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STATE OF WASHINGTON

STATE BUILDING CODE COUNCIL

Washington State Energy Code Development Standard Energy Code Proposal Form

Code being amended: Commercial Provisions Residential Provisions

Code Section # Table C404.2

Brief Description:

The 2021 IECC did not update the water efficiency table and neither does the integrated draft. The current table utilizes Energy Factor (EF). Starting in 2017 DOE required most hot water tanks to be rated by the Uniform Energy Factor (UEF) and the EF is no longer published. Proposed here is to adopt a new efficiency table which incorporates efficiency requirements from ASHRAE 90.1-2019 that reflect the current DOE standards.

Edits are also applied to C404.2.2 to make language consistent with the new table and other code requirements.

Proposed code change text: (Copy the existing text from the Integrated Draft, linked above, and then use underline for new text and ~~strikeout~~ for text to be deleted.)

C404.2 Service water-heating equipment performance efficiency. Water-heating equipment and hot water storage tanks shall meet the requirements of Table C404.2. The efficiency shall be verified through certification and *listed* under an *approved* certification program, or if no certification program exists, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Water-heating equipment intended to be used to provide space heating shall meet the applicable provisions of Table C404.2.

[Delete current Table C404.2 and footnotes and replace with this table and footnotes]

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

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	DRAW PATTERN	PERFORMANCE REQUIRED ^a	TEST PROCEDURE ^b
Electric Table-top water heaters ^g	≤12 kW	≥ 20 gal ≤120 gal ^f	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 CFR Part 430 App. E
Electric Storage water heaters ^{g,i} : resistance and heat pump	≤12 kW	≥ 20 gal ≤ 55 gal ^f	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 CFR Part 430 App. E
	≤12 kW	> 55 gal ≤120 gal ^f	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 CFR Part 430 App. E
Electric Storage water heaters ^{g,i}	> 12 kW			(0.3 + 27/Vm), %h	DOE 10 CFR 431.106 App B.
Grid-enabled water heaters ^g		>75 gal ^f	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 CFR 430 Appendix E
Electric Instantaneous water heaters ^h	≤12 kW	< 2 gal ^f	Very small Low Medium High	UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.91 UEF ≥ 0.92	DOE 10 CFR Part 430
	>12 kW & ≤ 58.6 kW ^c	≤ 2 gal ≤180F	All	UEF ≥ 0.80	DOE 10 CFR 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 CFR 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 CFR 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 CFR Part 430 App. E
	> 105,000 Btu/h ^{d,f}			80% E _t SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 CFR 431.106
Gas Instantaneous water heaters ^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 CFR Part 430 App. E
	≥ 200,000 Btu/h ^{d,f}	< 10 gal ^f		80% E _t	DOE 10 CFR 431.106
	≥ 200,000 Btu/h ^f	≥10 gal		80% E _t SL ≤ (Q/800 + 110√V), Btu/h	

TABLE C404.2, continued
MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

Oil Storage water heaters ^g	≤ 105,000 Btu/h	≤ 50 gal ^f	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 CFR 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 CFR Part 430 App. E
	>140,000 Btu/h			80% <i>E_t</i> SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 CFR 431.106
Oil Instantaneous water heaters ^h	≤ 210,000 Btu/h	< 2 gal		80% <i>E_t</i> EF ≥ 0.59 - 0.0005 × V	DOE 10 CFR Part 430 App. E
	> 210,000 Btu/h	< 10 gal		80% <i>E_t</i>	DOE 10 CFR 431.106
	> 210,000 Btu/h	≥ 10 gal		78% <i>E_t</i> SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 CFR 431.106
Hot water supply boilers, gas and oil ^h	≥300,000 Btu/h and < 12,500,000 Btu/h	< 10 gal		80% <i>E_t</i>	DOE 10 CFR 431.106
Hot water supply boilers, gas ^h	≥300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal		80% <i>E_t</i> SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 CFR 431.106
Hot water supply boilers, oil ^h	≥300,000 Btu/h and < 12,500,000 Btu/h	≥ 10 gal		78% <i>E_t</i> SL ≤ (Q/800 + 110√V), Btu/h	DOE 10 CFR 431.106
Pool heaters, gas	All	— ^f		82% <i>E_t</i>	DOE 10 CFR 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 CFR Part 430 App. P
Unfired storage tanks	All	—		Minimum insulation requirement R-12.5 (h-ft ² - °F)/Btu	(none)

