Following is the Version 5.0 product specification for ENERGY STAR certified water heaters. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1) Definitions: Below are the definitions of the relevant terms in this document.

A. Residential Water Heater (Consumer Water Heater): A product that utilizes gas, electricity, or solar thermal energy to heat potable water for use outside the heater upon demand, including:

a. Storage type units designed to heat and store water at a thermostatically-controlled temperature, including: gas-fired storage (gas storage-type) water heaters with a nameplate input of 75,000 Btu per hour or less, containing more than one gallon of water per 4,000 Btu per hour of input; heat pump type units with a maximum current rating of 24 amperes at an input voltage 250 volts or less, including all ancillary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.1

b. Instantaneous type units heat water, but contain no more than one gallon of water per 4,000 Btu per hour of input with an input capacity less than or equal to 200,000 Btu per hour for gas-fired instantaneous.1

c. Gas-fired storage residential-duty commercial water heaters include gas-fired storage water heaters that are designed to deliver hot water at a temperature less than or equal to 180°F, with an input rate greater than 75,000 Btu per hour and not exceeding 105,000 Btu per hour, containing more than one gallon of water per 4,000 Btu per hour of input, and storage volume less than or equal to 120 gallons. For models requiring electricity, a single-phase external power supply is used.2

d. Solar water heaters include a collector and storage tank, and use the sun’s energy to heat water using one of the five basic types of solar water heating systems:

i. forced circulation (includes both direct and indirect systems),
ii. integrated collector and storage,
iii. thermosiphon,
iv. self-pumped, or
v. photovoltaic (PV).

e. Integrated heat pump water heaters are residential water heaters where the compressor, evaporator, condenser, and storage tank are integrated into the same unit.

f. Split-System heat pump water heaters are residential water heaters where the compressor, evaporator, and/or condenser are separated from a storage tank that is specified by the manufacturer and rated as a single system.

1 Adapted from 10 CFR Part 430, Subpart A §430.2 Definitions; in case of any inconsistencies, definitions in the CFR are authoritative.
2 Adapted from 10 CFR Part 431, Subpart G §431.102 Definitions; in case of any inconsistencies, definitions in the CFR are authoritative.
g. Add-on Heat Pump Units are air to water heat pumps designed for use with a storage-type water heater or a storage tank that is not specified or supplied by the manufacturer.

B. Uniform Energy Factor\textsuperscript{3}: Uniform Energy Factor (UEF) is the measure of water heater overall efficiency.

C. Solar Uniform Energy Factor: Solar Uniform Energy Factor (SUEF) refers to the energy delivered by the total system divided by the electrical or gas energy put into the system.

D. First-Hour Rating\textsuperscript{3}: The First-Hour Rating (FHR) is an estimate of the maximum volume of “hot” water that a storage-type water heater can supply within an hour that begins with the water heater fully heated (i.e., with all thermostats satisfied). It is a function of both the storage volume and the recovery rate.

E. Maximum GPM Rating\textsuperscript{3}: Maximum GPM is the maximum gallons per minute of hot water that can be supplied by an instantaneous water heater while maintaining a nominal temperature rise of 67°F (37.3 °C) during steady-state operation.

F. Manufacturer Limited Warranty: Manufacturer limited warranty is an assurance by the manufacturer to the consumer that the water heater, including purchased system equipment and components, are guaranteed to work for a defined period of time.

G. Basic Model: All units of a given type of covered product (or class thereof) manufactured by one manufacturer and which have the same primary energy source and, which have essentially identical electrical, physical, or functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption or water efficiency.\textsuperscript{3} Further, all individual models within a basic model have the same certified rating based on the applicable sampling criteria per U.S. Department of Energy’s (DOE) regulations in Part 429\textsuperscript{4}, and this rating must be used for all manufacturer literature, the qualified product list and certification of compliance to DOE standards.

H. Lower Compressor Cut-off Temperature: The temperature below which a heat pump water heater’s compressor will no longer operate, such that the unit will only work as a conventional electric resistance water heater.

I. Combination Space-Heating and Water-Heating Appliance: Appliance that provides both space conditioning (boiler) and hot water heating with one appliance or energy source. The combination appliance circulates hot water from the water heater through a heat exchanger in the air handler. A blower will move the heated air through a standard duct system. In the summer, an air conditioner is connected to the exchanger and the system functions similarly, with cool air being pushed through the ductwork.

