Advanced Water Heating Specification, Residential

DRAFT Version 9

A Specification for Residential Electric Water Heaters

Effective Date: *pending*

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1 Introduction

Introduction pending final revision.

2 Scope and Definitions

2.1 Scope

This specification applies to products that meet all of the following:

- Electric fuel source only
- Employs an air-source heat pump
- Has a storage capacity not greater than 120 gallons
- Has a maximum current of 24 amps at 250 volts (6kW)
  See [reference to commercial spec]
- Meets the definition of a “water heater” in the Code of Federal Regulations as provided at 10 CFR 430.2
- Is of a configuration that can be tested under U.S. Department of Energy test procedures to produce both a First Hour Rating (FHR) and a Uniform Energy Factor (UEF) rating

The following products are out of scope:

- Combination systems that cannot operate solely as a water heater
- Products that employ a heating technology other than an air-source heat pump or electric resistance (including ground- or water-source heat pumps and combustion)
- Gas-fueled heat pump water heaters
  See Advanced Water Heating Specification for Gas-Fueled Residential Storage Water Heaters
  https://neea.org/img/documents/Natural-Gas-Advanced-Water-Heating-Specification.pdf

2.2 Definitions

audible alarm	a sound produced by a HPWH of at least 50 dBA when measured 1 meter from control interface. Control interface allows user to acknowledge and silence the alarm.
combination system	a mechanical system designed to perform both domestic water heating and one or more other functions, such as space cooling/heating, pool heating, etc.
control interface	the physical component of the HPWH that is the primary means by which a user selects operational settings and receives information about the HPWH’s operating state. Software installed on a device not included with the product’s purchase (e.g., an app for a mobile device) is not the control interface.
Cool Climate Efficiency (CCE)	an energy efficiency metric developed by NEEA for air-source heat pump water heaters installed in interior spaces. CCE is defined by Appendix A of this specification.
default mode	the operating mode used in DOE testing as described in 10 CFR Appendix E to Subpart B of Part 430 at Section 5: Test Procedures.
DOE standards	unless otherwise noted, the U.S. Department of Energy Conservation Standard for electric, storage-type consumer water heaters as published in 10 CFR Parts 429 and 430 on May 6, 2024

electronic notification	indication of a fault condition sent to the user via email, text message, app notification, or similar.
FHR test	test performed according to the procedures described in 10 CFR Appendix E to Subpart B of Part 430, 5.3.3 First-Hour Rating Test.
operating mode	a user-selectable option that alters the way in which the HPWH uses or restricts its heating components (heat pump and ER elements).
operating range	the set of conditions within which the heat pump of a HPWH is expected to operate, specifically the range of ambient air temperatures.
product	a heat pump water heater meeting the scope of this specification. In the case of a split-system HPWH in which the heat pump unit and water storage unit are not sold as a single item, product refers to the specific heat pump unit-water storage unit combination that was tested to produce a UEF and FHR.
Seasonal Coefficient of Performance (SCOP)	an energy efficiency metric developed by NEEA for air-source heat pump water heaters installed in exterior spaces. SCOP is defined by Appendix B of this specification.
UEF test	test performed according to the procedures described in 10 CFR Appendix E to Subpart B of Part 430, 5.4 24-Hour Simulated-Use Test.
visual alarm	an indication of an error or other problem with the operation of the HPWH, appears on the control interface and provides information that allows the user to address the error or problem.

3 Requirements

The AWHS specifies water heater performance, features, and manufacturer support that contribute to the purpose of the specification. It defines three tiers of requirements. This table provides a summary comparison of tier requirements. Full requirement specifications are outlined on the following pages.

