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Via Electronic Mail – **HVAC@energystar.gov**

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ENERGY STAR Residential Boilers Discussion Guide Comments

Taco Comfort Solutions, a 103 year old, third-generation family-owned global company based in Cranston, RI, engineers and manufactures high-efficiency indoor heating, cooling, and plumbing comfort systems. This includes the System M Air-to-Water Heat Pump, of which additional information can be found at: https://www.tacocomfort.com/product/system-m/.

We respectfully submit the following comments on the questions posed in the ENERGY STAR Residential Boilers Discussion Guide and look forward to continued engagement with the EPA and other governmental stakeholders as we move forward to better support air-to-water heat pumps and the role they will play in beneficial electrification and meeting our nation's climate goals.

We are also a member company of AHRI and are engaged with their Air-to-Water Heat Pump Task Force to review the questions and provide additional comments, especially related to the testing standards.

Sincerely,

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Sunset of EPA & DOE Energy Star Residential Boiler Program and Switched Focus to Air to Water Heat Pump; Questions

Question 1: Is the name "ENERGY STAR Heat Pump Boilers" for the new specification preferable to "ENERGY STAR Air-to-Water Heat Pumps"? No, it's better that Air-to-Water Heat Pumps (ATWHP) are not referred to or portrayed as a direct replacement for a boiler. ATWHP's have different performance characteristics which effects their ability to replace boilers on most retrofit installations without major distribution system alterations, mainly related to the maximum water temperature they can currently produce. Even in those cases where there is already a low-temperature distribution system, ATWHP's are still unique to boilers as they have an outdoor component of the equipment design which has a low ambient working temperature limitation, carry different rating systems, are tested to different agency safety approvals (especially since we are discussing, in the vast majority of cases, comparison with a combustible device), and also have the ability to provide chilled water for cooling. In a similar example, "mini-splits" are not referred to as "furnaces" just for ease of search.

It is understandable that Energy Star would suggest that using the word "boiler" would make search results easier but we feel that a closer relationship to the broader category of "heat pumps" would be more beneficial for drawing a difference between conventional (<100% efficient) boilers, furnaces and A/C units to this new category of 100%+ efficient heat pump driven products. Then the discussion would be about which type of heat pump is best for the application - "air-to-water" vs "water-to-water" (geothermal) vs "air-to-air" (mini-slit) style heat pumps.

Is there another name that would better align with customer expectations of the product? No, the word 'boiler' historically denotes a device (pressure vessel) that could 'boil' water at much higher temperatures than a heat pump. In many instances consumers don't know the difference between a boiler and a furnace anyway so most of the sizing, selection and installation recommendation is done by the professional installer with limited input by the homeowner. We are lucky if contractors just offer a standard versus modulating-condensing boiler as options.

Question 2: Are there broadly accepted industry definitions of air-to-water heat pumps or heat pump boilers? 'Air to Water Heat Pump' has been what the industry manufacturers have been using since their introduction into the North American market. Additionally, they have been using the subset of 'monobloc' or 'split system' to describe the difference of whether the refrigerant lines extend from the outdoor unit to the indoor unit (split system) or if water is used as the transfer between outside unit and indoor unit / distribution piping (monobloc).

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? No. Mixing distribution emitter types (and temperatures) is a common practice in distribution system design and doesn't require any specific attributes tied to the piece of equipment providing the heat, as long as the temperature and BTU capacity for the design can be met. The goal of proper system distribution design is to provide the appropriate amount of BTU's to each conditioned space, using an appropriate emitter style, to satisfy the heat loss of the structure – nothing of that changes whether it's a boiler or heat pump providing the BTUs.

Are the same products used in both situations? Yes

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? Yes, ATWHP's can do domestic water heating with the inclusion of an indirect storage tank so it would reason that in the testing and ratings for ATWHP their dual performance is acknowledged and they can accurately be compared to heat pump water heaters as a complete system solution.

Currently there are areas of the country (i.e. Massachusetts) where there are incentives for the installation of a heat pump water heater for domestic water heating and for ATWHP for space conditioning. However, the ATWHP does not qualify for the heat pump water heater rebate, so you have installers putting in both, just to maximize the rebate (an incentivized heat pump water heater costs less than an indirect storage tank), which is a complete waste of resources. We believe this is done because there is not a good comparative rating for an ATWHP vs a heat pump water heater which can be used to evaluate and incentivize them accordingly.

If so, what would the distinction be? In the testing and ratings, including Energy Star, there should be room for the recognition of ratings for ATWHP's space conditioning functionality as well as domestic hot water production efficiency.