2) Scope:

A. Included Products: Only products that meet the definition of a Residential Water Heater, as specified herein, are eligible for ENERGY STAR certification with exception of those products listed in Section 2B.

B. Excluded Products:

a. Electric resistance water heaters,

b. Add-on heat pump units,

\textsuperscript{3} 10 CFR Part 430, Subpart B, Appendix E

\textsuperscript{4} 10 CFR Part 429, Subpart B
c. Products intended only for commercial applications,

d. Combination space-heating and water-heating appliances.

3) Certification Criteria:

A. Product Performance Requirements for Electric Water Heaters:

Table 1: Criteria for Certified Electric Water Heaters

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ENERGY STAR Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform Energy Factor</td>
<td></td>
</tr>
<tr>
<td>Integrated HPWH</td>
<td>UEF ≥ 3.30</td>
</tr>
<tr>
<td>Integrated HPWH, 120 Volt / 15 Amp Circuit</td>
<td>UEF ≥ 2.20</td>
</tr>
<tr>
<td>Split-system HPWH</td>
<td>UEF ≥ 2.20</td>
</tr>
<tr>
<td>First-Hour Rating</td>
<td>FHR ≥ 45 gallons per hour</td>
</tr>
<tr>
<td>Warranty</td>
<td>Warranty ≥ 6 years on sealed system</td>
</tr>
<tr>
<td>Safety</td>
<td>UL 174 and UL 1995 or UL 60335-2-40</td>
</tr>
</tbody>
</table>

Lower Compressor Cut-Off Temperature (Reporting Requirement Only) Report ambient temperature below which the compressor cuts off and electric resistance only operation begins

B. Product Performance Requirements for Gas-Fired Water Heaters:

a. Gas-Fired Storage Water Heaters:

Table 2: Criteria for Certified Gas-Fired Storage Water Heaters

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ENERGY STAR Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform Energy Factor</td>
<td>UEF ≥ 1.00</td>
</tr>
<tr>
<td>First-Hour Rating</td>
<td>FHR ≥ 51 gallons per hour</td>
</tr>
<tr>
<td>Warranty</td>
<td>Warranty ≥ 6 years on system (including parts)</td>
</tr>
<tr>
<td>Safety</td>
<td>ANSI Z21.10.1/CSA 4.1</td>
</tr>
</tbody>
</table>

Note: Consistent with the Biden Administration’s commitment to decarbonization, EPA is proposing more stringent criteria for gas-fired storage water heaters, while allowing them to remain in scope as familiarity with electric alternatives grows. The proposed gas-fired storage water heater level could be met with developments in technologies like gas heat pump water heaters. EPA was unable to determine a cost-effective level that provides meaningful differentiation for units on the market.

The proposed criteria will increase the annual energy savings that EPA and utility partners can claim to 80 therms ($81) per year for gas-fired water heaters 55 gallons or less and to 46 therms ($46) per year.
for gas-fired water heaters greater than 55 gallons. We have not estimated payback; since there are
currently no products on the market meeting these criteria, the cost is unclear. If all gas storage water
heaters sold in the US met these requirements, the national savings would grow to over 4,875 million
therms, or over 25 MMT CO₂e. Savings are based on a comparison of the ENERGY STAR requirements
to the federal minimum standard for typical tank sizes of 40 and 65 gallons.

EPA welcomes comments on the proposed criteria, particularly on appropriate safety standards and any
such practical barriers to products entering the market.

b. Gas-Fired Instantaneous Water Heaters:

Table 3: Criteria for Certified Gas-Fired Instantaneous Water Heaters

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ENERGY STAR Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform Energy Factor</td>
<td>UEF ≥ 0.95</td>
</tr>
<tr>
<td>Maximum Gallons Per Minute</td>
<td>Max GPM ≥ 2.8 over a 67°F rise</td>
</tr>
<tr>
<td>Warranty</td>
<td>Warranty ≥ 6 years on heat exchanger and</td>
</tr>
<tr>
<td></td>
<td>≥ 5 years on parts</td>
</tr>
<tr>
<td>Safety</td>
<td>ANSI Z21.10.3/CSA 4.3</td>
</tr>
</tbody>
</table>

Note: EPA is proposing more stringent criteria for gas-fired instantaneous water heaters as noted above
to recognize differentiation within the market. The proposed criteria will recognize about 15% of products
available on the market.

The proposed criteria will increase the annual energy savings that EPA and utility partners can claim to
31 therms ($31) per year. This will improve the payback compared the that of the previous specification.
If all gas instantaneous water heaters sold met these criteria, EPA estimates that the national savings
would grow to over 225 million therms, or over 1.2 MMT CO₂e.