- a. Thermal efficiency (*E_t*) is a minimum requirement, while standby loss is a maximum requirement. In the standby loss equation, V is the rated volume in gallons and Q is the nameplate input rate in Btu/h. V_m is the measured volume in the tank in gallons. Standby loss for electric water heaters is in terms of %/h and denoted by the term “S,” and standby loss for gas and oil water heaters is in terms of Btu/h and denoted by the term “SL” Draw pattern (DP) refers to the water draw profile in the Uniform Energy Factor (UEF) test. UEF and Energy Factor (EF) are minimum requirements. In the UEF standard equations, V_r refers to the rated volume in gallons.
- b. Chapter 6 contains a complete specification, including the year version, of the referenced test procedure.
- c. Electric instantaneous water heaters with input capacity >12 kW and ≤58.6 kW that have either (1) a storage volume >2 gal; or (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power has no efficiency standard.
- d. Gas storage water heaters with input capacity >75,000 Btu/h and ≤105,000 Btu/h must comply with the requirements for the >105,000 Btu/h if the water heater either (1) has a storage volume >120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power.
- e. Oil storage water heaters with input capacity >105,000 Btu/h and ≤140,000 Btu/h must comply with the requirements for the >140,000 Btu/h if the water heater either (1) has a storage volume >120 gal; (2) is designed to provide outlet hot water at temperatures greater than 180°F; or (3) uses three-phase power.
- f. Water heaters or gas pool heaters in this category are regulated as consumer products by the USDOE as defined in 10 CFR 430 and do not need to be checked for code compliance. Numbers in table are for reference or to use for over code performance determinations.
- g. Table top and storage water heaters have a ratio of input capacity (Btu/h) to tank volume (gal) < 4000.
- h. Instantaneous water heaters and hot water supply boilers have an input capacity (Btu/h) divided by storage volume (gal) ≥ 4000 Btu/h-gal.
- i. There are no minimum efficiency requirements for electric storage-heat pump water heaters ≤ greater than 12 kW or for gas heat pump water heaters apply to both electric resistance and heat pump water heaters.

C404.2.2 High input-rated service water heating system for Group R-1 and R-2 occupancies. In new buildings with over 1,000,000 Btu/h installed service water heating capacity serving Group R-1 and R-2 occupancies, at least 25 percent of annual water heating energy shall be provided from any combination of the following water heating sources:

1. Renewable energy generated on site that is not being used to satisfy other requirements of this code; or
2. Site-recovered energy that is not being used to satisfy other requirements of this code.

Exception: Compliance with this section is not required if all service water heating is accomplished by equipment complying with one or more of the combined input capacity-weighted average equipment rating for each service water heating fuel source type is not less than the following:

1. Electric Resistance: An ~~One or more e~~lectric resistance water heaters ~~water~~ with an input capacity weighted average rating of 105% of exceeding the rated average minimum efficiency of Table C404.2 by 105%.
2. Electric Heat Pump:
 - a. ~~(10 CFR Part 430): One or more A h~~Heat pump water heaters with rated input \leq 12 kW and rated in accordance with 10 CFR Part 430 ~~with an input capacity weighted average rating of 105% of the rated efficiency of Table C404.2.~~
 - b. Electric Heat Pump (not listed in accordance with 10 CFR Part 430): One or more A cCommercial heat pump water heaters not rated in accordance with 10 CFR Part 430 shall have a COP of not less than 2.0. For air source heat pump equipment the COP rating will be reported at the design leaving heat pump water temperature with an entering air temperature of 60°F (15.6°C) or less. Supplemental water heaters not meeting the above criteria that function as auxiliary heating only when the outdoor temperature is below 32°F (0°C) or when a defrost cycle is required are not required to have a rated COP of 2.0. Such systems shall be sized and configured to lock out electric resistance or fossil fuel heating from operation when the outdoor temperature is above 32°F (0°C) unless the system is in defrost operation.
- 2.3. Fossil Fuels: A ~~One or more f~~ossil fuel water heaters with an input capacity weighted rated E_t of not less than 99.2% as determined by the applicable test procedures in Table C404.2.
- 3.4. Hot water heat exchangers used to provide service water heating from a district utility (steam, heating hot water).

