September 13, 2024

Ms. Abigail Daken:
U.S. Environmental Protection Agency
Office of Air and Radiation
1200 Pennsylvania Avenue NW
Washington, DC 20460

Subject: NEEA comments on the ENERGY STAR Draft 1 Test Method for Central Heat Pump Water Heater Systems

Dear Ms. Abigail Daken:

The following comments are submitted on behalf of the Northwest Energy Efficiency Alliance (NEEA). NEEA is a non-profit organization working to encourage the development and adoption of energy-efficient products, practices, and services. Funded by the regional utilities, NEEA is a collaboration of 140 utilities and efficiency organizations working together to advance energy efficiency in the Northwest on behalf of more than 13 million consumers. This unique partnership has helped make the Northwest region a national leader in energy efficiency.

Thank you for the opportunity to provide a response to the Environmental Protection Agency (EPA) on the ENERGY STAR Draft 1 Test Method for Central Heat Pump Water Heater Systems. We respectfully submit these comments for your consideration.

NEEA supports the EPA's ENERGY STAR Draft 1 Test Method for Central Heat Pump Water Heater Systems

NEEA fully endorses the EPA's initiative to develop a comprehensive test method for evaluating the performance of central heat pump water heater (HPWH) systems. Our efforts over the last decade have culminated in the development of key sections within the Advanced Water Heating Specification v8.1[1] (AWHS) specifically tailored to central HPWH systems. These efforts have included field demonstrations, lab testing, and modeling studies, which have provided valuable insights into what is critical for central HPWH performance and what is possible in the central HPWH market. As the EPA progresses in establishing a test method and rating system, we hope our foundational work within the AWHS will be utilized.

The AWHS currently uses an annual system coefficient of performance (SysCOP), calculated in four broad climate zones that span the United States, as its primary overall

[1] https://neea.org/img/documents/Advanced-Water-Heating-Specification.pdf

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rating metric. In anticipation of the EPA potentially integrating various component metrics into a consolidated metric in future revisions, NEEA has already laid the groundwork on potential methodologies through our SysCOP calculation built into the Commercial Product Assessment Datasheet[2] (PADS) posted on our website. The calculations built into the PADS are described in Appendix H of the AWHS. We see significant opportunities to refine, improve, and standardize this metric using data derived from ENERGY STAR testing.

NEEA supports the alignment of the AWHS with the forthcoming ENERGY STAR test method. SysCOP is a critical metric, and the following comments can facilitate the alignment, and enhance the value of, the ENERGY STAR test, and result in more accurate calculations of SysCOP.

NEEA recommends the EPA require manufacturers identify with one of the design configurations listed in the AWHS.

Our research shows the importance of system configuration on efficiency. We recommend the EPA incorporate the requirements in the central HPWH specification to promote good engineering practices in designing and installing these systems. NEEA provides Qualified Piping Configurations in section 3.3.5 of the AWHS, and NEEA's Commercial/Multifamily HPWH Systems Qualified Products List[3] (Commercial QPL) provides references to more detailed diagrams for each configuration. These diagrams have been developed through years of research, field demonstration and monitoring, and lab testing. The referenced diagrams in the Commercial QPL provide details such as sensor wiring diagrams with designated installation locations on or within the storage tanks and control sequences, which have been proven to allow for load shift capabilities. NEEA and our partners stand to benefit greatly from improved standardization, which guarantees savings and supports grid modernization through load shifting. The ENERGY STAR test method can help do that by aligning approved piping configurations with NEEA's AWHS.

NEEA supports collecting test results at multiple temperature points with certain modifications.

We strongly support requiring product testing and results reporting at multiple temperature points. This data is crucial for designing a central HPWH system and modeling its energy use, which will significantly advance the field. We anticipate that standardizing testing and reporting data proposed in this central HPWH system specification will accelerate market adoption.

NEEA supports the EPA's proposed evaporator testing conditions for air-source products at 5º F and 95º F dry bulb, and we recommend different intermediate points. We recognize that one of the primary purposes of this test data is to calculate the output capacity and efficiency under design conditions. To facilitate the necessary interpolation between data points that will be required, NEEA suggests using an approach similar to the one outlined in the AWHS. This method uses conditions spaced approximately 30º F apart and align

[2] https://neea.org/img/documents/Commercial-HPWH-Product-Assessment-Datasheet.xlsx
[3] https://neea.org/img/documents/commercial-HPWH-qualified-products-list.pdf

with the optional test conditions specified by the U.S. Department of Energy (DOE) in its most recent test procedure for consumer water heaters.[4] See the table below for NEEA's AWHS dry and wet bulb test conditions for central HPWH systems.