Question 5: EPA is interested in additional information about dual fuel boilers particularly market, cost, and performance information.

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 ratings of the ATWHP equipment, in most cases, have been based on AHRI 550/590 standard and the EN 14511 standard. In addition, Efficiency Vermont has requested a lower air temperature for product submission to their incentive program. It would be advisable that the EPA and other government agencies engage with equipment manufacturers, their trade associations, and other stakeholders to develop a specific set of test requirements which would also take into account the lower ambient temperatures which these machines need to operate under as well as the domestic hot water production issue addressed above. Considerations of what was done for the cold climate heat pump program would likely be a good starting point to address operation in colder climates. The testing burden for these is units could become substantial (time and expense) so coordination with existing international standards would greatly accelerate market adoption and reduce the barriers to new product entry into the US market.

Current ratings for Taco equipment include the publication of the following test points:

AHRI Standard Rating Condition 550/590 (I-P)-2018 from page 8 - table 1, heating:
with A8,3 / W40,6 in °C (A47 / W105 in °F)
with A8,3 / W48,9in °C (A47 / W120 in °F)
with A8,3 / W60 in °C (A47 / W140 in °F)
with A-8,3 / W48,9 in °C (A17 / W105 in °F)
with A-8,3 / W40,6 in °C (A17 / W120 in °F)
with A-8,3 / W60 in °C (A17 / W140 in °F)

AHRI Standard Rating Condition 550/590, cooling:
with A35 / W6,7-12,2 in °C (A95 / W44-54 in °F)

with A26,7 / W6,7 in °C (A80 / W44 in °F)
with A18,3 / W6,7 in °C (A65 / W44 in °F)
with A12,8 / W6,7 in °C (A55 / W44 in °F)

Efficiency Vermont required test point for incentive program submission:
with A-15 / W43,3 in °C (A5 / W110 in °F)

These data indicate the size and capacity of the system according to EN 14511, heating:
with A-7 / W35 in °C (A19 / W95 in °F)
with A2 / W35 in °C (A36 / W95 in °F)
with A7 / W35 in °C (A45 / W95 in °F)

EN 14511, cooling:
with A27 / W18 in °C (A81 / W64 in °F)
with A27 / W7 in °C (A81 / W45 in °F)
with A35 / W18 in °C (A95 / W64 in °F)
with A35 / W7 in °C (A95 / W45 in °F)

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? This point still needs to be discussed with the industry when determining a new rating procedure. In most cases, the back-up system would be either straight electrical resistance (including electric boilers), a conventual fossil-fuel fired boiler, a pellet / wood boiler, or separate thermal energy storage capacity. It is usually up the installers programming of the equipment of when this change-over (bivalence point) occurs, either at a specific temperature or within a certain amount of remaining performance range of the particular ATWHP unit's capability. The secondary equipment would have its own rating (i.e. AFUE for a boiler) but it would be difficult to have an overall system rating which would be applied to the ATWHP which takes multiple back-up system design elements into account. Regional temperature factors would also play a large role in this calculation.

What other testing considerations should be evaluated for performance in cold climates? There will likely need to be something developed like what was done with the cold climate heat pump ratings for mini-splits. We encourage the EPA and other government agencies to engage with equipment manufacturers, their trade associations, and other stakeholders to develop these ratings.

Question 8: How often are air-to-water heat pumps applied in combination systems that also provide domestic hot water? The best practice installations would all include the ATWHP for space conditioning and domestic hot water production. In practice, the installer has to weigh the demand capacity for domestic hot water production and determine if the ATWHP can handle both effectively as there may be issues for how long the ATWHP is making domestic hot water versus supplying heating or cooling to the structure. In most ATWHP unit's operational programming priority is given to DHW production.

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? Yes

Would this test fully capture the performance of the product in space and water heating modes? The standard covers the domestic water heating portion of a 2-part (split) system does not represent space heating or cooling operation. Again, we recommend that the EPA and other government agencies engage with equipment manufacturers, their trade associations, and other stakeholders to develop these new ratings.

