

# Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters Version 1.0

**Final Updated November 14, 2019**

## **1.0 Purpose**

This specification provides guidance to manufacturers and market actors who are interested in developing products that can provide high levels of consumer satisfaction and energy performance in a range of climates. The end goal of this effort is to ensure that the North American introduction of gas heat pump water heater (GHPWH) products will be as successful as possible to pave the way for GHPWHs to become the standard product for the storage gas water heating market. This specification, and the tiers contained herein, are not meant to require manufacturers to provide product; instead, they are designed to give consumers increasing levels of performance as product is introduced over the next decade.

Utilities and other entities that invest in market transformation programs and/or incentives require reliable energy savings and cold climate performance. Accordingly, the specification is also intended as a foundational document for utility program efforts that will work in partnership with manufacturers to accelerate market adoption of GHPWHs. Using this specification will help to improve market acceptance, reduce the number of geographically-targeted SKUs for manufacturers, and ensure that the expected savings materialize and are persistent.

This specification addresses key topics that fall into two main categories:

- Performance — energy efficiency and savings, condensate management, freeze protection, user controls, reliability
- Comfort/satisfaction — sufficient hot water for customer needs, noise, ease of installation, serviceability

## **2.0 Scope**

**2.1 Equipment Type.** This specification covers gas heat pump water heaters including those integrated with storage tanks, split systems, and engine-driven systems. A gas heat pump water heater is a device that is primarily fueled with gas to drive a refrigeration cycle to heat water by extracting heat from the ambient environment. Heat pump water heaters configured to “add on” to existing storage tanks are not covered by this specification. Combination space + water systems are not currently covered by this specification. A future version of this specification (or a related specification) may address these systems.

**2.2 Applications.** The specification covers both replacements for existing gas storage water heaters and alternatives to new gas water heaters. As such, storage tanks shall be configured to meet the space installation and code requirements for typical gas storage water heaters.

### 3.0 Product Tiers

**3.1 Overview.** Tiers are incorporated into this specification recognizing variations in product performance and supported applications. Table 1 summarizes each Tier:

**Table 1. Product Tier Overview**

	Minimum UEF*	Minimum Features	Sound levels*** Appendix C
<b>Tier 1.0</b>	1.0	<ul style="list-style-type: none"> <li>• ENERGY STAR compliance**</li> <li>• Freeze protection</li> <li>• 6-year warranty (parts)</li> </ul>	dBA < 65
<b>Tier 2.0</b>	1.15	Tier 1 plus: <ul style="list-style-type: none"> <li>• Shut-down notification</li> <li>• 10-year warranty (parts), 1-year labor warranty</li> <li>• Evaporator condensate management</li> </ul>	dBA < 60
<b>Tier 3.0</b>	1.3	Tier 2 plus: <ul style="list-style-type: none"> <li>• Air filter management</li> </ul>	dBA < 55
<b>Tier 4.0</b>	TBD	TBD	TBD
<b>Tier 5.0</b>	TBD	TBD	TBD

\* UEF – Uniform Energy Factor. See Appendix A for test and measurement method.

\*\* See Appendix D for details on ENERGY STAR qualification.

\*\*\* See Appendix C for details on measurement method.

## 4.0 Requirements for All Units (Tiers 1.0 and above)

**4.1 Standards Approval.** The unit shall be approved by Underwriters Laboratories (UL), Electrical Testing Laboratories (ETL), CSA International (CSA), or an equivalent third-party agency to the applicable standards and have the ability to be installed in the US and/or Canada.

**4.2 Uniform Energy Factor.** The unit shall meet minimum Uniform Energy Factor values under default operating mode settings according to Table 1. See **Appendix A** for the Uniform Energy Factor (UEF) Test Procedure.

**4.3 Sound Levels.** The unit shall not exceed maximum sound levels according to Table 1. See **Appendix C** for Sound Measurement Test Method.

**4.4 Freeze Protection Test.** Applicable only to units circulating water to system components outside the heated house envelope or buffer space (i.e., circulating water to a heat exchanger that is in a location subject to freezing temperatures). If applicable, the unit shall pass the 24-hour power-off freeze protection test as specified in **Appendix B**. The key reason for this test is to ensure that water heaters do not freeze during power outages. Manufacturers should clearly state in installation manuals how to install units to prevent freezing.

