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Subject: Plumbing Code Challenges and IAPMO Standards
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In an effort to improve the technical deployment of CHPWH systems, Ecotope is addressing specific aspects of system performance and product deployment. This memo focuses on plumbing code compliance challenges uncovered while working with manufacturers.

PLUMBING CODE CHALLENGES

The current plumbing code does not adequately guide the commercial heat pump water heater (CHPWH) market. Variability in enforcement and interpretation of the Unified Plumbing Code (UPC) and International Plumbing Code (IPC), inconsistencies between these model codes, and their patchwork adoption across the US – as well as Canada’s own national and provincial plumbing codes – present a network of regulations to navigate and potential confusions when applying code compliance to manufacturing emerging technologies.

Updates to the plumbing code would alleviate impediments for design engineers and barriers to entry manufacturers face in several scenarios, including:

- Meeting code requirements in jurisdictions unfamiliar with commercial HPWHs
- Substantial variance and complexity from plumbing codes create roadblocks to innovation and improvements to HPWH products

Clarifying the definition of a water heater and its interactions with potable water in code language would alleviate much of the uncertainty related to these scenarios. Additionally, one or more reference standards may help to level the playing field for manufacturers, engineers, and installers in emerging markets for HPWHs. Reference standards offer several advantages; they provide jurisdictions clarity and assurance as technologies and new design techniques emerge. In addition, they offer clear guidance for manufacturers and designers that, while not all US jurisdictions may immediately adopt a reference standard in code, model code administrators, such as IAPMO, and code and building officials often consider national standards as a basis for code updates. Ecotope interviewed IAPMO about the process of creating industry standards and discussed the challenges related to public health and safety, variations in design, and technology acceptance.

The following outlines several known plumbing-code-related barriers to HPWHs and then discusses potential solutions related to reference standards.

SPECIFIC CODE ISSUES

As part of the ongoing efforts for commercial heat pump water heater (CHPWH) market development, Ecotope works directly with several manufacturers. In the course of this work, our staff have collected a list of obstacles in code that impede market entry and growth. The following outlines those obstacles and offers insight into overcoming each.

The definition of several DHW system components may clarify the causes of inconsistent enforcement and interpretation of the plumbing code sections that affect potable water. In particular, whether there are differences in how plumbing code treats potable water versus cleaning and bathing water and drinking water – and their interactions with DHW systems. The inconsistencies in interpretation and enforcement are a source of concern for HPWH manufacturers.

Significantly, UPC does not define drinking, cleaning, or bathing water other than in reference to grey water as the wastewater from these sources. IPC does not reference drinking, cleaning, or bathing water. IPC defines *nonpotable water*, but UPC does not, only referencing *nonpotable water* in the definitions of *On-Site Treated Nonpotable Water* and an *Alternate Water Source*. Finally, both UPC and IPC define the term *water heater*, potentially helpful in aligning code language with enforcement and manufacturer, designer, and installer practices. These and the UPC and IPC definitions of *potable water* are below:

UPC Definitions

Potable Water. *Water that is satisfactory for drinking, culinary, and domestic purposes and that meets the requirements of the Health Authority Having Jurisdiction.*

On-Site Treated Nonpotable Water. *Nonpotable water, including gray water that has been collected, treated, and intended to be used on-site and is suitable for direct beneficial use.*

Alternate Water Source. *Nonpotable source of water that includes but not limited to gray water, on-site treated nonpotable water, rainwater, and reclaimed (recycled) water.*

Water Heater or Hot Water Heating Boiler. *An appliance designed primarily to supply hot water for domestic or commercial purposes and equipped with automatic controls limiting water temperature to a maximum of 210°F (99°C).*

Indirect-Fired Water Heater. *A water heater consisting of a storage tank equipped with an internal or external heat exchanger used to transfer heat from an external source to heat potable water. The storage tank either contains heated potable water or water supplied from an external source, such as a boiler.*

IPC Definitions

Potable Water. *Water free from impurities present in amounts sufficient to cause disease or harmful physiological effects and conforming to the bacteriological and chemical quality requirements of the Public Health Service Drinking Water Standards or the regulations of the public health authority having jurisdiction.*

Nonpotable Water. *Water not safe for drinking, personal, or culinary utilization.*

Water Heater. *Any heating appliance or equipment that heats potable water and supplies such water to the potable hot water distribution system.*

These definitions are useful to reference while reviewing the specific code issues outlined below. Resolving the inconsistency between UPC/IPC definitions regarding whether water heaters heat potable water would clarify many of the following issues.

