RESPONSE TO ENERGY STAR REQUEST FOR COMMENTS / COMMENTS INSERTED BELOW
ENERGY STAR Residential Boilers Discussion Guide, June 2023
EPA is proposing two actions: sunsetting the ENERGY STAR Boilers specification and launching a new specification for air-to-water heat pumps.
EPA and DOE will host a webinar on June 21, 2023, from 2:30-4:30pm, ET. Register here.
Comments are due to EPA and DOE by July 7, 2023, to HVAC@energystar.gov
Naming, Scope and Definitions
● Question 1: Is the name "ENERGY STAR Heat Pump Boilers" for the new specification preferable to "ENERGY STAR Air-to-Water Heat Pumps"? Is there another name that would better align with customer expectations of the product?
In my opinion these units are best described at "Air to Water Heat Pumps". They are also commonly called "Reverse Cycle Chillers" or "Hydronic Heat Pumps". IMO "Heat Pump Boilers" is not a particularly good choice and not one that is commonly used.
● Question 2: Are there broadly accepted industry definitions of air-to-water heat pumps or heat pump boilers? Generally, an air to water heat pump would be defined as a heat pump that uses a vapor compression refrigeration cycle with a refrigeration circuit including at least one each of a compressor, a fan, a metering valve, a reversing valve, and, at least two heat exchangers – where the supply-side (outdoor-side) heat exchanger is of the refrigerant-to-air type and where the load-side (indoor-side) heat exchanger is of the refrigerant-to-water type.
● Question 3: Is there any need to distinguish boilers that are used with hydronic coils in a forced air distribution system from those used with hydronic distribution? Are the same products used in both situations? I assume this is meant to say:

"Is there any need to distinguish **air to water heat pumps** that are used with hydronic coils in a forced air distribution system from those used with **radiant** distribution?"

Based on that, there is no distinction needed. It is the same supply-side hardware either way and it is not uncommon for an air to water heat pump to support both an air handler as well as a radiant delivery system within the same application.

● Question 4: EPA believes that products that can serve as domestic water heaters or as air-to-water heat pumps for space heating could simply be tested and rated for each use. Is there any need for a definitional distinction between heat pump water heaters and air-to-water heat pumps for space heating? If so, what would the distinction be? It should be noted that current heat pump water heater standards are not very applicable to air to water heat pumps that should be rated based on space heating and cooling in a closed loop, and not under conditions that are best for domestic hot water testing.

● Question 5: EPA is interested in additional information about dual fuel boilers particularly market, cost, and performance information. Considering that electrification is an environmental goal, and that the common "dual fuel" air to water heat pump application is where electric resistance backup heat is used as the send "fuel" source, this is by far the more common approach. As such, in our opinion, any fossil fuel boiler apparatus other than an integrated electric resistance heater connected into such system should be tested independently and stand on it's own as to its efficiency. With that said, extra credit should be given to those systems that can modulate the uses of electric resistance heat (or of any backup heat source) such that the compressor remains the primary source and does not get "knocked offline" by a secondary heating source.
Test Methods

● Question 6: As the evaporators are likely to be located outdoors, what range of outside air conditions are most representative to determine overall performance? The evaporator is only outdoors during the heating season. In the cooling season, the outdoor heat exchanger is the condenser, and the indoor-side exchanger is the evaporator. With that said, the operating conditions of the outdoor heat exchanger when used as a condenser would typically range up to 120F in the cooling season with 95F as a good rating point. In the heating season, the range is typically 0F or below and ratings are typically at 47F and 17F - these seem to be good numbers.

Of course the most important metric is the seasonal average efficiency. For example, for air to water heat pumps, its IPLV rating (similar to SEER) is vastly more important than its EER rating at any one specific temperature. Likewise in the heating season, the seasonal average coefficient of performance (Seasonal COP or SCOP), which is similar to HSPF, is vastly more important that the efficiency at any specific temperature.

● Question 7: At very low outside temperatures, the compressors for ATWHPs and dual fuel HPs may no longer provide useful efficient heat. We assume ATWHPs will include backup heating for this circumstance. Ideally, the test method would capture this behavior and incorporate it into an estimate of annual energy use. What is the best way to include backup heat in the test method? What other testing considerations should be evaluated for performance in cold climates? Yes, we certainly agree that a properly sized system will use backup heat at colder ambient temperatures, otherwise it would be grossly oversized for the majority of the heating season, and in an oversized design, SCOP could suffer and the hardware could become prohibitively expensive. We also agree that total heating performance including backup heat is important seasonal metricand must be captured.

We would suggest to use a BIN data model where the efficiency and capacity of a heat pump, combined in a weighted manner, produces a net-net COP (a COP of each method, with a final COP weighted number based on the performance map of the heat pump and BIN data.