EPA welcomes comments on the proposed criteria.

c. Gas-Fired Storage Residential-duty Commercial Water Heaters:

Table 4: Criteria for Certified Gas-Fired Storage Residential-duty Commercial Water Heaters

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ENERGY STAR Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uniform Energy Factor</td>
<td>UEF ≥ 1.00</td>
</tr>
<tr>
<td>Warranty</td>
<td>Warranty ≥ 6 years on system</td>
</tr>
<tr>
<td>Safety</td>
<td>ANSI Z21.10.3/CSA 4.3</td>
</tr>
</tbody>
</table>

Note: Similar to storage water heaters, EPA is proposing more stringent criteria for gas-fired storage
residential-duty commercial water heaters. EPA was unable to determine a cost-effective level that
provides meaningful differentiation for units on the market. Recognizing the Biden Administration’s
commitment to decarbonization, EPA has proposed a level that gas-fired storage residential-duty
commercial water heaters could meet with future developments in technologies like gas heat pumps.

water heaters allowing for gas storage products to remain within scope.

The proposed criteria will increase the annual energy savings that EPA and utility partners can claim to

112 therms ($114) per year. EPA welcomes comments on the proposed criteria.

C. Product Performance Requirements for Solar Water Heaters:

Table 5: Criteria for Certified Solar Water Heaters

<table>
<thead>
<tr>
<th>Criteria</th>
<th>ENERGY STAR Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solar Uniform Energy Factor</td>
<td>SUEF ≥ 3.00 for electric backup</td>
</tr>
<tr>
<td></td>
<td>SUEF ≥ 1.80 for gas backup</td>
</tr>
<tr>
<td>Warranty</td>
<td>Warranty ≥ 10 years on collector,</td>
</tr>
<tr>
<td></td>
<td>≥ 6 years sealed system,</td>
</tr>
<tr>
<td></td>
<td>≥ 2 years on controls,</td>
</tr>
<tr>
<td></td>
<td>≥ 1 year on parts</td>
</tr>
</tbody>
</table>

4) Connected Product Criteria – Optional:

This section presents connected criteria for ENERGY STAR certified water heaters. Compliance with
Section 4 criteria is optional. ENERGY STAR certified water heaters that comply with all Section 4 criteria
will be identified on the ENERGY STAR website as having ‘Connected’ functionality. As for all ENERGY
STAR products, these criteria define products which provide a combination of additional user functionality
and grid services, as appropriate for the product type.

A. Definitions

a. Communication Link: As shown in Figure 1, the mechanism for bi-directional data
   transfers between the Connected Water Heater Product and one or more external
   applications, devices or systems.

b. Connected Water Heater Product (CWHP): As shown in Figure 1, includes the ENERGY
   STAR certified water heater, integrated or separate communications hardware, and
   additional hardware and software required to enable connected functionality.
**Note 1:** Communication device(s), link(s) and/or processing that enables Open Standards-based communication between the CWHP and external application / device / system(s). These elements, either individually or together, could be within the water heater/controller, and/or an external communication module, a hub/gateway, or in the Internet/cloud.

c. **Consumer Authorized Third Party:** Any entity for which the consumer has provided explicit permission to access the CWHP connected functionality, in whole or in part, via a Communication Link. *Example: A consumer may allow a Home Energy Management System (HEMS) or a Demand Response Management System (DRMS) access to the CWHP connected functionality.*

d. **Demand Response (DR):** Changes in electric or gas usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity or gas over time, or to incentive payments designed to induce lower electricity or gas use at times of high wholesale market prices or when system reliability is jeopardized.\(^5\)

e. **Demand Response Management System (DRMS):** The system operated by a consumer authorized program administrator, such as the utility or third party, which dispatches signals with DR instructions and/or price signals to the CWHP products and receives messages from the CWHP product.

f. **Interface Specification:** A document or collection of documents that contains detailed technical information to facilitate access to relevant data and product capabilities over a communications interface.

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g. **Load Management Entity:** Consumer authorized DRMS, home energy management system, or the like.

h. **Open Standards:** Communication with entities outside the CWHP that use, for all communication layers, standards:
   - included in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards,\(^6\) and/or
   - included in the NIST Smart Grid Framework Tables 4.1 and 4.2, and/or
   - 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).\(^6\)

i. **On-Premises:** Refers to a function that relies only on equipment present at the physical installed location of the ENERGY STAR certified device/equipment.

j. **Load Shift:** A load shift operation moves energy that would have been used by a device within a time interval under normal operating conditions, to occur outside that time interval. Load shifting can be performed by a combination of load up and curtailment requests.