	Tier 1	Tier 2	Tier 3
Referential	DOE standards		
		ENERGY STAR® certified	
Efficiency Rating	UEF ≥ 2.30	UEF ≥ 3.30	If ER capacity > 1.5 kW: CCE ≥ 3.0 or SCOP ≥ 2.7
			If ER capacity ≤ 1.5kW: CCE ≥ 2.6 or SCOP ≥ 2.7
Electric Resistance	ER-only modes limited to 72 hrs		
		In FHR test, 66% of tank volume drawn before ER engages	
		Heat pump failure alerts	
			Modes using lower ER limited to 72 hrs
			No lower ER in default mode
Documentation	Printed manual covering topics for proper installation and operation		
Warranty	3 years coverage on sealed system	6 years coverage on sealed system	6 years coverage on all parts
	1 year coverage on labor for warranty claims		
Sound Level			≤ 50 dB(A)

3.1 Tier 1

3.1.1 Referential

3.1.1.1 DOE Standards

Complies with all aspects of the U.S. Department of Energy Conservation Standard for electric, storage-type consumer water heaters as published in 10 CFR Parts 429 and 430 on May 6, 2024 (“DOE Standards”).

3.1.2 Efficiency Rating

3.1.2.1 UEF

Has a Uniform Energy Factor (UEF) not less than 2.30.
If DOE Standards require a higher UEF for the product, that requirement also applies.

3.1.3 Electric Resistance

3.1.3.1 ER Mode Timeout

If user selects an operating mode that only uses ER heating the selection expires in 72 hours or less.

Upon expiration of the selection, the product reverts to either the default operating mode or the previously selected operating mode.

3.1.4 Installation and Operation Documentation

Product includes printed documentation for its installation and operation.

Documentation addresses the following topics, if applicable to the particular product design and intended use, with detail and clarity sufficient for a competent installer to install and a competent user to operate the product in a manner that promotes the proper and intended operation of the product.

A) Minimum room size for installation
B) Minimum clearances for installation and maintenance
C) Minimum clearances for airflow
D) Methods for improving ventilation of installation area/room
E) Ducting use and design
F) Effect of source air temperature on water heater performance
G) Climate considerations
H) Condensate management
I) Recommended maintenance activities and schedule
J) Descriptions of user-selectable options and their effects on operation and energy efficiency
K) Installation and/or operation of a thermostatic mixing valve
L) Warranty coverage, limitations, and claims process

Note: The Air Conditioning, Heating and Refrigeration Institute (AHRI) is currently developing a guideline for installation of residential heat pump water heaters. NEEA supports this effort and intends to adopt the guideline as an alternative or replacement for the requirement described here.

3.1.5 Warranty

3.1.5.1 Parts

Product carries a warranty of at least three years for all parts of the sealed system.

3.1.5.2 Labor

Manufacturer shall bear the full cost of professional labor required to resolve any product warranty claim(s) occurring within one year of purchase.

3.2 Tier 2

3.2.1 Referential

3.2.1.1 DOE Standards (same as tier 1)

Complies with all aspects of the U.S. Department of Energy Conservation Standard for electric, storage-type consumer water heaters as published in 10 CFR Parts 429 and 430 on May 6, 2024 (“DOE Standards”).

3.2.1.2 ENERGY STAR®

Is certified to version 5.0 of ENERGY STAR Program Requirements for Residential Water Heaters Partner Commitments as published July 18, 2022.

3.2.2 Efficiency Rating

3.2.2.1 UEF

Has a Uniform Energy Factor (UEF) not less than 3.30.
If DOE Standards require a higher UEF for the product, that requirement also applies.

Electric Resistance

3.2.2.2 ER Mode Timeout (same as tier 1)

If user selects an operating mode that only uses ER heating the selection expires in 72 hours or less.

Upon expiration of the selection, the product reverts to either the default operating mode or the previously selected operating mode.

3.2.2.3 Minimum Draw without ER

During the First Hour Rating (FHR) test, at least 66% of product’s rated storage volume is withdrawn before ER engages.

3.2.2.4 Heat Pump Failure Notification

If there is a failure of the heat pump system and ER heating is still operational, product produces:

A) A visual alarm, and
B) An audible alarm, an electronic notification, or both

3.2.3 Installation and Operation Documentation (same as tier 1)

Product includes printed documentation for its installation and operation.