● Question 8: How often are air-to-water heat pumps applied in combination systems that also provide domestic hot water? For these applications, can they use the test and metric for domestic hot water delivery efficiency found in 10CFR Part 430 Subpart B Appendix E? Would this test fully capture the performance of the product in space and water heating modes? We don't think 10CFR Part 430 Subpart B Appendix E is the best idea for air to water heat pumps domestic hot water applications. We would suggest that the same testing that is used to test the heat pump COP would be used, but with a 10F higher temperature to account for delta T requirements of the tanks indirect coil. For example, assuming a high temperature rating point of 120F supply temperature as you might have as a maximum for space heating, perhaps testing at 47F and 17F outdoor temperatures for the domestic hot water heating COP could simply be the same test but rated at 130F heat pump supply temperature vs. 120F, to account for the required coil delta.

● Question 9: Air-to-water heat pump systems can be designed to offer load shifting in addition to their other functions. Are there products offered that are specific to such applications? In other words, are systems that provide these functions designed and assembled on site using any air-to-water heat pump, or is there something specific about the product as it leaves the factory that enables this? Are there metrics appropriate for evaluating these capabilities in a product? The only real load shifting that currently makes sense is in the case of thermal storage (storing hot or cold water to be used at a later time). Use of PCM materials for storage may become viable at some point. There is no real use of load shifting today. And its tough to make a case for it, and is rarely used at all.

● Question 10: Are their additional considerations for the test method for air-to-water heat

pumps? We suggest to test cooling per AHRI 550/590 and test heating per EN14825
Specification Requirements

- Question 11: Do air-to-water heat pumps generally use multiple speed, variable speed, or inverter-driven compressors? For these products, do part-load tests in AHRI 550/590 reflect field operation? All of the better air to water heat pumps use variable speed compressors and AHRI 550/590 is a highly valid test
- Question 12: If units are sized for design conditions, what does that mean for their part-load heating performance? What have users' experiences been in the field?
When air to water heat pumps are sized properly they can meet the design heating load at ~95% of the annual heating hours and should be configured/sized according to the their performance map and using AHSRAE BIN data.
- Question 13: This test defines performance with 110F leaving water temperature. This will not provide sufficient heat when used in legacy heat exchangers, typically designed for 160-180F water. Do manufacturers recommend using these products in retrofit situations? If so, is there anything special they recommend making sure residents have enough heat? Air to water heat pumps are not designed to support legacy systems such as "radiators". A proper modern design will use a supply water temperature range of 90-100F for radiant systems and 105-110F when used with air handlers. The suggestion is to augment or replace legacy high temp equipment.
- Question 14: Many hydronically-heated homes are located in cold climates in the US. Is there a need for separate criteria for cold climate ATWHPs? Air to water heat pumps are excellent in both heating and cooling applications. Some areas may be too cold for air to water heat pumps to meet the full heating load and a properly sized system will generally not meet the load without backup. Even in the coldest USA climate zones, temperatures are well above 10F for >90% of their annual heating hours. Below that temp, most heat pumps that are properly sized will be using some amount of backup heat or may be entirely on backup. So no, what matters is the combined heat pump + backup heating efficiency across the full heating season. A system that does not need
- Question 15: Would it be useful for EPA to define connected criteria for air-to-water heat pumps, given that they can be deployed in systems that offer load shifting? How would the needed criteria compare to those in AHRI 1380 or AHRI 1430? We don't think so.
- Question 16: What is the cost of air-to-water heat pump systems? Does this provide the same service (e.g., covers full heating load, provides cooling, etc.) as competing systems? What are the design and installation costs for these systems in new construction and in a replacement scenario? Cost of air to water heat pumps are typically in the $5000-$10,000 range according to capacity and can provide heating, cooling, and domestic hot water. A complete air to water heat pump system will be similar in cost to a high-SEER standard system but with more flexibility and higher efficiency.
- Question 17: Are there any other considerations about the implementation of an air-to-water heat pumps specification that EPA should be aware of? Current best practices for radiant heating design is to meet the design day temperature =/<95F supply temp. For use with fan coils/air handlers, the air handlers should be sized based on their rated capacity at 105-110F. this generally requires a view of the air handling units extended performance map as their box labels will not be for these conditions. Proper system design should not ever require an operating temperature above 110F. There is a tendency to treat air to water heat pumps as if they are boilers. They are not boilers. Unlike an electric or fossil fuel boiler, they are subject to Carnot efficiency equation, their supply output temperatures should be a s low as possible for the highest efficiency. Worrying about how well they perform at, or especially above, 120F indicates a planned misuse the product. A fast and easy way to implement this would be to adopt IEC EN 14825 and follow what is done in Europe, and use existing standard 550/590 for cooling. All units should be required to have both ratings with some minimum standard required for each rating.