**4.5 Installation Guidance.** Installation guidance shall be provided so the unit is installed with adequate clearance for all airflow to and from the evaporator. The installation manual shall provide several possible configurations and/or installation scenarios to assist the installer.

**4.6 Limited NO<sub>x</sub> Emissions.** The unit shall meet the requirements of the South Coast Air Quality Management District (SCAQMD) Rule 1121, Revised 7/6/2018: "Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters."<sup>1</sup>

**4.7 Combustion Condensate.** Installation guidance shall be provided so the unit can meet all local codes governing the proper neutralization and drainage of combustion condensate. Additionally, the installation manual shall have reference to a kit or parts list for all necessary components to install such a system.

**4.8 Combustion Flue Gas Venting.** The product shall be rated as Category III, VI, or direct vent. Provisions for combustion and ventilation air must be provided in accordance with the installation manual and applicable codes and standards.

**4.9 Warranty and Service.** The unit shall carry a warranty of a minimum of 6 years for all system parts as well as a minimum of 1 year for labor from date of installation.

---

<sup>1</sup> <http://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/support-documents/rule-1121>

**4.9.1 Contact Information.** The unit shall include clear information on how to obtain warranty service, maintenance items, and technical support via a toll-free phone number clearly marked on the exterior of the unit.

**4.10 Evaporator Condensate Management.** Condensate shall be drained away according to local plumbing codes and industry best practices.

**4.10.1 Acceptable Condensate Piping.** The unit shall include a minimum standard piping connection for condensate drainage of proper size to function for the life of the product under normal use (field installation materials to be acquired by the installer for the connection). The manufacturer shall supply appropriate condensate piping specifications including piping diameter, length, allowable turns, and acceptable termination for gravity drains and for condensate pumping in locations, such as basements, where gravity drainage is not possible. Instructions for the installer shall highlight the importance of correct condensate line installation practices and adherence to local plumbing code.

**4.10.2 Condensate Overflow Shut-off and Alarm.** Units shall include a safety switch to shut off heat pump operation in the event of a blockage of the condensate removal system for any units installed in interior applications. An audible (see audible alarm section in section 5.2.3) and visible alarm shall be activated to signal the need for service in the event of a shut-off due to condensate drain failure.

**4.10.3 Condensate Collection Pan and Drain Service.** The condensate collection pan and drain shall be designed to obviate regular maintenance or interaction by the consumer for the life of the product. In the event of a blockage, the pan and drain shall be designed to allow the consumer to be able to clear the drain with normal household tools and restore normal operation of the condensate line. Collection pan equipment and installation shall meet local code.

## 5.0 Additional and Optional Requirements for Tiers 2.0 and Above

### 5.1 RESERVED

**5.2 Shut-down Notification.** The unit shall provide notification to the consumer that the heat-pump operation of the product has been disabled due to normal events, user selected override, or product failure.

**5.2.1 Normal, Temporary Event.** The unit shall display that the heat pump is not currently operating if the heat pump cycle is temporarily disabled due to specific operational controls (e.g., defrosting). The controls shall automatically restore heat pump operation as soon as conditions return to allowable control parameters (e.g., completion of the defrost cycle).

**5.2.2 User Selected Override.** If the unit has a temporary, user selectable heat pump override option, the unit shall provide a default override period of up to 72 hours before returning to the previously selected operating mode.

**5.2.3 Product Failure Alarm.** The unit shall provide the following alarms to the consumer that the unit has a failure and requires service:

- Visual alarm — shall be visible without removal of panels and/or covers and shall have clear direction to the homeowner to take needed action to solve the problem.
- Audible alarm or electronic notification to homeowner via email, text message, phone app, or similar. If an audible alarm used, the unit shall provide a homeowner acknowledgement feature that turns off the audible alarm. An audible alarm shall be at least 50 dBA as measured as the average sound value specified in Appendix C.

In total, the unit shall have a visual alarm and one or both of the following: audible alarm or e-notification alarm.

**5.3 Warranty and Service.** The unit shall carry a warranty of a minimum of 10 years for all system parts as well as a minimum of 1 year for labor from date of installation.