UPC 604.1, 606.1, 607.2, AND 608.2

Per nsf.org, NSF/ANSI 61: *Drinking Water System Components* establishes “minimum health-effects requirements for the chemical contaminants and impurities that are indirectly imparted to drinking water from products, components, and materials used in drinking water systems. This standard does not establish performance, taste and odor, or microbial growth support requirements for drinking water system products, components or materials.”

The standard is intended to cover materials that come into contact with drinking water, drinking water treatment chemicals, or both.

The UPC code states that 604.1, 606.1, 607.2, and 608.2 require NSF 61 certification on pipe, tube, and fittings; valves; and potable water tanks. However, water heaters are not explicitly named as requiring NSF 61, and manufacturers and code officials treat the potential NSF 61 requirement as an ambiguity that creates a barrier to entering the US market. Specifically, UPC Chapter 6 does not explicitly require NSF 61 for water heaters or heat exchangers. Most manufacturers do not provide NSF 61 on integrated hot water tank heaters. However, the plumbing code suggests that NSF 61 is required for hot water storage tanks without heating elements, which may fit the NSF definition of a potable water tank. Ecotope is not aware of any hot water storage tanks (other than stainless-steel tanks) that comply with NSF 61 today, and most Authorities Having Jurisdictions (AHJs) do not enforce the NSF 61 requirement for storage tanks or integrated water heaters. Ecotope’s conversations with manufacturers and code officials have revealed that the separate storage tanks required by central HPWH systems have created confusion for code compliance. This confusion may result in increased manufacturing costs and negatively impact HPWH adoption.

NSF’s guidelines intend to cover materials that come into contact with potable water, but by convention, if not code or law, NSF has not necessarily applied to hot water – which is not intended for drinking (although users may still consume it). For example, showerheads require an ASTM rating but not NSF 61 because showerheads do not explicitly deliver drinking water.

Requiring NSF 61 for HPWHs, where it has not been a requirement for integrated gas or electric resistance water heaters, creates an uneven playing field in a time when decarbonizing the elements of everyday life is at the heart of the transition to a fossil fuel free economy. Updated and clarified UPC and IPC code language and consistent enforcement would level the playing field and improve market adoption of HPWHs, a critical component for decarbonizing building energy consumption.

UPC 603.5.4 – HEAT EXCHANGERS

UPC 603.5.4 requires an air gap for double-walled heat exchangers to separate potable water from the heat-transfer medium, protecting the potable water system from contamination. However, several products in the US market without an air gap use walls in the heat exchanger to prevent contamination rather than air gaps.

UPC 607.2.2 – PIPING FOR RECIRCULATION SYSTEMS HAVING TEMPERATURE-ACTUATED MIXING VALVES

Few states have adopted UPC 607.2.2, but its language dictates a diversion away from a critical component of CHPWH design, returning circulated hot or tempered water to a separate swing tank rather than to the cold-water inlet pipe.

This rule may have been adopted to prevent legionella growth – by preventing stratification and water within legionella growth temperatures. However, in CHPWHs, several designs require the coldest entering water available to maximize energy efficiency. In these designs, water also achieves temperatures that meet standards for the

destruction of legionella and limit environmental factors for its growth. This code section creates a barrier to the optimal design and, therefore, adoption of low global warming potential, highly efficient CO₂-based CHPWHs in those states that adopt it.

INDUSTRY STANDARDS

Where public health is concerned, the precautionary principle applies, which asserts that when there are threats of serious harm from action or inaction, then “complete evidence of a potential risk is not required before action is taken to mitigate the effects of the potential risk” (Weir E, 2010) and “uncertainty must be resolved in favor of prevention” (Goldstein, 2001).

Lack of enforcement or manufacturer guidance on enforced code requirements results in an unpredictable market for manufacturers and those who purchase and use these products. The inconsistencies described above produce unpredictably safe products, resulting in consumer and enterprise uncertainty and stifling innovation – especially for new market entrants.

