

2021 WSEC-C MECHANICAL NAVIGATING THE NEW REQUIREMENTS FOR SPACE HEATING SYSTEMS



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WSEC Commercial Technical Support

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 - Email inquiries – **com.techsupport@waenergycodes.com**
- ▶ Classroom and webinar training
- ▶ We administer the technical support and compliance documentation webtool



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Codes

Increasing progressive effectiveness of energy codes

The NEEA Codes and Standards program supports regional stakeholders in the development and adoption, training and implementation of energy codes. States engage in the code development process along different cycles and code versions, but all states now use the International Energy Conservation Code (IECC) as a baseline for their commercial energy codes. All states except Oregon now use the IECC as the basis of their residential code. The adoption of codes is the responsibility of state code boards or agencies. Official state-by-state energy code information can be found on state building code websites:

Idaho - <http://dbs.idaho.gov/boards/index.html>

Oregon - <http://www.cbs.state.or.us/external/bcd/>

Washington - <https://sbcc.wa.gov/>

Montana - <http://svc.mt.gov/gov/boards/>



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WSEC technical support services are made possible thanks to the generous support of the Northwest Energy Efficiency Alliance

www.neea.org

Today's Presentation

- ▶ This presentation represents ETC's **unofficial** interpretation of code intent.
- ▶ Our technical support team is not an affiliate, nor do we speak for the Washington State Building Code Council (SBCC).
- ▶ The technical support we provide is advisory only and non-binding.



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2021 WSEC-C Official Opinions

- ▶ The Washington State Building Code Council (SBCC) has issued approximately ten official opinions on the 2021 WSEC-C.
- ▶ Official opinions from the SBCC are non-binding and advisory in nature.
- ▶ Official opinions inquiries regarding the C404 Service Water Heating provisions are currently working thru the SBCC official opinion process.
- ▶ Visit <https://sbcc.wa.gov/answers-opinions> to download opinions



Topics we'll discuss today ~

1. Service water heating (SWH) equipment efficiency criteria
2. Prescriptive requirements for SWH equipment selection
3. SWH system sizing requirements
4. Supplemental SWH allowances and requirements
5. Domestic hot water temp maintenance – circulation & heat trace systems
6. Piping insulation
7. Demand responsive water heating controls
8. Alterations to SWH systems in existing buildings
9. Q&A

A photograph of a public restroom sink area, overlaid with a semi-transparent blue filter. The image shows a long row of white sinks with chrome faucets. The focus is on the sink in the foreground, where water is flowing from the faucet. The background shows more sinks and the restroom environment, which is slightly out of focus. The text "SWH Equipment Efficiency" is centered over the image in a white, sans-serif font.

SWH Equipment Efficiency

EF vs UEF Ratings

- ▶ DOE has changed the rating metric for small capacity water heaters from Energy Factor (EF) to Uniform Energy Factor (UEF).
- ▶ UEF ratings vary depending on daily usage and first hour draw pattern.
- ▶ Minimum efficiency requirements in the 2021 WSEC-C are in UEF.
- ▶ Per SBCC Opinion #18-09, it is acceptable to use UEF ratings to demonstrate compliance with the 2018 WSEC-C.

UEF Rating Draw Pattern

BIN	BIN Daily Usage (Gallons)	First Hour Rating (Tank-Type Water Heaters)	Max GPM (Tankless Water Heaters)
Very Small	10	Less than 18 gallons	Less than 1.7
Low	38	18 to 51 gallons	1.7 to 2.8
Medium	55	51 to 75 gallons	2.8 to 4
High	84	75 gallons or larger	4 or more

Table C404.2

**TABLE C404.2
MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT**

Equipment Type	Size Category (input)	Subcategory or Rating Condition	Draw Pattern	Performance Required ^{d,j}	Test Procedure ^b
Electric table-top water heaters ^a	≤ 12 kW ^c	≥ 20 gal ≤ 120 gal	Very small Low Medium High	UEF ≥ 0.6323 - (0.0058 × Vr) UEF ≥ 0.9188 - (0.0031 × Vr) UEF ≥ 0.9577 - (0.0023 × Vr) UEF ≥ 0.9884 - (0.0016 × Vr)	DOE 10 C.F.R. Part 430 App. E
Electric storage water heaters ^{d,i} resistance and heat pump	≤ 12 kW ^c	≥ 20 gal ≤ 55 gal	Very small Low Medium High	UEF ≥ 0.8808 - (0.0008 × Vr) UEF ≥ 0.9254 - (0.0003 × Vr) UEF ≥ 0.9307 - (0.0002 × Vr) UEF ≥ 0.9349 - (0.0001 × Vr)	DOE 10 C.F.R. Part 430 App. E
	≤ 12 kW	> 55 gal ≤ 120 gal	Very small Low Medium High	UEF ≥ 1.9236 - (0.0011 × Vr) UEF ≥ 2.0440 - (0.0011 × Vr) UEF ≥ 2.1171 - (0.0011 × Vr) UEF ≥ 2.2418 - (0.0011 × Vr)	DOE 10 C.F.R. Part 430 App. E
Electric storage water heaters ^g	> 12 kW			(0.3 + 27/Vm), %h	DOE 10 C.F.R. 431.106 App B.
Grid-enabled water heaters ^{d,i}		> 75 gal	Very small Low Medium High	UEF ≥ 1.0136 - (0.0028 × Vr) UEF ≥ 0.9984 - (0.0014 × Vr) UEF ≥ 0.9853 - (0.0010 × Vr) UEF ≥ 0.9720 - (0.0007 × Vr)	10 C.F.R. 430 Appendix E
Electric instantaneous water heater ^h	≤ 12 kW	< 2 gal	Very small Low Medium High	UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.92	DOE 10 C.F.R. Part 430
	> 12 kW & ≤ 58.6 kW ^c	≤ 2 gal ≤ 180°F	All	UEF ≥ 0.80	DOE 10 C.F.R. Part 430
Gas storage water heaters ^g	≤ 75,000 Btu/h	≥ 20 gal & ≤ 55 gal ^f	Very small Low Medium High	UEF ≥ 0.3456 - (0.0020 × Vr) UEF ≥ 0.5982 - (0.0019 × Vr) UEF ≥ 0.6483 - (0.0017 × Vr) UEF ≥ 0.6920 - (0.0013 × Vr)	DOE 10 C.F.R. Part 430 App. E
	≤ 75,000 Btu/h	> 55 gal & ≤ 100 gal ^f	Very small Low Medium High	UEF ≥ 0.6470 - (0.0006 × Vr) UEF ≥ 0.7689 - (0.0005 × Vr) UEF ≥ 0.7897 - (0.0004 × Vr) UEF ≥ 0.8072 - (0.0003 × Vr)	DOE 10 C.F.R. Part 430 App. E
	> 75,000 Btu/h and ≤ 105,000 Btu/h ^d	≤ 120 gal ≤ 180°F	Very small Low Medium High	UEF ≥ 0.2674 - 0.0009 × Vr UEF ≥ 0.5362 - 0.0012 × Vr UEF ≥ 0.6002 - 0.0011 × Vr UEF ≥ 0.6597 - 0.0009 × Vr	DOE 10 C.F.R. Part 430 App. E
	> 105,000 Btu/h ^{d,f}			80% E _t SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 C.F.R. 431.106
Gas instantaneous water heater ^h	> 50,000 Btu/h and < 200,000 Btu/h	< 2 gal	Very small Low Medium High	UEF ≥ 0.80 UEF ≥ 0.81 UEF ≥ 0.81 UEF ≥ 0.81	DOE 10 C.F.R. Part 430 App. E
	≥ 200,000 Btu/h ^{d,f}	< 10 gal		80% E _t	DOE 10 C.F.R. 431.106
	≥ 200,000 Btu/h ^f	≥ 10 gal		80% E _t SL ≤ (Q/800 + 110√V), Btu/h	