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? There are capabilities in some ATWHP's which allows them to receive a signal from an external source, such as an electrical company, to turn them off for a period of time (peak demand) or run during low electrical rate periods. This functionality needs to be combined with a thermal storage buffer tank, a recommended best-practice or included with some units, that would allow the system to work off the stored water, which is effectively load shifting. However, these buffer tanks are usually not large enough (~30 gallons) to provide the desired length of load shifting to make a large enough impact like you might see in a commercial thermal energy storage system, where they use hundreds of gallons of water (or equivalent thermal storage material). At his point we believe that having this as another testing / rating criteria would not be beneficial. But since the ATWHP can also supply DHW, the current load shifting practices (i.e. utility demand response) for water heaters could be employed. But we do not know of any ATWHP which is California Title 24 – JA13 compliant or has CTA 2045 compatibility. In the Taco System M ATWHP dry contacts (Smart Grid 1 & 2) are available to accept utility signals to raise or lower setpoints or pause operation.

Question 10: Are their additional considerations for the test method for air-to-water heat pumps? We recommend that a working group be established to develop an appropriate test methodology which takes into account the current international standards along with the needs of the US and includes operation at lower outdoor temperatures, especially if ATWHPs need to be compared against boilers for heating applications.

Question 11: Do air-to-water heat pumps generally use multiple speed, variable speed, or inverter-driven compressors? Most are inverter-driven (variable speed).

For these products, do part-load tests in AHRI 550/590 reflect field operation? Not in totality. AHRI 550/590 is for rating equipment with a vapor compression cycle. For rating ATWHP's the industry manufacturer's have just used the air and water temperature values as a baseline, lacking alternative choices (besides EN 14511).

Question 12: If units are sized for design conditions, what does that mean for their part-load heating performance? Although systems need to be designed for the heating and cooling degree days (design conditions), the actual operation of the system rarely operates at that point. Since you have variable speed inverter-driven compressors, variable speed fans, and variable speed distribution pumps the overall equipment design is built around the premise of maximizing efficiency during part-load

operation. This operation is similar to using a boiler reset to reduce the supply water temperature based on outdoor temperature to efficiently match the structures heat loss, and minimize boiler start/stops. This operation is also beneficial to the electrical grid, especially in terms of start loads during peak events.

What have users' experiences been in the field? ATWHP users have been satisfied with the performance of the system and efficiency, especially at part-load where the COP's are maximized, as most installations have been in hydronic centric geographic locations where the design condition is below or close to the minimum ambient operating limit of the ATWHP, so a back-up system (bivalence) is activated during the design condition periods.

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? These units are currently not recommended for use with a distribution system (i.e. conventional baseboard) that requires the higher water temperature as the performance of these emitters drops substantially when supply temperatures go below 130 degrees. This is the reason why we are recommending against using the word 'boiler' to describe the current offerings of ATWHP's to avoid the market confusion that ATWHPs are drop-in replacements for boilers. As mentioned previously, the application of an ATWHP has to be one part of a holistic design approach. There are many benefits of using lower temperature water in the distribution system and the radiant industry has been educating on that for decades but low temperature systems only make up a small percentage of the overall hydronic based heating systems currently operating in the US.

If so, is there anything special they recommend making sure residents have enough heat? ATWHP's, like boilers, are installed by licensed professionals. The first part of any design (new or retrofit) begins with a room-by-room heat loss/gain with verification that the heat emitter will provide appropriate heat for that space.

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? Efficiency Vermont added in the A5 / W110°F rating to address the colder climates they have. A lower temperature rating would be beneficial, as well as the temperature limitations (lowest operating ambient and max supply water temperature).

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? They would be a good starting point but neither address thermal storage required for load shifting for the conditioning of the building.

Question 16: What is the cost of air-to-water heat pump systems? We ask that the EPA reach out to individual manufacturers to provide confidential costing or do a market study.

Does this provide the same service (e.g., covers full heating load, provides cooling, etc.) as competing systems? The benefit of an ATWHP is that it provides heating, cooling, and domestic hot water production in the same unit. It can also do this without the use of distributed, field-assembled refrigerant lines in the case of a monobloc systems.
What are the design and installation costs for these systems in new construction and in a replacement scenario? We ask that the EPA reach out to individual manufacturers to provide confidential

costing or do a market study. There have been several pilot programs and costs analysis that should be available to the EPA, including by the Massachusetts Clean Energy Center.

Question 17: Are there any other considerations about the implementation of an air-to-water heat pumps specification that EPA should be aware of? In an effort to reduce refrigerant GWP's we are seeing the move to alternative refrigerants, like R-290 (propane) but the downside is that the flammability for these refrigerants increase. Mono-block style ATWHP systems are ideally suited for keeping the refrigerants factory-charged, self-contained and outside of the building. EPA's support for the acceptance of these style units, especially in the codes, will be key in their market penetration to meet international accord's refrigerant GWP reduction goals.