Documentation addresses the following topics, if applicable to the particular product design and intended use, with detail and clarity sufficient for a competent installer to install and a competent user to operate the product in a manner that promotes the proper and intended operation of the product.

A) Minimum room size for installation
B) Minimum clearances for installation and maintenance
C) Minimum clearances for airflow
D) Methods for improving ventilation of installation area/room
E) Ducting use and design
F) Effect of source air temperature on water heater performance
G) Climate considerations
H) Condensate management
I) Recommended maintenance activities and schedule
J) Descriptions of user-selectable options and their effects on operation and energy efficiency
K) Installation and/or operation of a thermostatic mixing valve
L) Warranty coverage, limitations, and claims process

3.2.4 Warranty

3.2.4.1 Parts

Product carries a warranty of at least six years for all parts of the sealed system.

3.2.4.2 Labor (same as tier 1)

Manufacturer shall bear the full cost of professional labor required to resolve any product warranty claim(s) occurring within one year of purchase.

3.3 Tier 3

3.3.1 Referential

3.3.1.1 DOE Standards (same as tiers 1 and 2)

Complies with all aspects of the U.S. Department of Energy Conservation Standard for electric, storage-type consumer water heaters as published in 10 CFR Parts 429 and 430 on May 6, 2024 (“DOE Standards”).

3.3.1.2 ENERGY STAR® (same as tier 2)

Is certified to version 5.0 of ENERGY STAR Program Requirements for Residential Water Heaters Partner Commitments as published July 18, 2022.

3.3.2 Efficiency Rating

3.3.2.1 ER Capacity Over 1.5 kW

For products that include one or more ER heating element(s) with a combined maximum operating input capacity greater than 1.5 kW:

- Cool Climate Efficiency (CCE) no less than 3.0, or
- Seasonal Coefficient of Performance (SCOP) no less than 2.7

3.3.2.2 ER Capacity 1.5 kW or Less

For products not included in 3.3.2.1:

- CCE no less than 2.6, or
- SCOP no less than 2.7

3.3.3 Electric Resistance

3.3.3.1 Operating Mode Time Limits

If user selects an operating mode meeting one or more of the following descriptions, the selection expires in 72 hours or less.

A) Uses only ER for heating
B) Allows use of an ER element located in the lower half (by volume) of the storage tank when within the operating range.

Upon expiration of the selection, the product reverts to either the default operating mode or the previously selected operating mode.

3.3.3.2 Minimum Draw without ER (same as tier 2)

During the First Hour Rating (FHR) test, at least 66% of product’s rated storage volume is withdrawn before ER engages.

3.3.3.3 Heat Pump Failure Notification (same as tier 2)

If there is a failure of the heat pump system and ER heating is still operational, product produces:

A) A visual alarm, and
B) An audible alarm, an electronic notification, or both

3.3.3.4 Lower Element Restriction

In the default operating mode and when ambient air conditions are within the compressor operating limits, no ER element located in the bottom half (by volume) of the storage tank shall engage.

3.3.3.5 High Volume Draw Test

Products that include one or more ER heating element(s) with a combined maximum operating input capacity greater than 1.5 kW will undergo the High Volume Draw Test (Appendix D) and the results will be reported to NEEA. This is a testing and reporting requirement only: There is no minimum result necessary.

3.3.4 Warranty

3.3.4.1 Parts

Product carries a warranty of at least six years for all parts.

3.3.4.2 Labor (same as tiers 1 & 2)

Manufacturer shall bear the full cost of professional labor required to resolve any product warranty claim(s) occurring within one year of purchase.

3.3.4.3 Installation and Operation Documentation (same as tier 1 & 2)

Product includes printed documentation for its installation and operation.

Documentation addresses the following topics, if applicable to the particular product design and intended use, with detail and clarity sufficient for a competent installer to install and a competent user to operate the product in a manner that promotes the proper and intended operation of the product.