- ▶ Minimum efficiency requirements are federal standards defined by the US Dept of Energy under the Energy Policy and Conservation Act (EPCA)
- ▶ For small capacity equipment, calculations based on draw pattern are to be used to demonstrate compliance with provisions that require better than code efficiency.
- ▶ Calculation variables are defined in footnotes
 - V and Vr = Rated volume in gallons
 - Vm = Measured volume in tank in gallons
 - S and %h = Standby losses

TABLE C404.2 - Continued
MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

Equipment Type	Size Category (input)	Subcategory or Rating Condition	Draw Pattern	Performance Required ^{d,j}	Test Procedure ^b
Oil storage water heaters ⁹	≤ 105,000 Btu/h	≤ 50 gal	Very small Low Medium High	UEF = 0.2509 – (0.0012 × Vr) UEF = 0.5330 – (0.0016 × Vr) UEF = 0.6078 – (0.0016 × Vr) UEF = 0.6815 – (0.0014 × Vr)	DOE 10 C.F.R. Part 430
	> 105,000 Btu/h and ≤ 140,000 Btu/h ^e	≤ 120 gal ≤ 180°F	Very small Low Medium High	UEF ≥ 0.2932-0.0015 × Vr UEF ≥ 0.5596-0.0018 × Vr UEF ≥ 0.6194-0.0016 × Vr UEF ≥ 0.6740-0.0013 × Vr	DOE 10 C.F.R. Part 430 App. E
	> 140,000 Btu/h			80% E _t SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 C.F.R. 431.106
Oil instantaneous water heater ^h	≤ 210,000 Btu/h	< 2 gal		80% E _t EF ≥ 0.59 - 0.0005 × V	DOE 10 C.F.R. Part 430 App. E
	> 210,000 Btu/h	< 10 gal		80% E _t	DOE 10 C.F.R. 431.106
	> 210,000 Btu/h	≥ 10 gal		78% E _t SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 C.F.R. 431.106
Hot water supply boilers, gas and oil ^a	≥ 300,000 Btu/h and < 12,500,000 Btu/h	< 10 gal		80% E _t	DOE 10 C.F.R. 431.106
Hot water supply boilers, gas ^h	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal		80% E _t SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 C.F.R. 431.106
Hot water supply boilers, oil ^a	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal		78% E _t SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 C.F.R. 431.106
Pool heaters, gas	All			82% E _t	DOE 10 C.F.R. Part 430 App. P
Heat pump pool heaters	All	50°F db 44.2°F wb outdoor air 80.0°F entering water		4.0 COP	DOE 10 C.F.R. Part 430 App. P
Unfired storage tanks	All			Minimum insulation requirement R-12.5 (h-ft ² -°F)/Btu	(none)

Governed SWH equipment types include:

- Electric resistance storage
- Electric resistance instantaneous
- Electric air-source heat pump water heaters (HPWH)
- Fuel-fired storage (gas and oil)
- Fuel-fired instantaneous
- Fuel-fired hot water supply boilers
- Pool heaters (gas and heat pump)
- Storage tanks

Heat Pump Water Heaters

TABLE C404.2 - Continued
MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

Equipment Type	Size Category (input)	Subcategory or Rating Condition	Draw Pattern	Performance Required ^{d,j}	Test Procedure ^b
Electric storage water heaters ^{g,i} resistance and heat pump	≤ 12 kW ^c	≥ 20 gal ≤ 55 gal	Very small Low Medium High	UEF ≥ 0.8808 - (0.0008 × Vr) UEF ≥ 0.9254 - (0.0003 × Vr) UEF ≥ 0.9307 - (0.0002 × Vr) UEF ≥ 0.9349 - (0.0001 × Vr)	DOE 10 C.F.R. Part 430 App. E
	≤ 12 kW	> 55 gal ≤ 120 gal	Very small Low Medium High	UEF ≥ 1.9236 - (0.0011 × Vr) UEF ≥ 2.0440 - (0.0011 × Vr) UEF ≥ 2.1171 - (0.0011 × Vr) UEF ≥ 2.2418 - (0.0011 × Vr)	DOE 10 C.F.R. Part 430 App. E

- ▶ Per Footnote i, there are no minimum efficiency requirements for electric storage HPWHs with capacity greater than 12 kW.
- ▶ For projects complying with the high efficiency HPWH additional energy efficiency measure, the equipment rating conditions and minimum efficiency values are defined in Section C406.2.6.3.1. Requires at least a COP of 3, or a UEF of 3.4.

