John Grose of Sensible Technologies, Inc., responds in Blue. July 7, 2023.

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.
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?

Q1, "ENERGY STAR Air-to-Water Heat Pumps" is preferable to boilers. Even what we call boilers today have not been boiling water for steam for standard residential applications for over 50 years. Want to leave that term 'boilers' behind. But the best way going forward, in my opinion is "Hydronic Heat Pumps" We are converting to water from the outdoor heat pump and distributing to space conditioning and domestic hot water, via water as our delivery system. This is the definition of hydronic.

- Question 2: Are there broadly accepted industry definitions of air-to-water heat pumps or heat pump boilers?

Q2: AWHP converts outdoor air to space heating hot and chilled water via a refrigeration cycle.

- 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?

Q3: Since we are discussing AWHP's or HHP's, I'm ignoring the term boiler. HHP's can be used in either application, both air distribution as well as radiant, radiator, or fan coil systems.

- 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? Current residential HHP's that can do combined space conditioning and DHW are not capable of sustaining 140F without equipment life significantly degrading. But their advantage is that they can efficiently (high COP's) make usable hot water of 120F tank temps in volume. Current tank type AWHP's have tiny heating capacity, this means they need element back up more and customer satisfaction is lower due to slow water heating recoveries. To level the playing field, both systems should be tested to gallons per hour in heat mode only delivering 120F. This way energy consultants, engineers and contractors can supply informed recommendations and can better control end user expectations.
- Question 5: EPA is interested in additional information about dual fuel boilers particularly market, cost, and performance information.

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? Overall performance could be gauged from the climate zone medium temperatures. That is one point. The second point is design day. Third point is not to design to design day since design day temps are usually 2-3% of the hours per year. Allow back up element to boost on design days when sizing the HP's. But overall, HHP's use the IPLV rating, that allows for modulation of the HHP to load match to the outdoor and indoor conditions in the cooling mode. For Heating, use the SCOP rating, it can be converted to HSPF.

- 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?
Q7: See my response in Q6.

- 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?
Q8: 10CFR Part 430 Subpart B Appendix E is not the best idea for air to water heat pumps domestic hot water applications. How about using 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?
Q9: HHP's can load shift better than other space conditioning and DHW systems. But there must be added thermal mass, such are larger buffer tanks and DHW tanks. So those tanks can store the energy during high supply and cheap energy moments and then drawn out at peak electrical demand times.

- Question 10: Are their additional considerations for the test method for air-to-water heat pumps?
Q10: 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? Q11: 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?
Q12: 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 ASHRAE 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? Q13: Legacy systems require an improved building envelope to allow the lower operating outlet temps of HHP's in existing baseboard, radiator, or air handling systems. Otherwise, it must be understood to the end user that addition heat transfer must be installed.

- 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.

Q14: 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.

- 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?

Q15: I don't know. Study will be needed.

- 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?

A16: I'm seeing costs of air to water heat pumps in California are typically in the $15,000 to $25,000 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 and with DHW, but with more flexibility and higher efficiency. And with benefits of less noise and dust, and greater comfort with radiant heating/cooling options.

- Question 17: Are there any other considerations about the implementation of an air-to-water heat pumps specification that EPA should be aware of?

Q17: Current best practices for radiant heating design are to meet the design day temperature around 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 as 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.