Proposal Summary

Enhanced Air-To-Water Heat Pumps (AWHPs)

Updated September 30, 2025

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Measure Description

This proposal seeks to introduce mandatory and prescriptive requirements in Section 120.5 and 140.4, respectively for AWHP. This measure includes three proposals. Improve quality installation and operation and reduce the gap between manufactured performance and field performance by requiring guidelines, require a buffer tank and sizing limitation to improve the temperature stability, limit the concentration of ethylene glycol in some situations, and mandate AWHP/Water-to-Water Heat Pump (WWHP) isolation.

Submeasure 1: Improve Quality Installation Improving quality installation and operation will require new acceptance test, commissioning requirements, and “best practice guidelines” for design, installation, control, management and operation of Air-to-Water Heat Pumps (AWHPs) to ensure that they meet at least the advertised performance. Include limitations on buffer tank size in small volume loops with single stage AWHPs, require stratified buffer tanks, establish requirements for combination DHW and space heating systems, and reference other manufacturer product requirements (found in their literature) to ensure equipment is installed and operated as intended. These requirements will be applied for all AWHP installations including new, additions and alterations (system replacements and new system installations only) irrespective of climate zones, building and space types, and construction types.

Submeasure 2: Glycol Concentration Limits Place limits on ethylene glycol concentrations, with adjustments based on climate zone and system type, reducing the negative impacts on heat exchanger performance and pump power associated with excessive glycol concentrations.

Submeasure 3: AWHP Alignment with Boiler and Chiller Requirements Similar to equipment isolation requirements for other hydronic plant equipment such as chillers and boilers, this measure would require preventing the pump flow to any AWHP/WWHP that is in off condition without impacting the flow to active units.

Table 1 summarizes the scope of the proposed code change.

Table 1: Scope of Proposed Code Change

An "X" indicates the proposed code change is relevant.

Building Type(s)		single family	**Construction Type(s)**	X	new construction
		multifamily		X	additions
	X	nonresidential		X	alterations
Type of Change	X	mandatory	**Updates to Compliance Software**		no updates
	X	prescriptive		X	update existing feature
		performance		X	add new feature
Third Party Verification	X	no changes to third party verification			
		update existing verification requirements			
		add new verification requirements			

Justification for Proposed Change

A recent PG&E code readiness report[1] and other similar studies have shown that AWHP equipment frequently realizes much lower efficiencies than advertised. Opportunities exist to establish requirements in the code (and potentially during acceptance and commissioning) to prevent poor design and installation practices from being scaled in the industry as the hydronic heat pump product category continues to grow.

There are also some code-related obstacles to the widespread adoption of AWHPs. While there is a compliance option for AWHPs implemented in the compliance software, the requirements to meet this credit are unclear, hindering adoption. It has been difficult to get projects approved, as designers, plans examiners, and inspectors struggle to discern which requirements and forms to apply.

This measure will improve the communication of "best practice guidelines" for installation, control, management and operation of AWHPs to help ensure that the

[1] Weitze, H., Stober, W., and Gantley, M., Nonresidential Hydronic Heat Pumps: System Operation Field Study and Analysis, PGNE Code Readiness Final Project Report ET21PGE7201-2, October 2024. https://etcc-ca.com/reports/code-readiness-final-project-report-nonresidential-hydronic-heat-pumps-system-operation

advertised performance is achieved in practice. In addition, code language related to isolation of inactive units in multi-unit systems, which is already in place for chillers and boilers, will be adapted and applied to AWHPs. Finally, limits to glycol concentration will help improve heat exchanger and pump performance while protecting systems from freezing in colder climates. Additional verification tests will be required to demonstrate compliance.

The preliminary statewide energy savings for the first year from this measure are projected to be 4.24 GWh, which is likely underestimated since the savings were calculated for 4.5 million ft^2 (new construction only) assuming 10% savings of HVAC and DHW end uses. The final savings will be recalculated based on a more thorough assessment of common installation mistakes and the resulting energy impacts. Final savings analysis will include all non-residential building types along with additions and alterations.

Data Needs / Information Requests

The Statewide CASE Team is seeking the following information to inform the code change proposal. Data may be provided anonymously. To participate or provide information, please email [bhendron@frontierenergy.com] directly and copy info@title24stakeholders.com.

The Statewide CASE Team will network with stakeholders (e.g. HVAC designers, installers, facility managers, code officials) to collect incremental first cost and maintenance costs data to determine cost effectiveness. Some of the data gaps include design costs, installation costs (material and labor), inspection and commissioning costs, and maintenance cost.

The Statewide CASE Team will identify existing best practice guidelines for specific products from manufacturer websites and installation brochures, and identify more general guidance on installation, operation, and maintenance created by industry experts. The team will network with manufacturers, designers, and operators of AWHP equipment to determine weaknesses and gaps in available best practice documentation. The team will seek further understanding of the reasons for substandard practices, the prevailing practices, and how to mitigate the issues responsible for the low performance of AWHPs compared with the advertised performance.

