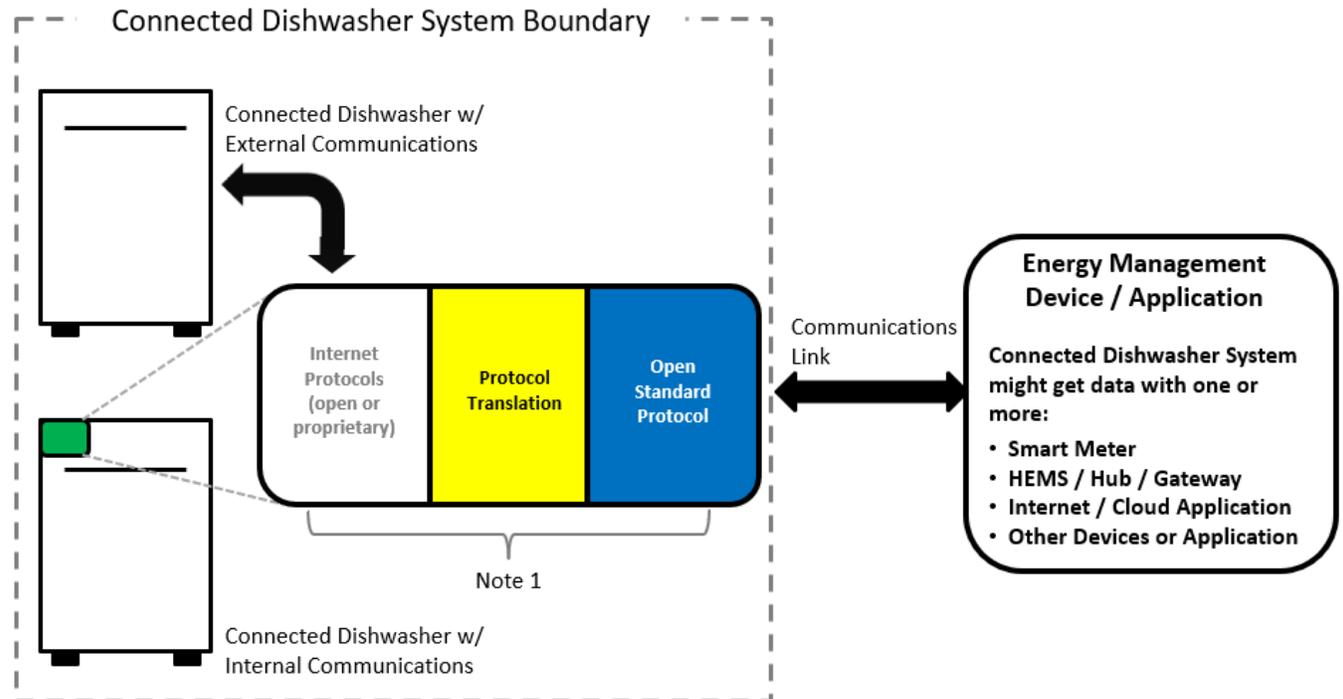
139 The following optional connected criteria are applicable to Included Products, Section 2.A, that meet the
140 definition of a standard dishwasher as defined in Section 1.A.1.

141 A. Connected Dishwasher System

142 To be recognized as connected and to be eligible for the connected allowance, a “Connected Dishwasher
143 System” (as shown in Figure 1) shall include the base appliance plus all elements (hardware, software)
144 required to enable communications in response to consumer-authorized energy related commands (*not*
145 *including third-party remote management which may be made available solely at the discretion of the*
146 *manufacturer*). These elements may be resident inside or outside of the base appliance. This capability
147 shall be supported through one or more means, as identified in section 4.B.2.

148 The specific design and implementation of the Connected Dishwasher System is at the manufacturer’s
149 discretion provided it is interoperable with other devices via open communications protocol and enables
150 economical consumer-authorized third party access to the functionalities provided for in sections 4.D, 4.F,
151 and 4.G. and the capabilities shall be supported through one or more means, as identified in section
152 4.B.2. A product that enables economical and direct, on-premises, open-standards based interconnection
153 is the preferred option for meeting this requirement, but alternative approaches are also acceptable.

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

Figure 1. Connected Dishwasher System Boundary – Illustrative Example

Note 1: Communication device(s), link(s) and/or processing that enables open standards-based communication between the Connected Dishwasher 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.