## **6.0 Additional Requirements for Tier 3.0**

**6.1 Default Settings.** The unit shall be shipped in the default operational mode used in demonstrating compliance to federal energy efficiency standards. The customer, technician, and/or installer shall have the ability to override the default setting. Enhanced efficiency operational modes may be selected by the consumer during installation. In the event of total power loss to the unit, it shall revert to the last settings selected.

**6.2 Air Filters: Routine Maintenance and Homeowner Notification.** If any air filters are present, they shall be either 1) permanent, washable media or 2) replaceable, standard filters in shapes and forms obtainable at a typical hardware store. The unit shall provide visible notification to the homeowner of appropriate need to change, or service, the filter to prevent compromise of performance of the heat pump from reduced airflow. Recommendations are to be defined by the manufacturer.

**6.3 Demand Response.** Demand response capability is not incorporated into the specification at this time. It is, however, recognized that both electric and gas demand response capabilities are potential areas of development in future technology. Future versions of the specification will revisit the requirement.

## **Appendix A: Uniform Energy Factor and First Hour Rating**

Overview: Measure and calculate a First Hour Rating (FHR) and Uniform Energy Factor (UEF). Follow the test procedure set forth by the Department of Energy: Section 6 of 10 CFR Pt. 430, Subpart B, App. E as published in Federal Register Vol. 79 No. 122, July 11, 2014. Follow the procedure as if testing a gas storage water. Upon completion of the test, calculate both First Hour Rating and Uniform Energy Factor.

## Appendix B: Freeze Protection Test

Overview: For units circulating water outside the hot water tank for purposes other than delivery to the house (i.e., to a heat exchanger for heating), test the water heater's ability to withstand adverse environmental events and remain functional afterwards as defined in 3.0 below.

### 1.0 Test setup:

- The ambient air in which the water heater is located shall be maintained at 20°F dry bulb for the duration of the test.
- Set tank delivery water temperature set point to 125°F.
- Set equipment to the default operating mode.
- Inlet and outlet water lines shall be insulated to provide an R value between 4 and 8 h-ft<sup>2</sup>-F/Btu for a minimum of 2 feet from the tank with 1" thick pipe insulation.

### 2.0 Test procedure:

- Establish normal water heater operation: If water heater is not operating, initiate a draw. Terminate that draw when equipment cut-in occurs. When the tank recovers and the heaters cut out, wait 5 minutes. Then, shut off all power to the water heater for 24 hours.
- After 24 hours, turn on power to the water heater and allow it to recover to the set point.
- Initiate a draw until the heater cuts in. Allow tank to recover to the set point.
- Shut off power to the water heater and inspect for damage.

3.0 Functionality. The water heater will have passed the test if all the following criteria are met:

- The heat pump runs and the tank recovers after the 24hr off period.
- There is no freezing or rupture of any water-related connections or components including but not limited to heat exchangers, pumps, condensate lines, or other heat pump components apart from the standard plumbing connections required for a traditional electric resistance water heater.



## Appendix C: Sound Pressure Measurement Test Method

Overview: A simplified, repeatable test to measure sound pressure level

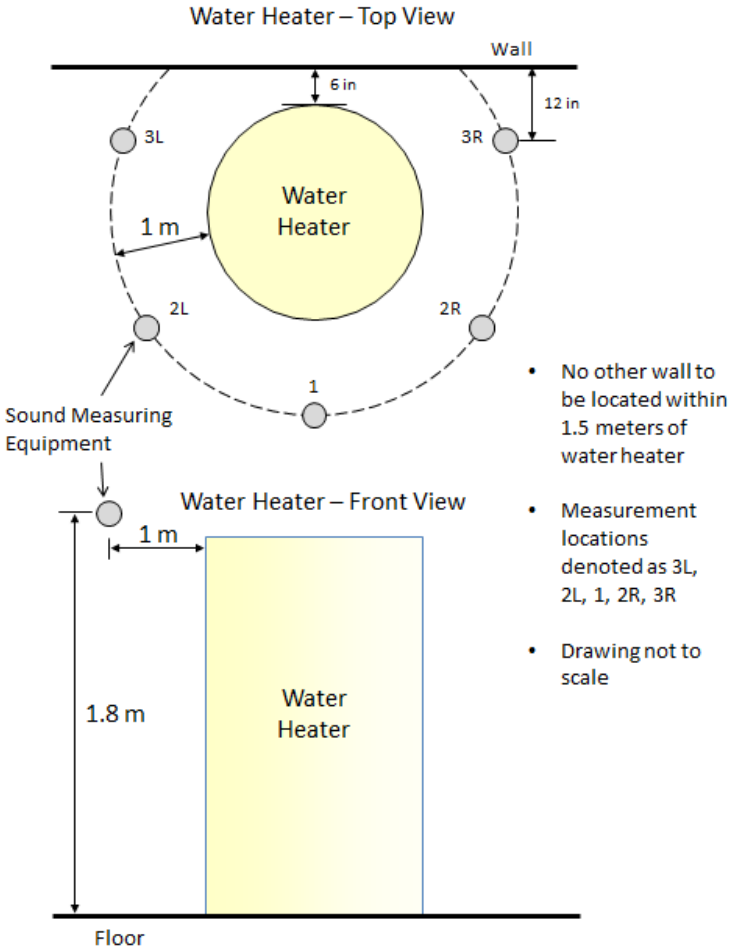
### 1.0 Test setup:

- The testing room shall approximate a reverberation chamber. The approximate reverberation room is defined as follows: most surfaces are relatively hard — standard laboratory flooring materials such as concrete or linoleum, and cinder block or drywall walls; the room need not be empty of other equipment, though other noise sources should be turned off. Efforts to dampen noise, such as applying anechoic tiles or baffles, shall not be performed. Measurements made in an anechoic or semi-anechoic style chamber are not valid. The test concept is to approximate a typical garage, basement, or house utility room.
- Place the water heater 6” away from one wall in the room.
  - All other walls or objects shall be at least 1.5 meters away from the water heater.
  - Ambient noise shall be less than or equal to 35dBA.
  - Unit shall be run without ducting attached for those units for which this is an option.
- Initiate normal water heater operation under an operating mode that uses all moving components simultaneously, including, but not limited to, the compressor, fan, or pumps. Allow the unit to operate in this mode for 1minute before proceeding and ensure that a steady state of operation is maintained during the entire sound measurement procedure.
  - Inlet water temperature shall be 58°F ±10°F
  - Ambient air conditions shall be 67°F ±18°F

### 2.0 Test procedure:

- Measure the A-weighted sound pressure level:
  - At five points 1 meter distant from the water heater surface at a 1.8-meter height above the base of the water heater (see Figure 1). Points 3L and 3R should be 12” from the wall.
  - If the water heater has an airflow intake or exhaust flow path around the circumference of the equipment, position the unit as follows, so the airflow is not directly aimed at a measurement point: aim the intake or exhaust between points (3L, 2L), (2L, 1), (1, 2R), or (2R, 3R). In no case should the flow path be directed between points (3L, 3R).
- Average all five measurements into a single sound value.

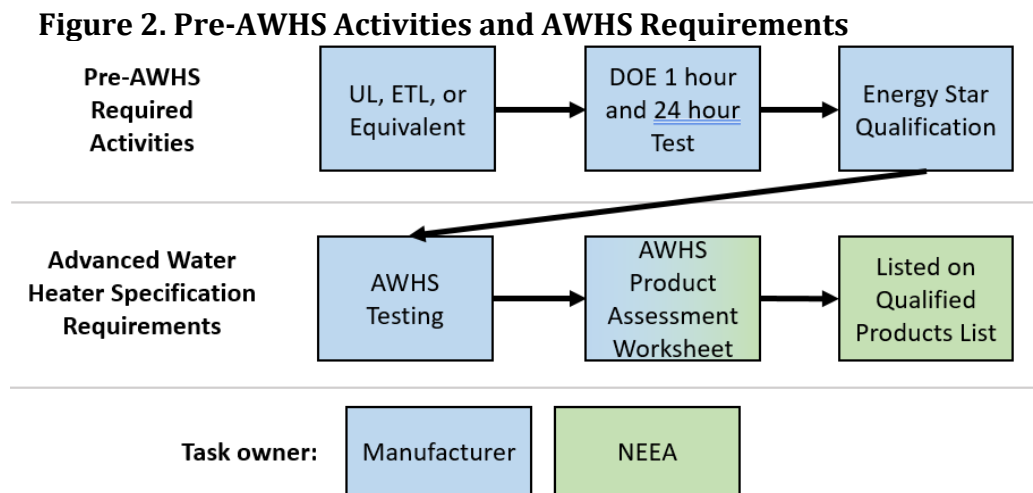
**Figure 1. Test Setup for Sound Pressure Measurement**