A) Minimum room size for installation
B) Minimum clearances for installation and maintenance
C) Minimum clearances for airflow
D) Methods for improving ventilation of installation area/room
E) Ducting use and design
F) Effect of source air temperature on water heater performance
G) Climate considerations
H) Condensate management
I) Recommended maintenance activities and schedule
J) Descriptions of user-selectable options and their effects on operation and energy efficiency
K) Installation and/or operation of a thermostatic mixing valve
L) Warranty coverage, limitations, and claims process

3.3.5 Sound Level

Sound pressure level of no more than 50 dB(A) as measured by the Sound Pressure Measurement Test Method (Appendix C).

Note: AHRI is currently evaluating standards for the measurement of heat pump water heater sound levels. NEEA supports this effort and intends to adopt the standards as an alternative or replacement for the requirement described here. That revision may require the disclosure of test results rather than requiring compliance with a maximum sound level.

4 Endorsements

In addition to tier rating, products qualified to AWHS can also qualify for optional endorsements. Endorsements are included on the Qualified Products List along with other pertinent information about the product.

4.1 Load Flex

The Load Flex endorsement is available to products that meet either or both of the following criteria:

4.1.1 EcoPort^{CM}

Product is listed in the OpenADR Alliance's EcoPort Certified Product Database https://ecoport.openadr.org

4.1.2 AHRI 1430

Product has been tested to and found compliant with standard AHRI 1430-2022 (I-P): Demand Flexible Electric Storage Water Heaters (with Addendum 1).

4.2 Adaptive Control

NEEA recognizes the potential benefits of pattern-learning control systems for HPWHs. As this emerging technology continues to develop, the AWHS may be updated to include an endorsement to identify products that apply it in ways that improve energy efficiency.

5 Qualification

5.1 Qualified Products List

NEEA maintains a list of HPWHs that it has found to satisfy the requirements of this specification, the Qualified Products List (QPL).

The QPL is available on NEEA's website:
https://neea.org/resource/residential-hpwh-qualified-products-list/
A new version of the QPL will be published once version 9 goes into effect.

For each listed product, the QPL includes the following:

- Identifying information (brand name, model number, nominal storage capacity)
- Tier
- UEF
- CCE (included for all products rated to tier 3, optional for others)
- SCOP (included for all products rated to tier 3, optional for others)
- Endorsements

5.2 Submission Process

Manufacturers of HPWHs or their chosen representatives may submit products for inclusion on the QPL. NEEA evaluates these submissions and, at its sole discretion, determines whether a product meets the requirements of AWHS, and of which tier.

5.2.1 Direct Submission

Manufacturers may submit products for inclusion on the QPL by submitting the required materials to *email address TBD*.

A complete submission includes:

- Product Assessment Datasheet (PADS)
- Installation and operation manual(s)
- A copy of the applicable warranty language

The PADS form is available on NEEA's website:
https://neea.org/resource/residential-hpwh-product-assessment-datasheet/
A new version of the PADS will be developed for version 9 once the revision is finalized.

The information required in the PADS depends on the tier rating, product design, and any requested endorsements. Laboratory test reports are not required.

While a product will not be qualified to AWHS until all necessary materials have been received and reviewed, manufacturers are welcome to contact NEEA with questions, to request a pre-review of partial data, and for direction on product testing requirements.

5.2.2 Authorized Partner Organizations

This section reserved for use in a future revision of the specification.

NEEA is exploring additional pathways for manufacturers to submit product for the QPL, intended to reduce administrative burden and combine it with other certification processes.

5.3 Testing Requirements

Qualification to tier 1 does not require data from tests beyond those required for DOE standards.

Qualification to tier 2 does not require data from tests beyond those required for ENERGY STAR certification.