SWH Equipment Efficiency

Other SWH equipment types with no minimum efficiency requirement

- ▶ Gas heat pump water heaters (GHPWH)
- ▶ Electric instantaneous water heaters with:
 - Input capacity > 12 kW and ≤ 58.6 kW
 - Either (1) a storage volume > 2 gal; or (2) is designed to provide outlet hot water at temp $> 180^{\circ}\text{F}$; or (3) uses 3-phase power
- ▶ Additional instructions for fuel-fired storage water heaters are defined in the Table C404.2 footnotes.
- ▶ *If no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer.*



Image courtesy of Robur

I

Prescriptive SWH Compliance Path



Steps to Demonstrate Prescriptive Compliance

- 1. Calculate Primary SWH Capacity Needed** – Calculate the design total capacity “... for service hot water production during the peak demand period” based on the sizing criteria defined in Section C404.2.1.1.
 - Production = System **output capacity inclusive** of integral & external storage
 - Primary = The design output capacity **exclusive** of supplemental capacity
- 2. Select Primary System & Equipment Types**
 - **Electric air-source heat pump water heaters (HPWH) are required to provide at minimum 50% of the primary capacity**
 - Remaining primary capacity can be provided by HPWHs, fossil fuel or electric resistance equipment or other source of heat energy (solar thermal, waste heat recovery, district energy, etc).

Steps to Demonstrate Prescriptive Compliance

3. Allocate Primary SWH Capacity

- Convert all SWH system & equipment output capacity values to Btu/h
- Calculate what percentage of the design total peak demand capacity each SWH system & equipment type will provide

4. Calculate Supplemental SWH Capacity Needed – Calculate and tally the design total output capacity for all supplemental heating uses based on the sizing criteria defined in Section C404.2.1.4.

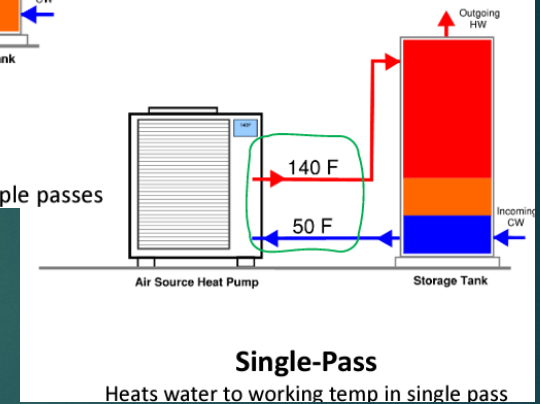
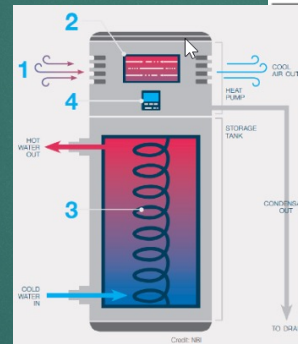
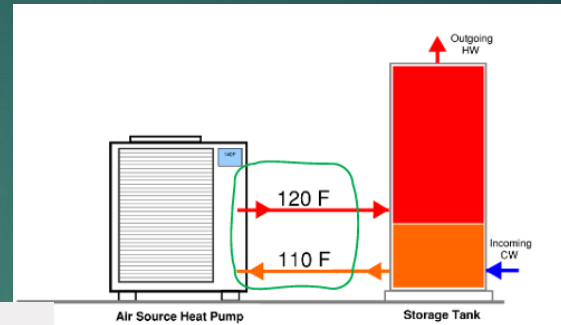
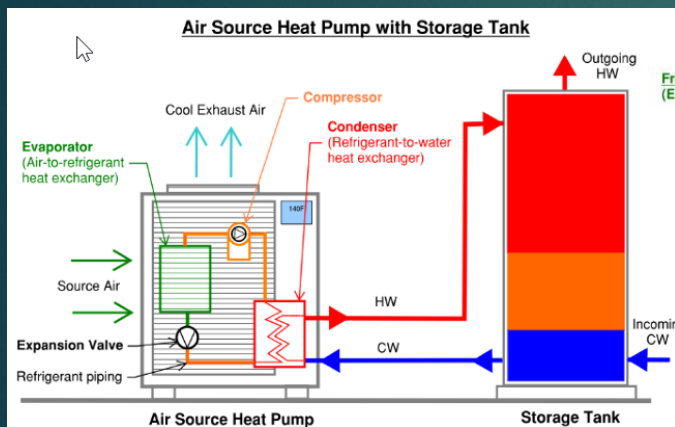
5. Documentation - Provide a summary of all details described in Steps 1 thru 4 in the permit submittal documentation.

SWH Equipment Efficiency Comparison

	COP
FOSSIL FUEL	0.80 - 0.90
ELECTRIC RESISTANCE	1.0
ELECTRIC HEAT PUMP	2.0 – 4.0

COP = Energy Output/Energy Input

HPWH System Types



Visit the Lighting Design Lab website for course recordings and handouts on the design, operation and maintenance of commercial HPWH systems

<https://www.lightingdesignlab.com/course-recordings-and-handouts>

Step 1 - Primary SWH Capacity

Determine Primary SWH Capacity Needed

- ▶ Peak demand shall be calculated using the equipment manufacturer's selection criteria or other *approved* methodology.
- ▶ Peak demand sizing criteria required for heat pump water heaters:
 - Air-source heat pumps
 - Use 40°F entering dry-bulb or wet-bulb outdoor air temperature.
 - Shall also be sized to deliver no less than 25% of the calculated peak demand when the entering dry-bulb or wet-bulb temperature is 24°F.
 - Ground-source heat pumps – Use 44°F ground temperature

Step 2 - System & Equipment Types

Select Primary System & Equipment Types

▶ Prescriptive Baseline

- **Electric air-source heat pump water heaters (HPWH)** shall provide no less than 50% of the required primary capacity during the peak demand period.
- Remaining primary capacity is allowed to be provided by **any SWH system or equipment type** (includes HPWHs, fossil fuel & electric resistance equipment and other sources of heat energy).
- The combination of all SWH systems, including storage, shall provide sufficient hot water capacity to satisfy the peak demand.