1. **Available data sources:** Some data is available through published studies of AWHP performance drivers.

2. **Data gaps and plan to address them:** The Statewide CASE Team plans to research manufacturer's literature for details on system installations and knowledge of correct sequence of operations (SOO). The Statewide CASE Team will reach out to various stakeholders including heat pump manufacturers, control manufacturers, contractors, Architectural, Engineering and Construction (AEC) firms, and Testing Adjusting and Balancing (TAB) contractors to collect information directly about the technical feasibility of the proposed measures.
3. **Data Needs/Stakeholder Information Requests:** It would be desirable to obtain more information about current installation practices and how the performance of AWHPs is affected by installation or operational errors. It would also be helpful to know typical design values for glycol concentration, buffer tank size, and typical flow rate while individual AWHPs in multi-unit systems are turned off.

Efforts will be made to understand how the proposed standard may impact the market as well as the individual market actors. A more in-depth literature search may reveal causation of market gaps for AWHPs, such as installed cost, lack of familiarity, perceived performance risk, and code approval challenges.

While NOMAD will also be estimated based on market feedback, the market (particularly distributors, manufacturers, and designers) is envisioned as a primary source of data for many aspects of this measure.

Draft Code Language

1.1 Guide to Marked Up Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2025 documents are marked with blue underlining (new language) and ~~strikethroughs~~ (deletions).

This proposal introduces a new set of prescriptive requirements for AWHP in Section 140.4 to require "best practice guidelines" for installation, control, management and operation of AWHPs to ensure that they at least meet, if not exceed, the advertised performance. If substandard design and installation practices take hold at this phase in AWHP deployment, then substandard systems will be in place for years to come and could also give the product a bad reputation. In addition, the plan will include additional Acceptance Test requirement for AWHPs in 120.5.

This measure is applicable to new construction, additions, and alterations (system replacements and new constructions only) in all climate zones.

The proposal includes three sub-measures

a) Update AWHP Installation Requirements
b) Limit concentration of ethylene glycol
c) Revise language currently geared toward chillers and boilers to factor in AWHP/Water-Water Heat Pump (WWHP) considerations.

All sub-measures are applicable to new construction, additions, and alterations (system replacements and new constructions only) in all climate zones.

1.2 Title 24, Part 1

There are no proposed changes to Title 24, Part 1.

1.3 Title 24, Part 6

The proposed measure will include the following changes to Sections 120.2, 120.5 and 140.4:

a. **Update AWHP Installation Requirements:** Add new requirements for 120.5 and 140.4(r) (new) as the following:
   i. Add language to 120.5 Acceptance Test requirement for AWHP
   ii. Add prescriptive language to 140.4- Develop best practice guidelines for installation, control, management and operation of AWHPs to ensure that they meet at least the advertised performance.
   iii. Include sizing and load factor calculation requirements
   iv. Add a buffer tank requirement to provide stability in supply temperatures and to allow reduction in AWHP sizes
   v. Commissioning requirements
b. **Limit concentration of ethylene glycol:** Add new requirements to Section 120.2 and JA2
   i. Change title of Section 120.2 to “Requirements for Space-Conditioning Systems”
   ii. Maximum glycol percentage of 33%, except in heating-only systems using boilers with aluminum heat exchangers.
   iii. Disallow glycol when winter median of extremes in JA2 is >32°F.
   iv. Require scaling glycol percentage with heating design dry bulb in JA2
c. **Revise language currently geared toward chillers and boilers to factor in AWHP/WWHP considerations:**

i. Add a separate record 140.4(k)4 below, after 140.4(k) 2 and 140.4(k)3, as

140.4(k)2: "**Chiller isolation**. When a chilled water system includes more than one chiller, provisions shall be made so that flow through any chiller is automatically shut off when that chiller is shut off while still maintaining flow through other operating chiller(s). Chillers that are piped in series for the purpose of increased temperature differential shall be considered as one chiller."

140.4(k)3: "**Boiler isolation**. When a hot water plant includes more than one boiler, provisions shall be made so that flow through any boiler is automatically shut off when that boiler is shut off while still maintaining flow through other operating boiler(s)."

140.4(k)4: AWHP/WWHP Isolation: When a central plant includes more than one AWHP/WWHP, provisions shall be made so that flow through any HP is automatically shut off when that HP is shut off while still maintaining flow through other operating HP(s).

ii. The following additional change is proposed in Section **120.5(a)8**

120.5(a)8: Boiler or chiller or AWHP/WWHP that require isolation controls as specified by Section 140.4(k)2 or 140.4(k)3 or 140.4(k)4 shall be tested in accordance with NA7.5.7.

1.4 Reference Appendices

There are no proposed changes to the reference appendices.