Qualification to tier 3 requires additional product testing:

Test	Required for	Reference
E_{50}	Products requesting a CCE rating	10 CFR Part 430, Appendix E to Subpart B, 2.8 Optional Test Conditions (Heat Pump-Type Water Heaters)
E_5	Products requesting a SCOP rating	
E_{34}		
E_{95}[1]		
Sound Pressure Level	All products	Appendix C: Sound Pressure Measurement Test Method
High Volume Draw Test	Products that include one or more ER heating element(s) with a combined maximum operating capacity greater than 1.5 kW	Appendix D: High Volume Draw Test

The optional Load Flex endorsement may require testing as defined by the organization that maintains the standard used to demonstrate compliance with the endorsement requirement.

At its discretion, NEEA may apply the result of one test to more than one model if those models are reasonably expected to be functionally equivalent in regard to the characteristics measured by the test. Manufacturers are encouraged to contact NEEA at *email address TBD* to discuss requirements before testing. Testing waivers may be made available for:

- Models that are identical except for branding or model number
- A set of models that vary only in storage capacity
- A set of models that vary only in features that are inconsequential to test performance (e.g. leak sensors, automatic shut-off valves, wireless communication capabilities)

5.4 Qualification and Rating Review

NEEA maintains the right to remove or modify any QPL listing at its discretion.

Parties that have submitted a product listed on the QPL may have that listing removed by contacting NEEA at *email address TBD*.

Parties that have submitted a product listed on the QPL are responsible for notifying NEEA of any material changes to the applicability of information submitted for that listing to products bearing the listing's brand and model number by emailing *email address TBD*.

Any party that questions a listing on the QPL may request its review by emailing *email address TBD*.

[1] With outdoor air conditions of 95F & 25% RH, indoor air conditions of 67.5F & 50% RH

Appendix A: Cool Climate Efficiency Calculation

In the final AWHS version 9.0, this section will include an adaptation of "Appendix A.1.2. Cool Climate Efficiency Calculation Climates (5-6)" from version 8.1. ***The calculation method will not change****, but it will refer to test procedures defined by DOE ("10 CFR Part 430, Appendix E to Subpart B, 2.8 Optional Test Conditions (Heat Pump-Type Water Heaters).") rather than the test procedures defined in AWHS version 8.1 "Appendix A.1.1 Temperature Range Performance Testing – Integrated Units".*

Appendix B: Seasonal Coefficient of Performance Calculation

In the final AWHS version 9.0, this section will include an adaptation of "Appendix A.4: Temperature Range Performance Testing – Split Systems" from version 8.1. ***The calculation method will not change****, but it will refer to test procedures defined by DOE ("10 CFR Part 430, Appendix E to Subpart B, 2.8 Optional Test Conditions (Heat Pump-Type Water Heaters).") rather than the test procedures defined in AWHS version 8.1.*

Appendix C: Sound Pressure Measurement Test Method

This test method is unchanged from version 8.1.

Overview: A simplified, repeatable test to measure sound pressure level. Future versions of this specification intend to adopt and use an industry consensus standard, when one arises, specifically designed to measure HPWH sound levels.