[Note to TAG: Revisions to additional section to eliminate the need to average <12kW UEF and > 12kW unrated tanks]

C404.2.1 High input-rated service water heating systems for other than Group R-1 and R-2 occupancies. In new buildings where the combined input rating of the water-heating equipment installed in a building is equal to or greater than 1,000,000 Btu/h (293 kW), the combined input capacity-weighted average efficiency of water-heating equipment shall be one or both of the following ~~no less than the following for each water heating fuel source:~~

1. Heat pump water heater, Electric: A rated COP of not less than 2.0. For air source heat pump equipment, the COP rating will be reported at the design leaving heat pump water temperature with an entering air temperature of 60°F (15.6°C) or less.
2. Fossil ~~f~~Fuel fired with a combined input-capacity-weighted average ; ~~A rated~~ E_t of not less than 92 percent as determined by the applicable test procedures in Table C404.2.

Exceptions:

1. Where not less than 25 percent of the annual service water-heating requirement is provided from any of the following sources:
 - 1.1. Renewable energy generated on site that is not being used to satisfy another requirement of this code; or
 - 1.2. Site recovered energy that is not being used to satisfy other requirements of this code.
2. Redundant equipment intended to only operate during equipment failure or periods of extended maintenance.
3. Electric resistance heated systems installed as part of an alteration where the water heating equipment is installed at the grade level in a building with a height of four stories or greater.
4. Hot water heat exchangers used to provide service water heating from a district utility (steam, heating hot water).
5. Water heaters provided as an integral part of equipment intended to only heat or boost the heat of water used by that equipment.
6. For electric heat-heat pump water heater systems, supplemental electric resistance and fossil fuel water heaters not meeting this criteria that function as auxiliary heating only when the outdoor temperature is below 32°F (0°C) or when a defrost cycle is required are not required to have a rated COP of 2.0. Such systems shall be sized and configured to lock out electric resistance or fossil fuel heating from operation when the outdoor temperature is above 32°F (0°C)

unless the system is in defrost operation.



Purpose of code change:

Change water heater efficiency table so that tank ratings are expressed in UEF rather than the out dated UEF. Table content source is 90.1-2019. Reformatted for the WSEC. Edited C404.2.2 to make consistent with the new table that combines electric resistance and heat pump storage tank water heaters into one category, clarify language and adjust exception 4 from 90% to 92% to be consistent with C404.2.1.

Your amendment must meet one of the following criteria. Select at least one:

- Addresses a critical life/safety need.
- The amendment clarifies the intent or application of the code.
- Addresses a specific state policy or statute. (Note that energy conservation is a state policy)
- Consistency with state or federal regulations.
- Addresses a unique character of the state.
- Corrects errors and omissions.

Check the building types that would be impacted by your code change:

- Single family/duplex/townhome
- Multi-family 4 + stories
- Institutional
- Multi-family 1 – 3 stories
- Commercial / Retail
- Industrial

Your name Mike Kennedy Email address mikekennedy@energysims.com

Your organization Mike Kennedy, Inc Phone number 3603010098

Other contact name [Click here to enter text.](#)

Economic Impact Data Sheet

Briefly summarize your proposal’s primary economic impacts and benefits to building owners, tenants and businesses.

No substantial change stringency from the WSEC 2018 is proposed except where national standards progressed.
The primary benefit will be code clarity.

Provide your best estimate of the construction cost (or cost savings) of your code change proposal? (See OFM Life Cycle Cost [Analysis tool](#) and [Instructions](#); use these [Inputs](#). **Webinars on the tool can be found [Here](#) and [Here](#)**)

Show calculations here, and list sources for costs/savings, or attach backup data pages

No cost calculation completed since stringency is the same as 90.1-2019

Provide your best estimate of the annual energy savings (or additional energy use) for your code change proposal?

Show calculations here, and list sources for energy savings estimates, or attach backup data pages

No cost calculation completed since stringency is the same as 90.1-2019

List any code enforcement time for additional plan review or inspections that your proposal will require, in hours per permit application:

Reduce enforcement time by regulating water heaters with available metric rather than outdated metric.

All questions must be answered to be considered complete. Incomplete proposals will not be accepted.