## Appendix D: Qualification Process

All the steps necessary for ENERGY STAR qualification are required by the Advanced Water Heater Specification. A broad overview of the pre-AWHS activities and subsequent AWHS requirements are shown in the flow chart below (Figure 2). It is the manufacturer’s responsibility to take the water heater through preparation of the referenced AWHS Product Assessment Worksheet, at which point it is handed off to the managing agency (currently the Northwest Energy Efficiency Alliance (NEEA)). If all requirements are met, the product will be listed on the Qualified Products List (QPL). The QPL is updated as needed to keep current with products on the market.

Both the Product Assessment Worksheet and Qualified Products List for gas heat pump water heaters are currently under development. Once complete, they will be posted on the NEEA website and referenced here.



Manufacturers are encouraged to perform their own Advanced Water Heater Specification testing or facilitate it through any third-party EPA-recognized laboratory.<sup>2</sup> In the event the manufacturer does not perform this testing (and submits an incomplete assessment worksheet), qualification will be delayed until the managing agency or the manufacturer performs (if they are self-reporting and validated by NEEA or its designated managing agency) the requisite testing.

Upon meeting all the requirements for qualification, a product will be added to the Qualified Products List and classified into the appropriate tier level.

<sup>2</sup> See [https://www.energystar.gov/index.cfm?fuseaction=recognized\\_bodies\\_list.show\\_RCB\\_search\\_form](https://www.energystar.gov/index.cfm?fuseaction=recognized_bodies_list.show_RCB_search_form)

## Appendix E: Disqualification and Re-qualification Process

NEEA and/or the managing agency may evaluate a product at any time to ensure that the product meets the requirements of the Advanced Water Heater Specification. The evaluation may find that products that have previously been qualified to the Specification may no longer qualify or may qualify for a different tier level. Disqualification may result from, but not be limited to, any of the following scenarios:

- 1) Re-testing new units or versions of the product in a lab.
- 2) By inspection of the product if certain product features available at the time of initial qualification are no longer commercially available.
- 3) In-field testing reveals substantial differences between in-field performance and lab-tested performance (greater than 5%). “Substantial” is here defined as having a material impact on the aggregate performance in the population of products under study, such that the product in aggregate no longer qualifies to meet the minimum tier (Tier 1) of the Specification or qualifies for a different tier.
- 4) Product safety issues are observed in the field, or otherwise discovered in lab or field testing.
- 5) Challenge to Qualified Products:  
An entity (manufacturer, regulatory agency, or advocacy group) may challenge the placement of a product on the Qualified Product List (QPL) listed product. This challenge event consists of the party challenging the results contacting the QPL managing agency (currently NEEA) in writing that potential discrepancies in test results may exist. The managing agency shall notify the challenged party in writing and coordinate a mutually agreeable testing lab for verification testing. Random units shall be pulled from distribution and sent to the testing lab. The full cost of doing the test (including procurement, shipping, and testing) shall be borne by whichever entity is found in error.

In all the above scenarios, NEEA and/or the managing agency will share the information with existing programs or technical work groups (if established) for review. Upon review, NEEA and/or the managing agency may decide to proceed with the disqualification/tier-reclassification, or to proceed no further for reasons such as lab or field-testing errors, insufficient confidence in testing results, or administrative errors in the testing process. NEEA and/or the managing agency may request that the manufacturer provide additional information, or perform additional third-party testing, to determine the outcome.

Upon deciding to proceed with disqualification/tier-reclassification, NEEA and/or the managing agency shall inform the manufacturer and provide 20 days for a written response from the date of notice. NEEA shall share the written response (if any) with the existing programs or technical work groups (if established), gather feedback, make a final decision, and inform the manufacturer of the decision. If a previously qualified product is found to not meet specifications and/or the specified tier level, the product will be de-listed.

Once products are disqualified or have been assigned to a different tier, the manufacturer may petition for requalification or assignment to the original tier level. The information provided in the petition (such as updated lab and field tests, manufacturing process or design changes) will be analyzed by NEEA and/or the managing agency and shared with the existing programs or technical work groups (if established). At that point a decision will be made and communicated to the manufacturer.