▶ ***There are also exceptions to consider...***

Section C404.2.1 - SWH system type
Section C404.2.1.1 - Primary HP system sizing

Electric Resistance Allowance

C404.2.1 Exception #1

- ▶ 24 kW plus 0.1 watts per SF of electric resistance SWH capacity is allowed **PER BUILDING**.
- ▶ Base site allowance taken off the top before all other system type requirements are applied.

EXAMPLE: New 10,000 SF building, can be any occupancy type

Allowance = 24 kW + (10,000 SF x 0.1 watts/1,000)

= 24 kW + 1kW

= **25 kW Electric Resistance Allowance**

SWH Equipment Types

- ✓ Electric resistance storage water heaters
- ✓ Electric instantaneous water heaters
- ✓ Under counter/sink tankless water heaters
- ✓ Electric hybrid water heaters

Section C404.2.1 - SWH system type

Alternate Sources of Heat Energy

C404.2.1 Exception #2

- ▶ Capacity from alternate heat energy sources are included in the calculations to **offset all or a portion of** the 50% primary capacity that is prescriptively required to be provided by a HPWH.
- ▶ **NOT** an exemption for Section C404.2.1 and all related sub-sections.
- ▶ **Eligible alternate sources** – Solar thermal, wastewater heat recovery, and other *approved* waste heat energy sources such as ground-source and water-source heat pump systems, condenser systems and steam condensate systems

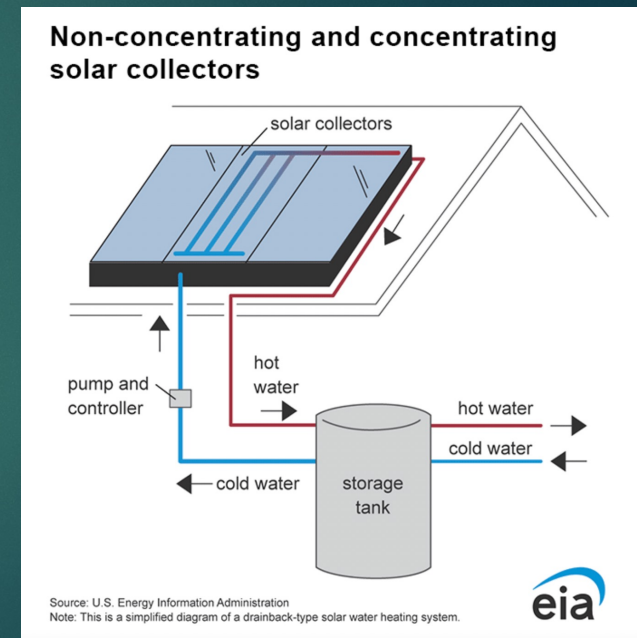


Image courtesy of the US Energy Information Administration

C404.2.1

Exemptions

C404.2.1 Exceptions #3, #4, #5, #6 and #7

- ▶ These exceptions provide an **exemption**, meaning if a project complies with the exception then the project is deemed to comply.
- ▶ If **ALL** of the primary peak demand capacity is addressed by these exceptions, then the project is **exempt** from all requirements in Section C404.2.1, as well as all related sub-sections (Sections C404.2.1.1 thru C404.2.1.5).
- ▶ If **only a portion** of the primary peak demand capacity is addressed by these exceptions, then systems & equipment that provide the **remaining primary capacity** shall comply with the prescriptive requirements per Section C404.2.1 and all related sub-sections.

Exemptions

C404.2.1 Exceptions #4, #5, #6 and #7

- ▶ **Pre-existing district energy** – SWH systems are served by a district energy system that serves multiple buildings and was in service prior to 3/15/2024.
- ▶ **Commercial food service & approved process equipment** – Electric resistance booster heaters are allowed for systems that require supply water temperature 120°F or higher.
- ▶ **Low carbon district energy** – SWH systems are served by a system that complies with the WSEC-C definition for *low-carbon district energy exchange system*, OR, *low-carbon district cooling & heating or heating only systems*.
- ▶ **Essential facilities** – Group I-2 and I-3 occupancies that by regulation are required to have in place redundant emergency backup systems.

NOTE - Italicized words are defined terms in the code



Advanced Water Heating Specification

Find the electric and natural gas advanced water heating specifications and accompanying qualified products lists below.

Advancing the market for heat pump water heaters

Utilities, energy efficiency organizations and market partners developed the Advanced Water Heating Specification (AWHS) to advance higher performing electric and gas heat pump water heaters. While this specification is rooted in ensuring performance in cooler northern climates, its applicability and benefits extend well beyond the Northwest. The specification also enhances the end goals of NEEA's water heating programs - to influence the passage of federal standards requiring heat pump levels of performance for both gas and electric storage water heaters.