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**B. Communications**

a. The CWHP Communication Link, in Figure 1, shall use Open Standards for all communication layers to enable functions listed in Sections 4B) and 4C).

b. An Interface Control Document (ICD), Application Programming Interface (API), or other documentation shall be made available to interested parties that, at minimum, allows access to the functions listed in Sections 4B) and 4C).

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**C. Remote Management and Consumer Feedback**

The CWHP shall provide the following functionality:

a. **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.

   i. Higher energy mode settings shall be temporary: If a remote management signal puts the CWHP into a mode that uses more energy than the mode selected locally, the product shall revert to the locally set mode within 72 hours if no additional user input is received.

b. **User Alerts:**

   The CWHP shall be capable of providing at least two types of messages relevant to optimizing its energy consumption, either:

   i. On the product (e.g. water heater and/or controller), and/or

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\(^6\) [https://sepapower.org/knowledge/catalog-of-standards/]
ii. Transmitted to consumers and consumer authorized third parties via a communication link. This link can include open standards protocols used for Demand Response or could use a secondary communication link.

For example, messages relevant to energy consumption for water heaters might address a fault condition, a reminder to descale heating elements, heat pump refrigerant charge, or a report of energy consumption that is outside the product’s normal range.

c. **Energy Reporting:**

The product shall be capable of transmitting measured or estimated instantaneous power draw in current conditions via a communication link to a Load Management Entity and other consumer authorized devices, services, or applications. Products compliant with the Demand Response criteria in Section 4C) meet this criterion through energy reporting there.

**D. Demand Response (DR)**

Gas-fired Instantaneous Water Heaters are exempt from this functionality and may be recognized as connected without meeting the criteria in this subsection. Solar water heaters are anticipated to only respond to demand response signals while using grid power.

a. **DR Communications Protocols:**

The CWHP shall meet the communication and equipment performance standards for CTA-2045 or OpenADR 2.0b (Virtual End Node), or both.

b. **Override:**

The product shall provide an easily accessible means for consumers to override demand response events during the event or ahead of time for a scheduled event, except for Grid Emergency/Off Mode events. When the event is overridden, the CPWH shall return to normal operation as set by the customer. Temporary overrides shall be limited to a duration up to 72 hours without additional user input; after this time, the CPWH will return to its previous operating mode.

c. **Loss of connectivity:**

A ‘loss of connectivity’ event is defined as 15 minutes without connection. The CWHP shall respond as follows:

i. If a ‘loss of connectivity’ event occurs while processing a DR event with a set duration or end time, product may complete DR event as planned, returning to normal operation as set by the customer afterwards, or if over-ridden.

ii. If a ‘loss of connectivity’ event occurs while processing a DR event without a set duration or end time, product will resume normal operation within 30 minutes.

iii. If the CWHP is capable of storing and operating with a time of use schedule, the unit may continue operating on that schedule during a ‘loss of connectivity’ event.

d. **Minimum Load Shift:**

CWHP shall be capable of load shifting either:

i. **Basic Load Shift:** 0.5 kWh or more via a combination of Basic Load Up and General Curtailment responses defined in 4)D.f. under the conditions defined in the ENERGY STAR Test Procedure for Water Heater Demand Response, or
ii. **Advanced Load Shift:** 1.0 kWh or more via a combination of Advanced Load Up and General Curtailment responses defined in section 4)D.f. under the conditions as defined in the ENERGY STAR Test Procedure for Water Heater Demand Response. Manufacturers shall report which load shift test was used for each model.

e. **DR Information and Messaging:**

The CWHP shall support the following upstream messaging from the device when available and may support the additional (optional) messaging capabilities. Support for these messaging signals is implemented via the open standards protocol used in the product. The required mapping for these events is described in Appendix B. While the required or optional functionality may vary based on product type and either protocol may be used, the messaging must be communicated via the specified protocol command within this appendix.

Data provided by below messaging functions shall be calculated from product state no older than 60 seconds from request.