Label	Dry Bulbº F	Wet Bulbº F
Min	Manufacturer specified	Manufacturer specified DB minus 1
A	5	2
B	34	31
C	68	57
D	95	69

NEEA acknowledges that minor changes may improve alignment with other industry standard test points, and we fully support that alignment. For example, comparable standards typically set test condition B at 35º F dry bulb / 33º F wet bulb. Similarly, it may be logical for condition C to match the consumer water heater test conditions of 67.5º F and 50% relative humidity.

We recommend the EPA adopt a minimum temperature condition labeled "Min," which manufacturers can select based on the equipment's capabilities. This value could be significantly below zero for some products. We propose that manufacturers test and report performance at the lowest operating conditions for products that do not function at the A or B conditions (e.g., 47º F dry bulb and 43º F wet bulb). This approach would provide engineers and installers with critical information for accurately sizing heat pumps.

Lastly, we recommend that the EPA collect and report the minimum and maximum operating ambient temperatures for the compressors, similar to its approach for residential water heaters.

NEEA recommends prioritizing a variety of ambient, entering, and leaving temperature conditions over a seasonal metric.

The entering water temperature also strongly impacts performance. We support the EPA's proposal to differentiate condenser entering water temperature and temperature rise conditions for single-pass and multi-pass equipment.

Moreover, since groundwater temperatures correlate with air temperatures, we recommend varying supply water temperatures during test conditions.

In a return to primary central HPWH installation, the incoming mains water temperature will partially mix with hotter water in a tank or circulation loop. As a result, the water entering the heat pump is warmer than the mains. We recommend the approach taken by the AWHS, as shown in the table below. Multi-pass systems generally operate differently from single-pass systems, which results in more consistent entering water temperatures. Therefore, a single entering water temperature is appropriate. We support the EPA's

[4] eCFR :: 10 CFR Part 430 Subpart B -- Test Procedures

proposal for the outlet water temperature of 140º F. However, central HPWHs designed for multi-pass typically do not target a specific outlet water temperature, so we recommend the test method provide instructions for manufacturers to manually balance the water flow through the central HPWH to target 140° F. Additionally, we encourage the EPA to consider an optional or alternative higher temperature of 150º F and/or 160º F to represent products used with swing tank system designs.

Label	Single-Pass Entering Water Temperature º F	Multi-Pass Entering Water Temperature º F	All Systems Outlet Water Temperature º F
A	72	125	140
B	76	125	140
C	81	125	140
D	86	125	140

Recommended temperatures in the table above align with the performance map temperature required in NEEA's PADS for Single-Pass Return to Primary for Single-Pass and Multi Pass-Return to Primary for Multi-Pass. These temperatures were proposed to the AHRI 1300 committee by NEEA with favorable acceptance from present members including CEE and many manufacturers.

NEEA recommends the EPA add an ambient test in the mid-30sº F range and capture performance changes during defrost.

NEEA encourages the EPA to include an ambient test condition (for air-source products) at or near 34-35º F. Understanding performance and defrost at conditions ranging from 30-40º F is critical for Northwest climates. Studies, such as the Bayview Tower Demonstration[5], supported by NEEA, demonstrate the crucial importance of understanding defrost in this temperature range, where air temperatures are cool, but the air can still hold significant amounts of moisture.

To adequately size the product, engineers and installers must know its output capacity and defrost derate at these temperatures. We recognize that testing air-source products in this range will likely encounter evaporator coil frosting and subsequent defrosting, which adds complexity to the test method. However, the test procedure for the 35º F condition in AHRI Standard 210/240, *Performance Rating of Unitary Air-conditioning and Air-source Heat Pump Equipment*, provides a template for conducting such a test and evaluating the results. We encourage the EPA to leverage this and other existing procedures for space heating heat pumps to include this test point. Although accounting for defrost adds complexity, it is crucial to determine if the defrost reduces output capacity by 5%, 10%, 20%, or more. This information is essential for installing a central HPWH system with sufficient water heating capability under design conditions that involve frosting and defrosting.