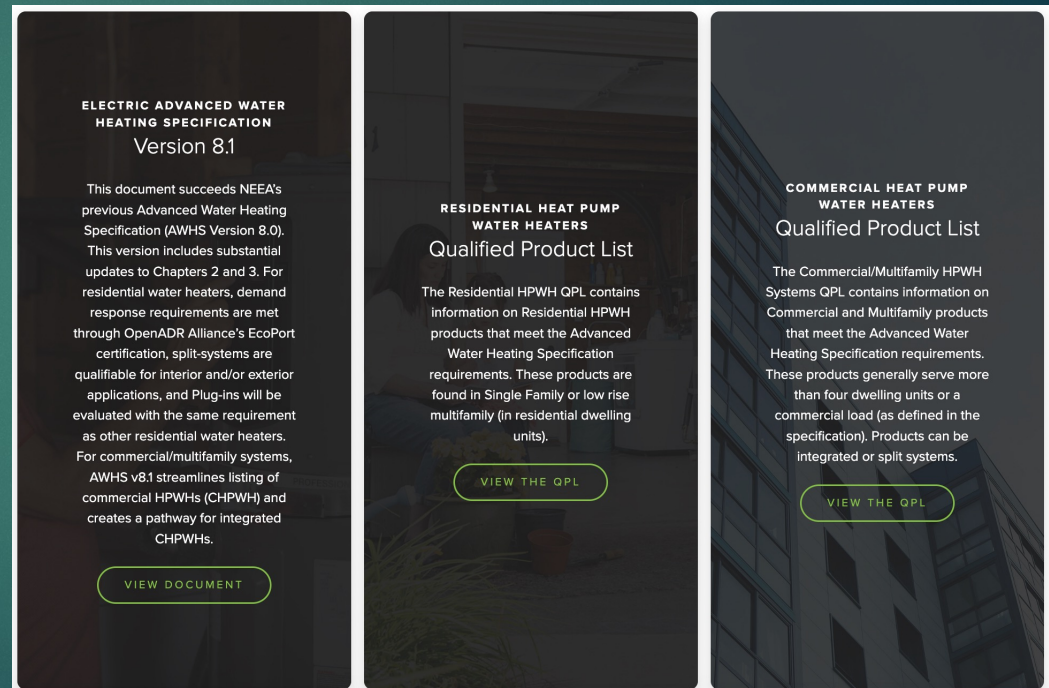
The latest version of the AWHS is version 8.0. Additional resources such as qualified products lists (QPLs) are available in the listed resources below.

[VIEW ALL RESOURCES](#)

NEEA Advanced Water Heating Specification

C404.2.1 Exception #3

- ▶ Systems & equipment that comply with the NEEA Commercial Electric Advanced Water Heating Specification are exempt from C404.2.1 and all related sub-sections.
- ▶ Eligible equipment must be listed in the NEEA Qualified Products List (QPL).



<https://nea.org/our-work/advanced-water-heating-specification>

C404.2.1

Step 3 - Allocate Primary SWH Capacity

Test for Prescriptive Compliance

- ▶ **Reminder** – No less than 50% of the required primary capacity for service hot water production during the peak demand period shall be provided by HPWHs. The remaining 50% primary capacity can be provided by any system type.
- ▶ Calculate what percentage of the design total peak demand capacity each SWH system & equipment type and heat energy source will provide.
- ▶ Test capacity allocation for compliance with Section C404.2.1.1.

Step 3 - Allocate Primary Capacity

Example #1 – 25,000 SF luxury hotel

- Peak demand SWH capacity = 1,000,000 Btu/h
- Exception #3 - HPWHs complying with NEEA AWHS = 500,000 Btu/h

50% primary capacity required to be provided by HPWHs:

$$1,000,000 \text{ Btu/h} - 500,000 \text{ Btu/h} = (500,000 \text{ Btu/h}) \times 0.5 = \mathbf{250,000 \text{ Btu/h}}$$

REQUIRED HPWH CAPACITY

Remaining 50% primary capacity that can be provided by HPWHs, fossil fuel or electric resistance equipment, or other heat energy sources = **250,000 Btu/h**

AWHS - NEEA Advanced Water Heating Specification

Step 3 - Allocate Primary Capacity

Example #2 – 25,000 SF luxury hotel

- Peak demand SWH capacity = 1,000,000 Btu/h
- Exception #1 - Electric resistance allowance = 24 kW + 2.5 kW = 90,500 Btu/h
- Exception #2 - Available wastewater heat recovery capacity = 200,000 Btu/h

50% primary capacity required to be provided by HPWHs:

$$1,000,000 \text{ Btu/h} - 90,500 \text{ Btu/h} = (909,500 \text{ Btu/h}) \times 0.5 = 454,750 \text{ Btu/h}$$

Deduct wastewater heat recovery capacity:

$$454,750 \text{ Btu/h} - 200,000 \text{ Btu/h} = \mathbf{254,750 \text{ Btu/h}}$$

REQUIRED HPWH CAPACITY

Remaining 50% primary capacity that can be provided by HPWHs, fossil fuel or electric resistance equipment or other heat energy sources = **454,750 Btu/h**

Step 4 - Supplemental Capacity

Calculate Supplemental SWH Capacity Needed

- ▶ Total output capacity of **all supplemental** SWH sources shall not exceed the total output capacity of **all primary** SWH sources.
- ▶ Supplemental capacity is allowed to be provided by **any SWH system or equipment type** (includes HPWHs, fossil fuel & electric resistance equipment and other sources of heat energy).
- ▶ For the purpose of determining **allowed supplemental capacity**, the electric resistance base site allowance and exempt systems and equipment capacities are **NOT** included in the primary output capacity total.
- ▶ Use the same sizing criteria as defined for primary SWH systems and equipment capacity (identical sizing criteria in Sections C404.2.1.1 and C404.2.1.4).

Step 4 - Supplemental Capacity

Supplemental heating for HPWHs is allowed for the following conditions

- ▶ Defrost of compressor coils
- ▶ When the primary HPWH system cannot deliver the SWH demand capacity due to low ambient air temperature conditions.
- ▶ Controls criteria - During normal operations, supplemental heating shall operate only when the entering air temp is less than 40°F and the primary HPWH compressor shall operate simultaneously with supplemental heating.



Design Note - Unitary HPWHs can be installed within conditioned spaces provided the compressor is sized to meet 100% of the peak demand without supplemental heating.

Step 4 - Supplemental Capacity

Supplemental heating is also allowed for the following uses

- ▶ Temperature maintenance of heated-water circulation systems, provided supplemental heating system is physically separate from the primary SWH system.
- ▶ Heat tracing of piping for freeze protection or for the purpose of temperature maintenance in lieu of circulation systems.
- ▶ For back-up capacity only, if the primary SWH system or equipment experiences equipment failure.