Because plumbing code and code enforcement does not adequately guide the HPWH market in its current state, an accepted industry standard or set of standards may provide more explicit guidance for improving codes and code enforcement for CHPWHs, leveling the market playing field for all water heating strategies.

IAPMO

IAPMO develops and maintains several Industry Standards widely accepted in various Jurisdictions. They also develop and maintain the UPC.

ANSI certification has the broadest level of acceptance across jurisdictions in the US, as is the National Standards Canada (NCS) certification in Canada. IAPMO has accreditation for both ANSI and NCS. ANSI/NCS works directly with accredited standards development organizations (SDOs) like IAPMO to certify the standards developed under their guidance. This direct connection to ANSI/NCS ensures that emerging standards are vetted properly and provides an increased opportunity for broad adoption.

The following IAPMO Industry Standard classifications are relevant to CHPWH development.

- **IGC:** IAPMO Guidance Criteria (IGC) is the designation used for consensus industry standards that cover products not yet addressed by existing standards. IGCs can provide manufacturers/product developers a vehicle for introducing new products to the marketplace.
- **IS:** Installation Standards (IS) is the designation used for consensus industry standards that cover installation practices for plumbing products.

IAPMO also develops and maintains standards with the following National Standards:

- **ANSI/NSC:** IAPMO ANSI standards are consensus standards covering products and materials approved as ANSI and/or NSC standards.
- **ASSE:** ASSE product and professional standards are developed through true industry consensus. Experts from all segments of the plumbing and mechanical industries from across the country gather to determine the minimum performance and knowledge requirements for products and professionals.

ANSI certification is not required for code adoption, acceptance, or reference, and IAPMO alone can certify the product or product category to the standards required by an Authority Having Jurisdiction (AHJ). However, ANSI acceptance can improve acceptance in national and international model codes.

Each Industry Standard developed with IAPMO must adhere to its policies and procedures. These policies and procedures provide AHJ's confidence in adopting codes and regulations that require adherence to IAPMO Industry Standards.

RECOMMENDATIONS

Because CHPWHs consist of standard, often familiar components but in novel configurations, jurisdictions and manufacturers may assume that existing codes and standards cover these systems. However, as described in this memo, several inconsistencies exist in manufacturing and public health considerations alone. An IGC offers a vehicle to clarify these and other inconsistencies in a documented, reviewed, and internationally recognized manner, offering manufacturers peace of mind when entering a new market or jurisdiction. Additionally, the UPC refers to IGCs when considering new code provisions.

Additionally, because of the importance and variation of CHPWHs as a design (rather than a product alone), Installation Standards may complement the Northwest Energy Efficiency Alliance's Advanced Water Heating Specification and provide a forum to standardize the most common specifications further, and clarify conflicts regarding installation, such as those regarding TMVs in UPC 607.2.2.

We recommend additional exploration into the value chains associated with these standards and potentially submitting one or more applications to an IGC or installation standard to clarify plumbing code uncertainties and further standardize CHPWH designs and adoption.

CONCLUSION

This memo outlined several examples describing the variability in the enforcement and interpretation of plumbing codes in the US. This variability presents challenges to AHJs seeking to enforce the highest levels of public health, consumers and design engineers looking to deploy highly safe and energy-efficient technology, and manufacturers seeking to meet the demands of these stakeholders and take advantage of the opportunities in emerging markets.

We recommend exploring two IAPMO standards for CHPWHs:

- An IGC may provide an industry-recognized method to clarify the uncertainties and inconsistencies described in this memo while also providing a platform to introduce CHPWHs to more markets
- An installation standard may serve as an essential complement to the AWHs, further standardizing the design and installation of CHPWHs.

REFERENCES

- Goldstein, B. D. (2001). The precautionary principle also applies to public health actions. *American journal of public health*, 91(9), 1358-61. doi:10.2105/ajph.91.9.1358
- Weir E, S. R. (2010 , Sep-Oct). Canadian framework for applying the precautionary principle to public health issues. . *Can J Public Health*. , 101(5), 396-8. doi: 10.1007/BF03404860