**Required Messaging I/O**

- **Device Type** – Electric Resistance / Gas-fired Storage / Heat Pump.
- **Operational State** – Information on product running state, DR conditions operating on product, opt in/out state, and fault conditions. The following states will be able to be reported, as applicable to the chosen DR protocol:
  - **Idle Normal** – Water heater is not heating but is in a normal mode of operation.
  - **Running Normal** – Water heater is in a Normal Operating Mode and the water heater is presently heating (heat pump compressor or any heating elements are energized).
  - **Running Curtained Grid** – Water heater is running in a grid service mode of operation and the water heater is presently heating (heat pump compressor or any heating elements are energized).
  - **Running Heightened Grid** – Water heater is processing a load up request and water is being heated.
  - **Idle Grid** – Water heater is in a grid service operational mode and the water heater is not heating water.
  - **Water Heater Error** – Device is malfunctioning. Recommended use: Failure of heat pump or element.
  - **Idle Heightened** – Water heater is processing a Load Up request and water is not being heated.
  - **Idle Opted Out** – Water heater is overridden has no/insignificant energy consumption.
  - **Running, Opted Out** – Water heater is overridden and is consuming energy.

- **Current Available Energy Storage Capacity** – The amount of grid energy that the end device can take now (kWh or therms). It is recognized that under some extraordinary circumstances, the Current Available Energy Storage could exceed the Total. For example, if a water heater temperature has fallen well below the normal minimum regulation range.\(^7\)

- **Power/Demand (Instantaneous)** – Measured or estimated power consumption in current conditions (kW, Btu/hr, or therms).

\(^7\) CTA-2045-A
Optional Messaging I/O:

- **Energy Use** – Measured or estimated cumulative energy use of product (kWh or Btu, therms).
- **Current Total Energy Storage Capacity** – The total amount of grid energy storage that the end device represents. For example, the energy capacity of a water heater would be the total amount of energy (kWh or therms) supplied to move the tank from its minimum operating temperature (e.g. what it would allow itself to drop to during a curtailment event) to its maximum operating temperature (e.g. what it could run up to when asked to “Load Up” before shutting off).⑦

f. Error! Bookmark not defined.DR Requests and Responses:

The CWHP shall also support the required DR operational modes listed below and may support additional open standard defined DR signals. Support for these requests is implemented via the open standards protocol used in the product. The required mapping for these events is described in Appendix B. While the required or optional functionality may vary based on product type and either protocol may be used, the messaging must be communicated via the specified protocol command within this appendix.

Required Operational Mode Functionality:

<table>
<thead>
<tr>
<th>Operational Mode Request</th>
<th>Required for which products</th>
<th>Expected use and consumer impact</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Curtailment (Shed/Light Shed)</td>
<td>All product types</td>
<td>Daily, several hours long; minimal impact</td>
<td>Avoids using energy that the device otherwise would have used under normal operating conditions, up to allowing the stored thermal energy in the tank to reduce moderately. For Heat Pump Water Heaters with resistive elements, the water heater shall avoid use of electric resistance elements during and immediately after the event unless user needs cannot be met.①</td>
</tr>
<tr>
<td>Emergency Curtailment (Critical Curtailment/Deep Shed))</td>
<td>Electric storage and Solar ERWH</td>
<td>Daily, less than 1 hour; may be some consumer impact</td>
<td>Avoids using energy that the device otherwise would have used under normal operating conditions, up to allowing the stored thermal energy in the tank to deplete to a very low level, less than that for a General Curtailment request. For Heat Pump Water Heaters with resistive elements, this request would result in heat pump only operation during the request period.①</td>
</tr>
<tr>
<td>Grid Emergency (Off Mode/Full Shed)</td>
<td>Electric storage and Solar ERWH</td>
<td>Annually or less; consumer impact may be significant</td>
<td>Immediately, stop using energy for water heating when safe to do so.①</td>
</tr>
</tbody>
</table>
### Required Operational Mode Functionality

<table>
<thead>
<tr>
<th>Operational Mode Request</th>
<th>Required for which products</th>
<th>Expected use and consumer impact</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Load Up:</strong> Basic or Advanced</td>
<td>Basic: All product types</td>
<td>Daily, several hours long</td>
<td>Use and/or store additional thermal energy that device otherwise would not have used/stored under normal operation. Allows the stored thermal energy to increase, within safety parameters as determined by the manufacturer up to user set point for Basic Load Up. For Advanced Load Up, the device may exceed user set point.² For heat pump water heaters with resistive heating elements, the use of the elements should be avoided as much as possible to satisfy this request.¹</td>
</tr>
<tr>
<td></td>
<td>Advanced: Optional</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. For all commands both immediate events and events scheduled in advance will be supported.
2. **Advanced Load Up** response is anticipated to be used on installations with a mixing valve, and is anticipated to require a user action to enable this request for the first time.