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B. Communications

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1. Open Standards – Communication with entities outside the connected dishwasher system that enables connected functionality (sections 4.D, 4.F, 4.G) must use, for all communication layers, standards:

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- a. Included in the Electric Power Alliance Catalog of Standards,⁴ 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).

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2. Communications Hardware Architecture – Communication with entities outside the Connected Dishwasher System that enables connected functionality shall be enabled by any of the following means, according to the manufacturer's preference:

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- 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

⁴ http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PMO#Catalog_of_Standards_Processes

180 d. Open standards-based communication port(s) on the appliance in addition to A, B or C, above
181 If option B or C is used, the communication module/device(s) must be easy for a consumer to install
182 and shipped with the appliance, provided to the consumer at the time of sale, or provided to the
183 consumer in a reasonable amount of time after the sale.

184 C. Open Access

185 To enable interconnection with the product, in addition to section 4.B.1 that requires open-standards, an
186 interface specification, Application Programming Interface (API) or similar documentation shall be made
187 available to interested parties that at a minimum, allows transmission, reception and interpretation of the
188 following information:

- 189 1. Energy Consumption Reporting specified in section 4.D (must include accuracy, units and
190 measurement interval);
- 191 2. Operational Status, User Settings & Messages specified in section 4.F (if transmitted via a
192 communication link);
- 193 3. Demand Response specified in section 4.G.

194 D. Energy Consumption Reporting

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

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

205 E. Remote Management

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

211 F. Operational Status, User Settings & Messages

- 212 1. The product shall be capable of providing the following information to energy management systems
213 and other consumer authorized devices, services or applications via a communication link:
 - 214 • Operational / Demand Response (DR) status (for example: off, standby, cycle in process, delay
215 appliance load, temporary appliance load reduction).
- 216 2. The product shall be capable of providing the following information on the product and/or to energy
217 management systems and other consumer authorized devices, services or applications via
218 communication link:
 - 219 • At least two types of messages relevant to the energy consumption of the product. For example,
220 messages for dishwashers might address performance issues or report energy consumption that
221 is outside the product's normal range.

222 G. Demand Response

223 At a minimum, the product shall be capable of providing the following capabilities for all cycle and setting
224 combinations, except where otherwise noted:

225 1. Delay Appliance Load (DAL) Capability:

226 a. Default settings – The product shall ship with default settings that enable a response for at least 4
227 hours.

228 b. Consumer override – The consumer shall be able to override the product’s DAL response before
229 or during a delay period.

230 c. The product shall be able to provide a DAL response per consumer initiated operating cycle, but
231 is not required to provide more than three DAL responses in a rolling 24-hour period (with a
232 maximum of one 4-hour response per dishwasher cycle).

233 2. Temporary Appliance Load Reduction (TALR) Capability: Upon receipt of signal and in accordance
234 with consumer settings, except as permitted below, the product shall restrict its average power draw
235 during the load reduction period to no more than 250 watts.

236 a. Default settings – The product shall ship with default settings that enable a response for a time
237 period of at least 10 minutes.

238 b. The product is not required to provide a response if the consumer selected wash cycle is a cycle
239 explicitly designed or primarily intended for sanitization, such as those in compliance with
240 NSF/ANSI Standard 184. The product user documentation and/or the product itself must indicate
241 that the cycle is designed or intended for sanitization.

242 **Note:** EPA encourages products to provide TALR responses in these cycles whenever consumer
243 expectations would not be impacted.

244 c. Consumer override – The consumer shall be able to override the product’s TALR response
245 before or during a load reduction period.

246 d. The product shall be able to provide at least one TALR response during each consumer initiated
247 operating cycle.

248 Illustrative DR Examples:

249 1. The product receives a DAL signal with a 10-hour delay period. The consumer overrides and
250 starts a load. The product need not respond to subsequent DAL or TALR signals during that cycle.
251 However, after this cycle completes, the consumer must initiate a 2nd override in order to start a
252 second cycle without delay.

253 2. While running a cycle, the product receives and responds to a TALR signal. During its response,
254 the product receives a DAL signal with a 4-hour delay period. Since the consumer has elected to
255 override, the product does not need to respond to the DAL signal in the current cycle. However, after
256 this cycle completes, if within the DAL delay period; the consumer must initiate an override in order to
257 start a subsequent cycle without delay.