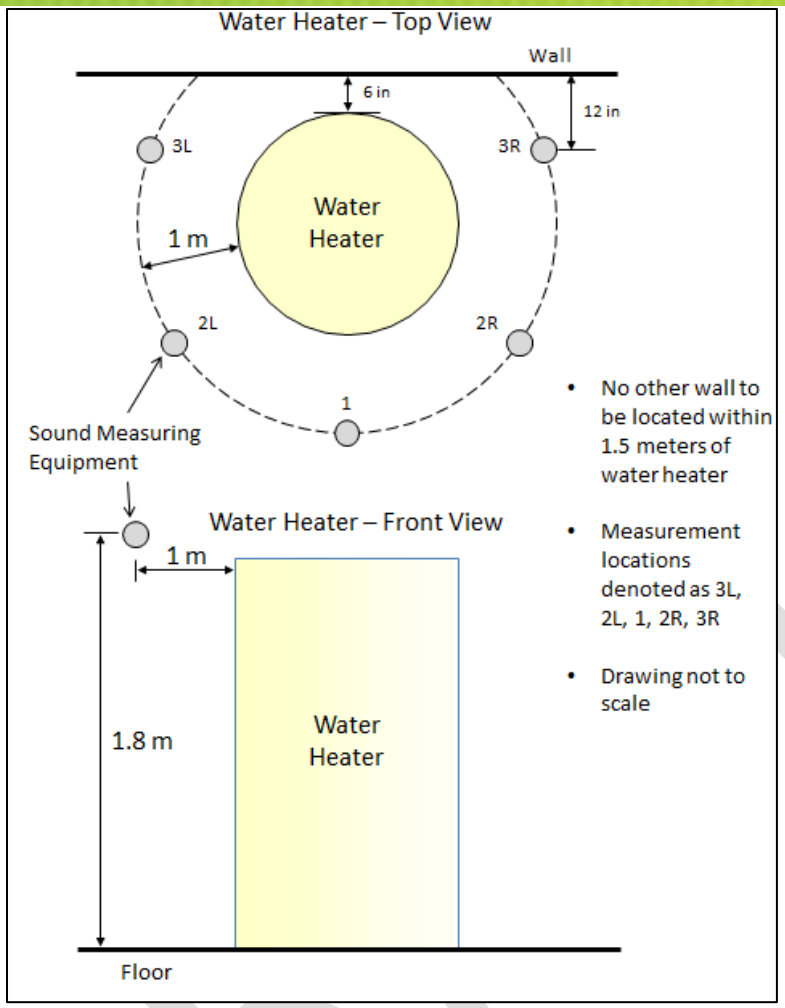
Test Setup

- The testing room shall approximate a typical garage, basement, or house utility room defined as follows: most surfaces are relatively hard — standard laboratory flooring materials such as concrete or linoleum, and cinderblock 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.
- 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 at least 10 dBA less than the water heater being measured. For example, if unit under test is measured at 56 dBA, the ambient noise level may be < 46 dBA.
    - 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 one minute before proceeding and ensure that a steady state of operation is maintained during the entire sound measurement procedure.
- Environmental parameters are as follows:
    - DOE (required)
        - Inlet water temperature shall be 58°F ±5°F
        - Ambient air conditions shall be 67.5°F ±5°F
    - Cool Climate Efficiency (CCE) (optional)
        - Inlet water temperature shall be 50°F ± 5°F
        - Ambient air conditions shall be 50°F ± 5°F

Test Procedure

- Measure the A-weighted sound pressure level:
    - At five points one meter distant from the water heater surface at a 1.8 meter height above the base of the water heater (see Figure below). 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: Test Setup for Sound Pressure Measurement


Water Heater – Top View
Wall
6 in
12 in
3L
3R
Water Heater
1 m
2L
2R
1
Sound Measuring Equipment
Water Heater – Front View
1 m
1.8 m
Water Heater
Floor
No other wall to be located within 1.5 meters of water heater
Measurement locations denoted as 3L, 2L, 1, 2R, 3R
Drawing not to scale

Appendix D: High Volume Draw Test

In the final AWHS version 9.0, this section will include an adaptation of "Appendix A.3: High Volume Draw Test" from version 8.1. ***The test procedure will not change <u>except for the draw pattern assignment</u>.***

The current test procedure assigns draw volumes based on the nominal storage capacity of the unit under test. The revision for version 9.0 will assign draw volumes based on the effective actual storage capacity. For water heaters that ***do not*** *use a mixing valve to temper stored water before delivery under default settings, the basis will be* V_{st} *as defined in DOE test procedures. For water heaters that* ***do*** *use a mixing valve to temper stored water before delivery under default settings, the new test procedure will define a basis derived from values produced in the UEF test.*

No tier of AWHS requires that a product achieve any specific result in the High Volume Draw Test. The test is a reporting requirement only, and applies only to tier 3 products that have ER heating capacities over 1.5 kW.