[5] https://www.bpa.gov/-/media/Aep/energy-efficiency/emerging-technologies/20230829-mitsu-co2chpwh-bayview-towers-report.pdf

NEEA recommends the EPA include a market delivery structure.

The AWHS outlines three Market Delivery Methods in section 3.4.3, which are meant to provide programmatic guidance for recommended performance validation steps. For example, a Custom Engineered market delivery system is recommended to have a more stringent performance validation process than a Fully-Packaged Skid-Mounted system. NEEA recommends that the EPA include a similar market delivery structure to categorize products and recommend steps for validating performance.

NEEA recommends the EPA include an optional requirement for connectivity.

We encourage the EPA to include optional connected capability reporting requirements to encourage manufacturers, similar to those for residential HPWH manufacturers. NEEA urges the EPA to recognize and give credit to central HPWHs that have at least one of the following methods of demand response: ANSI/CTA-2045 port (EcoPort)[6] or AHRI 1430-2022 (I-P): *Demand Flexible Electric Storage Water Heaters (with Addendum 1)* or subsequent industry standards for commercial and central water heaters.

In addition to the essential communications functions that enable a central HPWH to respond to request signals, we recommend the EPA also promote the following:

- Non-communications demand response functions. These features might include storing a user-supplied operating schedule or optimizing operations based on a time-of-use electricity rate schedule.
- Recommended load shift control sequences to define how the system alters controls when a signal is received. Recommended load shift controls are provided in the configuration diagrams referenced to NEEA's Commercial QPL.

As noted above, system configuration is crucial for central HPWH energy efficiency, and the same applies to its configurations supporting demand response. The control sequences must define controls for ALL electric heating devices within the hot water system, not just the HPWHs.

Additional miscellaneous recommendations:

NEEA recommends defining central HPWH specifically as air-to-water and water-to-water heat pumps. Narrowing this specification would eliminate many of the proposed requirements in Section 4. This change will remove the ground coupling and its test requirements, allowing for the expansion of the system boundary to include essential hot water system components in multifamily buildings.

Testing of the recirculation pump may not be necessary, but defining configuration is recommended. The recirculation pump's energy consumption is highly dependent on the connected recirculation piping. When the recirculation system is balanced properly, our analysis shows pump energy use is negligible compared to heating equipment energy

[6] "Customers and Installers Now Have a Choice." EcoPort, n.d. https://ecoport.openadr.org/

usage. NEEA recommends requiring manufacturers to provide guidance on recirculation pump controls and balancing of the hot water distribution system.

NEEA recommends that the ENERGY STAR specification set a reasonable minimum efficiency level achievable by a minimally compliant central HPWH system but not by an electric resistance water heater. NEEA's AWHS provides tiers of SysCOP across four broad climate zones for central HPWH systems in section 3.4.2.

List single- and multi-pass systems separately, and note if the single-pass system must be installed in a swing tank configuration. NEEA recommends the EPA test and list each central HPWH separately for single- or multi-pass configurations, as the test conditions and efficiency vary. For example, NEEA's Commercial QPL includes separate listings based on the configuration for the same model number.

NEEA suggests removing the requirement that central HPWH capable of ducted and nonducted configurations be tested in the ducted configuration. The heat pump is typically installed outdoors; ducted configurations are atypical. Requiring units to be tested in the ducted configuration will penalize those units. Testing all units in the non-ducted configuration will allow for more equitable comparison between units that can and cannot be ducted.

NEEA suggests increasing the measurement interval of ambient room temperature to 1-minute in section 4.2.1 (line 357) to align with the data collection interval (line 371 and 374).

NEEA suggests providing guidance on "Mean tank temperature" (line 374) to include the number of and location of temperature sensors required to measure the mean tank temperature of unfired storage tanks.

NEEA encourages the EPA to consider including hybrid system listings. Consider listing configurations that use a hybrid system that includes an electric heat pump with gas trim or a gas swing tank. SysCOP calculations can assume some trim heat is required when temperatures are below some standard temperature, such as 35° F.

NEEA welcomes the opportunity to discuss our comments further and looks forward to continued engagement throughout the ENERGY STAR test method development process.

Sincerely,

Adam Gage
Sr. Product Manager
Northwest Energy Efficiency Alliance