258 3. While running a cycle, the product receives and responds to a TALR signal. After its response
259 and within the same operational cycle, the product receives a second TALR signal. Since the product
260 is required to provide one TALR response per operating cycle, it does not need to respond to the
261 second signal.

262 H. Information to Consumers

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

270 **Note:** For Version 7.0, EPA has made modest edits to the connected criteria section by updating the language
271 per the more recent appliance specifications' connected criteria.

272 Since 2010, the landscape for connected products has changed significantly. For large loads, such as central air
273 conditioners, water heaters, and pool pumps, there is an emerging consensus around a few protocols for sending
274 DR requests (OpenADR and CTA-2045). EPA's current long-term vision for DR with smaller loads, such as
275 dishwashers and most other appliances, focuses on their integration into a smart home, which will respond as a
276 whole to DR requests using whichever resources makes sense for that particular home. Similarly, the ability of a
277 smart home system to optimize to schedule smaller loads for hours when energy costs are low makes such
278 systems attractive and convenient for the growing number of consumers enrolled in time of use and other variable
279 rates. Because of this, interoperability and ease of integration will be increasingly important in the connected
280 criteria for appliances and other products. For more information see the [product development webpage](#) for
281 ENERGY STAR Smart Home Energy Management Systems (SHEMS). EPA invites stakeholders to provide any
282 other new developments.

283 1. The Association of Home Appliance Manufacturers (AHAM) published a study in September 2010, AHAM
284 Assessment of Communication Standards for Smart Appliances⁵, which evaluates existing communication
285 protocols designed for the smart grid. All standards listed in this document would be considered open standards.

286 2. EPA recognizes that standardized messages to enable requisite connected functionality may not be
287 available. In such cases, manufacturer-specific messaging is unavoidable, and is permitted by certain open
288 standards. In cases where proprietary messaging is necessary, the API or similar documents must ensure open
289 access to the connected functionalities outlined in Section 4.C.

290 EPA is exploring data security reporting requirements for models with Connected Functionality. EPA requests
291 stakeholders provide feedback on potential data security reporting and if it would provide value to consumers and
292 stakeholders.

293 **5) Test Requirements**

294 A. One of the following sampling plans shall be used for certification to ENERGY STAR.

295 1. A representative unit shall be selected for testing based on the definition for Basic Model provided in
296 Section 1 above; or

297 2. Units shall be selected for testing per the sampling requirements as defined in Table 4:

⁵ https://www.smartgrid.gov/document/assessment_communication_standards_smart_appliances_home_appliance_industrys_technical_eval

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Table 4: ENERGY STAR Sampling Requirements for Dishwashers

Product	Code of Federal Regulations Reference
Residential Dishwashers	10 CFR § 429.20, which references 10 CFR § 429.11

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- B. When testing energy and water efficiency of residential dishwashers, the following test methods shall be used to determine ENERGY STAR certification:

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Table 5: Test Methods for ENERGY STAR Certification

ENERGY STAR Requirement	Test Method Reference
Energy Consumption (kWh/year)	10 CFR 430, Subpart B, Appendix C1*
Water Consumption (gallons/cycle)	

*And in accordance with any applicable DOE issued test procedure guidance, listed here: <http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1>

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- C. Compliance with Connected functionality, as specified in Section 4, shall be through examination of product and/or product documentation. In addition, upon publication of a final test method, demand response functionality shall be tested using the ENERGY STAR Test Method for Residential Dishwashers to Validate Demand Response. Once the final Test Method is published, it must be used to certify demand response functionality in order for a product to remain listed as having connected functionality on the Certified Product List, and to be eligible for any connected allowance.

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Note: For Version 7.0, EPA updated the language in the Testing Requirements section, in coordination with DOE, to reflect the most recent version to this section for appliance specifications.

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6) Effective Date

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The ENERGY STAR Residential Dishwasher specification shall take effect on **TBD**. To certify as ENERGY STAR, a product model shall meet the ENERGY STAR specification in effect on the 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.

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Note: EPA expects Version 7.0 to be effective 9 months after the Final Draft specification is published; the expected effective date would be in Q1 2021. EPA asks manufacturer partners to provide information on when they begin working on designing new product lines. Ideally, EPA would like to align the publication of the final specification revision to align with manufacturers' new product development phase timeframes.

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7) Future Specification Revisions

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EPA reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. Revisions to the specification will be arrived at through industry discussions. In the event of a specification revision, please note that the ENERGY STAR certification is not automatically granted for the life of a product model