Prescriptive HPWH System Review

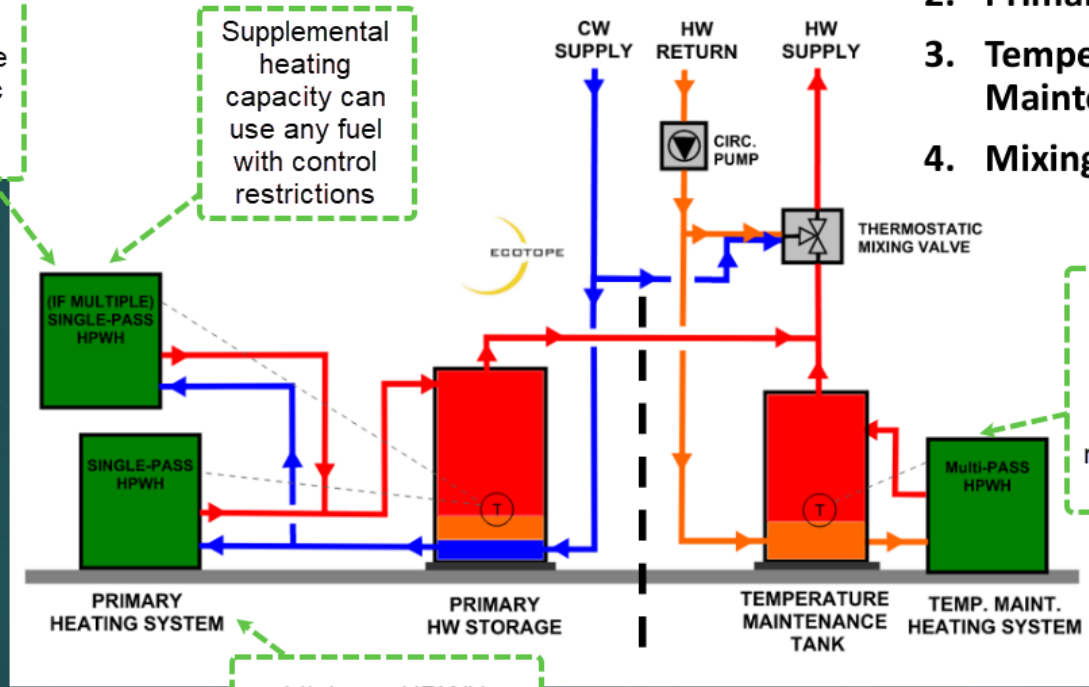
Four HPWH System Components

1. Heat pump
2. Primary storage tank
3. Temperature Maintenance System
4. Mixing valve

Remaining primary SWH capacity can be HPWH, electric resistance, or fossil fuel

Supplemental heating capacity can use any fuel with control restrictions

Temperature maintenance systems can be HPWH. electric resistance, or fossil fuel



Minimum HPWH Capacity to meet 50% of peak demand

Fossil Fuel Compliance Path

Additional energy credits are required

- ▶ Alternative compliance path for the 50% primary peak demand capacity that is required to be provided by HPWHs, but is provided instead by fossil fuel or electric resistance SWH systems and equipment.
- ▶ **The number of additional energy credits required are per Table C401.3.3, which is in addition to the number of additional energy efficiency measure credits (AEM) required per Table C406.1.**
- ▶ Additional energy credits are capacity-weighted based on the percentage of primary peak demand capacity being provided by fossil fuel or electric resistance systems and equipment.
- ▶ **Use adjusted AEM credit values in Table C406.2(2)** for the fossil fuel compliance path, **DO NOT** use Table C406.2(1) credit values.

**C401.3
C401.3.3.2
Table C406.2(2)**

Fossil Fuel Compliance Path

**TABLE C401.3.3
ADDITIONAL CREDITS REQUIRED**

Measure Title	Applicable Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building - Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	7	24	101	38	111	56
New building - Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C401.3.3.2	198	212	27	17	79	107
Building additions - Additional efficiency credits required for space heating systems using the fossil fuel pathway	C401.3.3.1	4	12	51	19	56	28
Building additions - Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C402.3.3.2	99	106	14	9	40	54

Number of additional required credits is based on the project type, occupancy group **and service water heating system type**

Fossil Fuel Compliance Path

Example – New Retail Building (Group M) complying with SWH Fossil Fuel Pathway

- Required **AEM credits** per Table C406.1 = **74 credits**
- Required **additional energy credits** per Table C401.3.3 = **79 credits**
- **Proposed design capacities – 30% wastewater heat recovery, 70% condensing boilers**
- % of primary peak SWH demand capacity that Fossil Fuel Pathway applies to = **20%**

$$\text{Total required credits} = 74 + (79 \times 0.20) = 74 + 15.8 = 89.8$$

Required Credits for Projects	Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building energy efficiency credit requirement	C406.2	54	41	42	48	74	49

Measure Title	Applicable Section	Occupancy Group					
		Group R-1	Group R-2	Group B	Group E	Group M	All Other
New building - Additional efficiency credits required for service water heating systems using the fossil fuel pathway	C401.3.3.2	198	212	27	17	79	107

- High performance DOAS + 20% reduced lighting power + Enhanced lighting controls
- 40 credits + 40 credits + 11 credits = **91 credits**

Step 5 - Documentation

Details to include in project documents

- ▶ Design total capacity needed for service hot water production during the peak demand period
- ▶ SWH equipment schedule with rated output capacities and efficiencies
- ▶ List of alternate sources of waste heat energy and design capacity, if applicable
- ▶ Primary capacity allocation calculation
- ▶ Total supplemental heating capacity



Domestic Hot Water Distribution Systems



Temperature Maintenance

Heated-Water Circulation System Controls

- ▶ Circulation pumps shall have an ECM motor with adjustable speed setting for balancing.
- ▶ Configure controls to automatically turn the circulation pump off during extended periods when there is no domestic hot water demand.
- ▶ Single riser or zone systems – Configure controls to automatically turn the pump off when the water in the circulation loop is at the design temperature.
- ▶ Multiple riser or zone systems – Provide a means to balance flow rate thru each riser or zone. If pump is variable flow, provide self-actuating thermostatic balancing valves on each riser.