### Optional Operational Mode Functionality:

<table>
<thead>
<tr>
<th>Operational Mode Request</th>
<th>Required for which products</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Set Point Adjustment</strong></td>
<td>Optional</td>
<td>Adjusts product thermostat set point up or down if safe to do so.</td>
</tr>
<tr>
<td><strong>Relative Price Signal(s)</strong></td>
<td>Optional</td>
<td>Communicates information to endpoint on current energy cost and upcoming changes, to allow consumer configuration of when grid energy should be used and when it should be curtailed if possible.</td>
</tr>
</tbody>
</table>

¹. For all commands both immediate events and events scheduled in advance will be supported.
2. **Advanced Load Up** response is anticipated to be used on installations with a mixing valve, and is anticipated to require a user action to enable this request for the first time.
E. Additional Information for Consumers

a. If additional modules, devices, services, and/or supporting infrastructure are required in order to activate the CWHP’s communications capabilities, installation instructions and a list of these requirements shall be made available at the point of purchase and prominently displayed in the product literature. It is also suggested that information be provided on the product packaging and on the product. These instructions shall provide specific information on what must be done to activate these capabilities (e.g. a product package or product label might briefly state, “This product has Wi-Fi capability and requires Internet connectivity and a wireless router to enable interconnection with 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:

a. A single unit is selected, obtained, and tested. The measured performance of this unit and of each subsequent unit manufactured must be equal to or better than the ENERGY STAR specification requirements. Results of the tested unit may be used to certify additional individual model variations within a basic model as long as the definition for basic model provided in Section 1, above, is met; or

b. Units are selected for testing and results are calculated according to the sampling requirements defined in 10 CFR Part 429, Subpart B §429.17. The certified rating must be equal to or better than the ENERGY STAR specification requirements. Results of the tested unit may be used to certify additional variations within a basic model as long as the definition for basic model provided in Section 1, above, is met. Further, all individual models within a basic model must have the same certified rating based on the applicable sampling criteria. This rating must be used for all manufacturer literature, the qualified products list, and certification of compliance to DOE standards.

B. When testing residential water heaters, the following test methods shall be used to determine ENERGY STAR certification:
Table 6: Test Methods for ENERGY STAR Certification

<table>
<thead>
<tr>
<th>Applicable Products</th>
<th>ENERGY STAR Requirement</th>
<th>Test Method Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas and Electric products (not including gas-fired storage residential-duty commercial water heaters); FHR is applicable to storage products and Maximum GPM is applicable to instantaneous products.</td>
<td>Uniform Energy Factor (UEF)</td>
<td>10 CFR Part 430, Subpart B, Appendix E*</td>
</tr>
<tr>
<td>First Hour Rating (FHR)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maximum GPM Rating</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas-fired Storage Residential-duty Commercial products</td>
<td>Uniform Energy Factor (UEF)</td>
<td>10 CFR Part 430, Subpart B, Appendix E*</td>
</tr>
<tr>
<td>Connected Products</td>
<td>Demand Response</td>
<td>Test Method to Validate Demand Response</td>
</tr>
</tbody>
</table>

* Includes any applicable guidance that DOE has issued regarding the testing of these products (See http://www1.eere.energy.gov/guidance/default.aspx?pid=2&spid=1).

C. Compliance with Connected Criteria

a. Aside from demand response functionality, compliance with connected criteria, as specified in Section 4), shall be through examination of product and/or product documentation.

D. Significant Digits and Rounding:

a. All calculations shall be carried out with actual measured (unrounded) values. Only the final result of a calculation shall be rounded.

b. Unless otherwise noted in this section, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.

c. Reporting on the ENERGY STAR website shall be performed using calculation results or measured values that are rounded to the nearest unit in the last right-hand digit as specified in the corresponding specification requirement below.

6) Effective Date:

The ENERGY STAR Version 5.0 Residential Water Heaters specification shall take effect on TBD. 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 on which a unit is considered to be completely assembled.

Note: The effective date of Version 5.0 will be approximately 9 months after it is finalized. EPA currently expects an effective date in 2023. Version 4.0 will be effective January 2, 2022, so some units will need to be recertified twice in quick succession, though one of those will be purely administrative, as the criteria for each product type will only change once. EPA urges certification bodies to keep the process as easy as possible.
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 the ENERGY STAR certification is not automatically granted for the life of a product model.