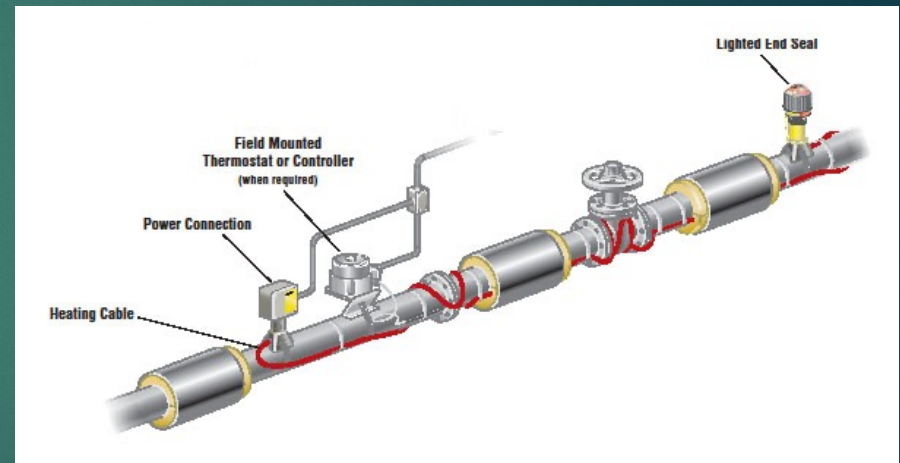


Image courtesy of Taco

Temperature Maintenance

Heat Trace System Controls

- ▶ Configure controls to monitor domestic hot water temp in the piping system and automatically adjust energy input to the heat tracing to maintain the design hot water temp.
- ▶ Controls shall automatically turn off heat tracing when there is no hot water demand.
- ▶ System shall comply with IEEE 515.5



SWH Piping Insulation

TABLE C403.10.3
MINIMUM PIPE INSULATION THICKNESS (thickness in inches)^a

FLUID OPERATING TEMPERATURE RANGE AND USAGE (°F)	INSULATION CONDUCTIVITY		NOMINAL PIPE OR TUBE SIZE (inches)				
	Conductivity Btu · in./(h · ft ² · °F) ^b	Mean Rating Temperature, °F	< 1	1 to < 1-1/2	1-1/2 to < 4	4 to < 8	≥ 8
> 350	0.32 – 0.34	250	4.5	5.0	5.0	5.0	5.0
251 – 350	0.29 – 0.32	200	3.0	4.0	4.5	4.5	4.5
201 – 250	0.27 – 0.30	150	2.5	2.5	2.5	3.0	3.0
141 – 200	0.25 – 0.29	125	1.5	1.5	2.0	2.0	2.0
105 – 140	0.21 – 0.28	100	1.0	1.0	1.5	1.5	1.5
40 – 60	0.21 – 0.27	75	0.5	0.5	1.0	1.0	1.0
< 40	0.20 – 0.26	75	0.5	1.0	1.0	1.0	1.5

- ▶ Supply piping from SWH appliances to plumbing fixtures shall be insulated per Table C403.10.3.
- ▶ Piping insulation shall be continuous including through hangers and supports.
- ▶ Hot water piping that is part of the final pipe run to a plumbing fixture and is not part of the heated-water circulation system, is not required to be insulated.
- ▶ Heated water circulation systems - Insulation on the supply & return piping shall be **at least 1.0 inch thicker** than required per Table C403.10.3.