A. The Federal minimum efficiency standards are based on the unit volume, reflecting the influence of design elements on efficiency. However, since ENERGY STAR levels are not, comparison between them is challenging. EPA may consider restructuring this specification to include similar metrics that are dependent on volume and categorized further by draw pattern. This may include a distinct level for low draw pattern units in the future.

B. EPA is also in discussion with the Northwest Energy Efficiency Alliance on their Advanced Water Heating Specification and with the Advanced Water Heating Initiative as they expand to national action, seeking to harmonize specifications as much as possible in the future. This may include adding reporting or performance requirements similar to those in the other specifications.
Note: Appendix A in the Version 4.0 specification contained criteria in terms of EF and TE, as a courtesy for the specification to be used by Natural Resources Canada for products sold only in Canada. As this is no longer necessary, the entire appendix has been removed, meaning that all products certified to Version 5 must use UEF or SUEF. The remaining appendices have been re-numbered.

Appendix A – Demand Response Message Mapping

Table 7: Normative DR Message Mapping

<table>
<thead>
<tr>
<th>Category</th>
<th>Subtype</th>
<th>Demand Response Messaging</th>
<th>Response Result</th>
<th>ANSI/CTA (2045-A)</th>
<th>OpenADR (2.0b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic Signals</td>
<td>Curtailment Load Up</td>
<td>General Curtailment</td>
<td>Reduce load (moderate)</td>
<td>Shed 8</td>
<td>oadrDistributeEvent: SIMPLE level 1. 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Emergency Curtailment</td>
<td>Reduce load (major)</td>
<td>Critical Peak Event 8</td>
<td>oadrDistributeEvent: SIMPLE level 2. 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Grid Emergency</td>
<td>Turn off (if possible)</td>
<td>Grid Emergency 8</td>
<td>oadrDistributeEvent: SIMPLE level 3. 9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Load Up</td>
<td>Use more energy (if possible)</td>
<td>Load Up 8</td>
<td>oadrDistributeEvent: NEAR / FAR flag. CHARGE STATE, LOAD_DISPATCH. 9</td>
</tr>
<tr>
<td></td>
<td>Run Normal</td>
<td>Return to Normal Operation</td>
<td>Return to defaults</td>
<td>End Shed / Run Normal 8</td>
<td>oadrDistributeEvent: CANCELLED. 9</td>
</tr>
<tr>
<td></td>
<td>Dev. Logic / Load System Load</td>
<td>Real Time System Load</td>
<td>Use / do not use energy when appropriate (follow programming)</td>
<td>Request for Power Level 10 [Section 8.2.1]</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dev. Logic / Price Signal</td>
<td>Utility Peak Load Price Signal</td>
<td>Present Relative Price 10, [Section 9.1.3]</td>
<td>oadrDistributeEvent: ELECTRICITY_PRICE9</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Excess Capacity(DER)</td>
<td>Grid Guidance 8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Device Properties &amp; Enrollment</td>
<td>Opt Out Dev. Info</td>
<td>Consumer Override</td>
<td>Skip response to event within opt out</td>
<td>Customer Override Message, in response to Operational State Query or load reduction request 8</td>
<td>oadrCreateOpt: device sends upstream opt message 11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Device Information</td>
<td>Indicates all mandatory product information</td>
<td>Info Request 10 [Section 9.1.1]</td>
<td>Ei:eiTargeType (endDeviceAsset)</td>
</tr>
</tbody>
</table>

8 CTA-2045-A: Table 8-2
9 Section 8.1, OpenADR 2.0b EiEvent Service; Figures 4 & 5, EiEvent Patterns; Section 8.2.2, OpenADR 2.0b Signal Definitions; Table 1, Signals
10 CTA-2045-A: Table 9-2
11 Section 8.5, OpenADR 2.0b EiOpt Service; Figure 17, Interaction Diagram: Create Opt
### Status

**State Reporting Requirements**
- Provide state information to requestor

**Operational State Query**
- [Section 8.2.4](#)
- (see Table 8)

**EiReport.**
- oadrPayloadResource Status
- (see Table 8 and 9)

### Hardware Requirements

**Power (Instantaneous)**
- Demand of product (W)
- GetCommodity Read, code 0
- oadrPayloadResource Status: energyReal

**Energy (Cumulative)**
- Energy used by product (kWh)
- GetCommodity Read, code 0
- oadrPayloadResource Status: energyReal

### Device Energy Storage

**Current Energy Storage Capacity**
- Available energy storage (Wh)
- GetCommodity Read, Code 7
- oadrPayloadResource Status: oadrCapacity: oadrCurrent

**Total Energy Storage Capacity**
- Energy storage under ideal conditions (Wh)
- GetCommodity Read, Code 6
- oadrPayloadResource Status: oadrCapacity: oadrNormal

### Table 8: Operational State Codes

<table>
<thead>
<tr>
<th>Op State Code</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Idle Normal</td>
</tr>
<tr>
<td>1</td>
<td>Running Normal</td>
</tr>
<tr>
<td>2</td>
<td>Running Curtailed Grid</td>
</tr>
<tr>
<td>3</td>
<td>Running Heightened Grid</td>
</tr>
<tr>
<td>4</td>
<td>Idle Grid</td>
</tr>
<tr>
<td>5</td>
<td>Water Heater Error</td>
</tr>
<tr>
<td>6</td>
<td>Idle Heightened</td>
</tr>
<tr>
<td>11</td>
<td>Idle, Opted Out</td>
</tr>
<tr>
<td>12</td>
<td>Running, Opted Out</td>
</tr>
</tbody>
</table>

### Table 9: OpenADR 2.0b Operational State Reporting

**OpenADR 2.0b EiReport Service**

<table>
<thead>
<tr>
<th>REQ</th>
<th>Report Name</th>
<th>x-CTA2045_Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1.1</td>
<td>Report Structure</td>
<td>Status</td>
</tr>
<tr>
<td></td>
<td>rID</td>
<td>OperationalState</td>
</tr>
<tr>
<td></td>
<td>Report Type</td>
<td>Reading</td>
</tr>
<tr>
<td></td>
<td>Reading Type</td>
<td>Direct Read</td>
</tr>
<tr>
<td></td>
<td>Units</td>
<td>customUnit</td>
</tr>
</tbody>
</table>

**ANSI/CTA-2045-A Message**

<table>
<thead>
<tr>
<th>Message</th>
<th>Operational State Query Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Element Mapped to rID</td>
<td>Opcode 2 of Basic 0x13</td>
</tr>
</tbody>
</table>

---

12 CTA-2045-A, Appendix A & Appendix B
13 Electric Power Research Institute, Communication Protocol Mapping Guide 1.0, OpenADR 2.0 to ANSI/CTA-2045-A, Table 2-3 Measurement and Reporting Mapping Requirements
Appendix B (Informational) – Demand Response Use cases

a. Peak Load Reduction: Curtailment and Emergency Curtailment

i. Includes protocols for both advance notice and scheduled peak shed (reduction), and emergency curtailment programs.

ii. Utility implementation may vary regionally but would be accessed via the open standards application layer specification for General Curtailment, Emergency Curtailment, and Off Mode in the relevant standard. See Informational Appendix B for messaging examples in common protocols.

iii. Implementation could include downward adjustment of set points via application layer Set Point Adjustment. No requirements set on this parameter.

b. Spinning Reserves: Short Term Curtailment and (Simple) Load Up

iv. Includes protocols for short term curtailment and load up. Utility implementation may vary regionally but would be accessed via the open standards application layer specification for General Curtailment and Load Up in the relevant standard. See Informational Appendix B for messaging examples in common protocols.

v. Implementation could include application layer Set Point Adjustment downward. No requirements set on this parameter.

c. Thermal Storage

vi. Includes routines which can incorporate tank stratification strategies and set point adjustment up to on-site maximum allowed tank temperature during load up (ramp) event. This storage is then used to reduce energy usage during a targeted future time period.

vii. Utility implementation may vary regionally but would be accessed via the open standards application layer specification for Set Point Adjustment and Load Up in the relevant standard. See Informational Appendix B for messaging examples in common protocols.

viii. Manufacturer strategies may include analysis of Utility Peak Load Price Signal and Excess (DER) Capacity signals to assist in identifying times where Thermal Storage should be initiated by the product.

Note: Impact of thermal storage strategies varies by tank capacity and installation circumstances.

d. Fast Response: Frequency Balancing

ix. Fast response routines, where <10 second response intervals are used to frequency balance sections of an operator’s grid, are still under active development. Additional research and more widespread adoption would be necessary prior to including this protocol in the standard DR suite for CWHP’s.

x. Utility implementation would require communication with the CWHP, providing Real Time System Load signals to the application layer of the product.

Note: Fast response operational modes require relay technology capable of a large number of switching cycles, which typically require upgraded contactor terminals.