C404.6/C407.3.1

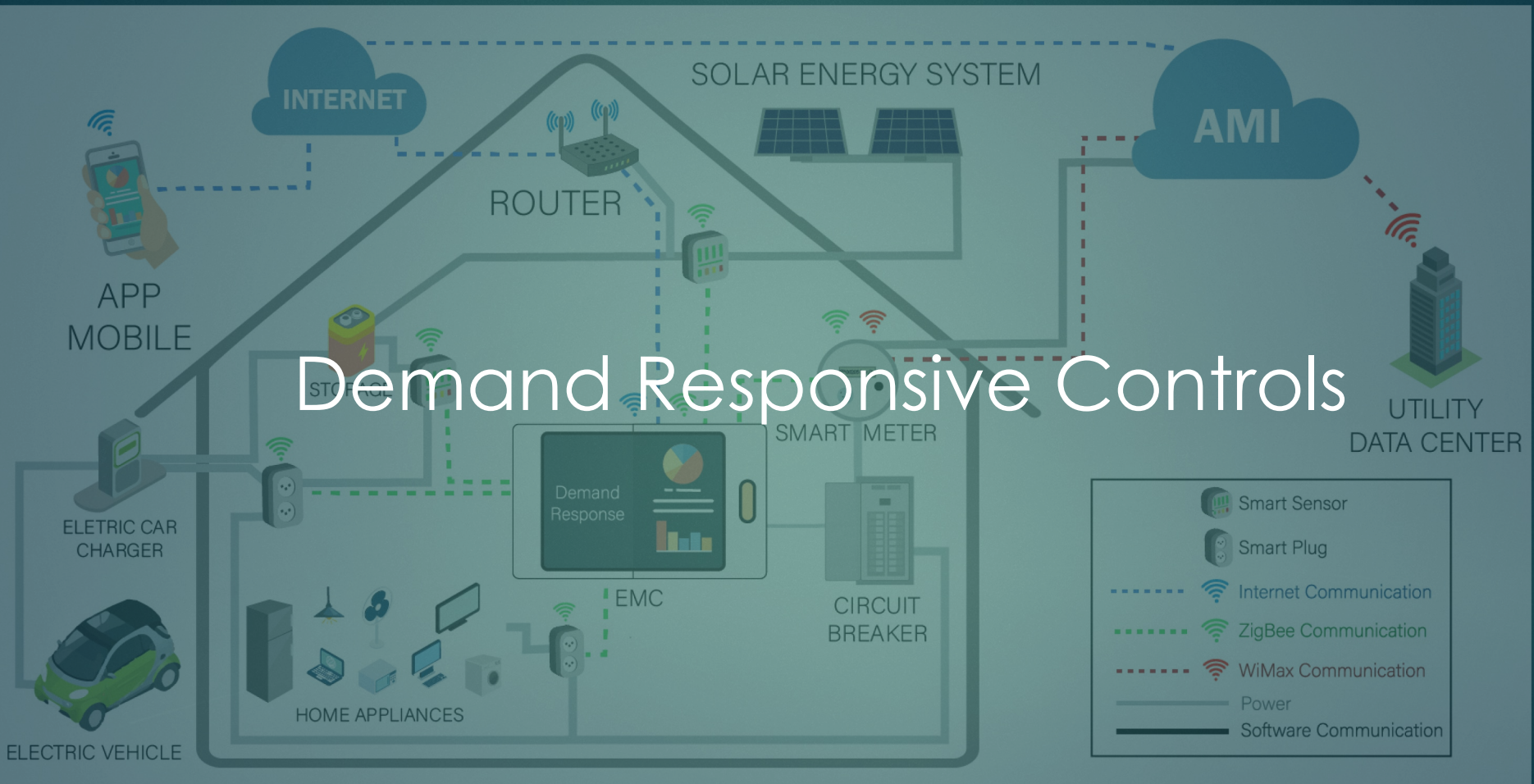
Efficient Supply Piping Methods

- ▶ Two Available Methods
 - Maximum allowable pipe length
 - Maximum allowable pipe volume
- ▶ **UPDATED** - Allowed length for hot water supply runouts to public lavatory faucets has increased to 8 lineal feet for 1/2" and 5/8" piping.

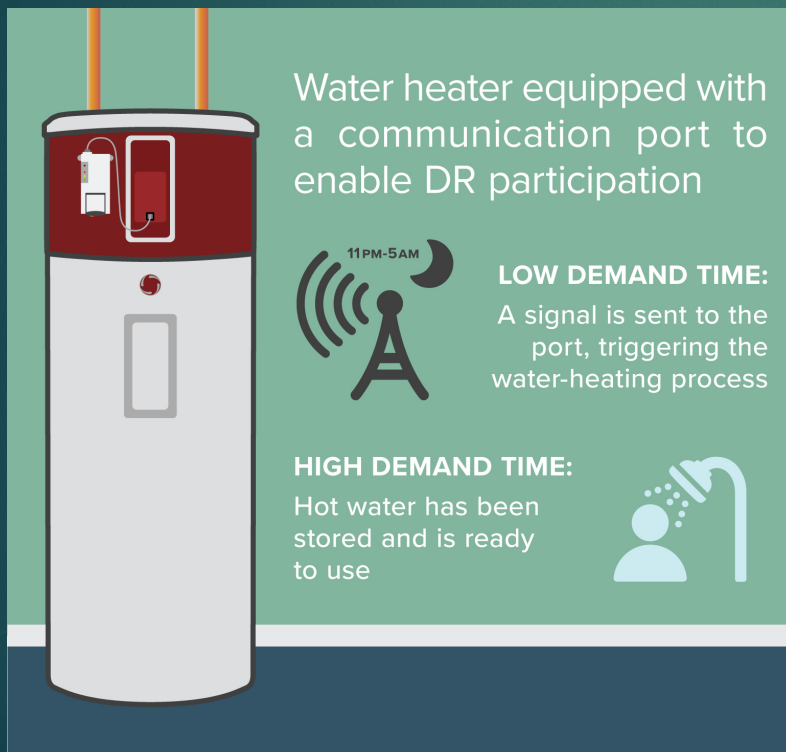
Table C404.3.1
Piping Volume and Maximum Piping Lengths

Nominal Pipe Size (inches)	Volume (liquid ounces per foot length)	Maximum Piping Length (feet)	
		Public lavatory faucets	Other fixtures and appliances
1/4	0.33	6	50
5/16	0.5	4	50
3/8	0.75	3	50
1/2	1.5	8	43
5/8	2	8	32
3/4	3	0.5	21
7/8	4	0.5	16
1	5	0.5	13
1 1/4	8	0.5	8
1 1/2	11	0.5	6
2 or larger	18	0.5	4

Demand Responsive Controls



Demand Responsive Water Heating



- ▶ Required for electric resistance tank-type water heaters with rated storage volume between 40 and 120 gallons and nameplate input rating $\leq 12\text{kW}$.
- ▶ Requires a Demand Response (DR) communication port.
- ▶ Provides a future opportunity for electric service providers to reduce peak system demand and keep energy rates low.
- ▶ Not required for water heaters that require 3-phase power.
- ▶ Other exceptions may apply



SWH System Alterations

Images courtesy of Ecotope Hot Water Forum

SWH System Alterations

New Systems and Equipment

- ▶ New SWH systems and equipment, and components of existing systems that are altered or replaced, shall comply as required for new construction.
- ▶ If the requirement to provide SWH capacity via HPWHs applies to the project, the alteration can include new fuel-fired and/or electric resistance equipment in lieu of HPWHs, provided the project complies via the fossil fuel pathway.
- ▶ Fossil fuel pathway for a SWH alteration
 - Alteration shall comply with the number of additional energy credits required for a building addition per Table C401.3.3.
 - Only additional energy credits per Section C401.3.3 are required. The AEM credit requirements in Section C406.1 **do not apply to alterations** per Section C503.1.

C401.3
C404.2.1
C503.5

SWH System Alteration Exceptions

Equipment replacement projects that are exempt from C404.2.1 & C401.3

- ▶ **Like-for-like replacement** – Existing SWH appliance is replaced with a new appliance that is the same type, has the same or lower capacity, and the same or higher efficiency.
- ▶ Exempt appliances:
 - Electric resistance water heaters with ≤ 12 kW input
 - Gas storage water heaters with $\leq 75,000$ Btu/h
 - Gas instantaneous water heaters with $\leq 200,000$ Btu/h and ≤ 2 gallons of tank storage
- ▶ Where existing building constraints make full compliance technically infeasible, **as pre-approved by the code official**. Includes existing available floor space, ceiling height, structural loading capacity and electrical service capacity.

2021 WSEC-C MECHANICAL NAVIGATING THE NEW REQUIREMENTS FOR SPACE HEATING SYSTEMS



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