

Received from Scott Spielman, Ecotope, 8/22/20

Code Section # C404.2 Service water-heating equipment performance efficiency.

Brief Description:

Ease tank insulation requirements for High Temperature hot water storage for heat pump water heating systems. Exempts HPWH storage tanks from the additional insulation requirements for higher temps.

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.

TABLE C404.2

MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED ^{a, b}	TEST PROCEDURE
Water heaters, electric	≤ 12 kW ^d	Tabletop ^e , ≥20 gal and <120 gal	0.93 – 0.00132V, EF	DOE 10 CFR Part 430
		Resistance ≥20 gal and ≤55 gal	0.960 - 0.0003V, EF	
		Grid-enabled ^f >75 gal and ≤120 gal	1.06-0.00168V, EF	
	> 12 kW ^d	Resistance ≥20 gal	(0.3 + 27)/V _m %/h ^g	Section G.2 of ANSI Z21.10.3
	≤ 24 amps and ≤ 250 volts	Heat pump	2.057 – 0.00113V, EF	DOE 10 CFR Part 430
Instantaneous water heaters, electric	All	Resistance	0.93 - 0.00132V, EF	DOE 10 CFR Part 430

TABLE C404.2 (continued)

MINIMUM PERFORMANCE OF WATER-HEATING EQUIPMENT

EQUIPMENT TYPE	SIZE CATEGORY (input)	SUBCATEGORY OR RATING CONDITION	PERFORMANCE REQUIRED ^{a, b}	TEST PROCEDURE
Storage water heaters, gas	≤ 75,000 Btu/h	≥ 20 gal and ≤ 55 gal	0.675 - 0.0015V, EF	DOE 10 CFR Part 430
		>55 gal and ≤100 gal	0.8012 – 0.00078V, EF	
	> 75,000 Btu/h	< 4,000 Btu/h/gal	80% E_t (Q/800 + 110√V)SL, Btu/h	Section G.1 and G.2 of ANSI Z21.10.3
Instantaneous water heaters, gas	> 50,000 Btu/h and < 200,000 Btu/h	≥ 4,000 (Btu/h)/gal and < 2 gal	0.82 - 0.0019V, EF	DOE 10 CFR Part 430
	≥ 200,000 Btu/h ^c	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	Section G.1 and G.2 of ANSI Z21.10.3
	≥ 200,000 Btu/h	≥ 4,000 Btu/h/gal and ≥10 gal	80% E_t (Q/800 + 110√V)SL, Btu/h	
Storage water heaters, oil	≤ 105,000 Btu/h	≥20 gal	0.68 - 0.0019V, EF	DOE 10 CFR Part 430
	> 105,000 Btu/h	< 4,000 Btu/h/gal	80% E_t (Q/800 + 110√V)SL, Btu/h	Section G.1 and G.2 of ANSI Z21.10.3
Instantaneous water heaters, oil	≤ 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 2 gal	0.59 - 0.0019V, EF	DOE 10 CFR Part 430
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	Section G.1 and G.2 of ANSI Z21.10.3
	> 210,000 Btu/h	≥ 4,000 Btu/h/gal and ≥10 gal	78% E_t (Q/800 + 110√V)SL, Btu/h	
Hot water supply boilers, gas and oil	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and < 10 gal	80% E_t	Section G.1 and G.2 of ANSI Z21.10.3
Hot water supply boilers, gas	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥4,000 Btu/h/gal and ≥10 gal	80% E_t (Q/800 + 110√V)SL, Btu/h	
Hot water supply boilers, oil	≥ 300,000 Btu/h and < 12,500,000 Btu/h	≥ 4,000 Btu/h/gal and > 10 gal	78% E_t (Q/800 + 110√V)SL, Btu/h	
Pool heaters, gas and oil	All	—	82% E_t	ASHRAE 146
Heat pump pool heaters	All	—	4.0 COP	AHRI 1160
Unfired storage tanks ^h	All	—	Minimum insulation requirement R-12.5 (h x ft ² x °F)/Btu	(none)

For SI: °C = [(°F) - 32]/1.8, 1 British thermal unit per hour = 0.2931 W, 1 gallon = 3.785 L, 1 British thermal unit per hour per gallon = 0.078 W/L.

- a. Energy factor (EF) and thermal efficiency (E_t) are minimum requirements. In the EF equation, V is the rated volume in gallons.

- b. Standby loss (SL) is the maximum Btu/h based on a nominal 70°F temperature difference between stored water and ambient requirements. In the SL equation, Q is the nameplate input rate in Btu/h. In the SL equation for electric water heaters, V is the rated volume in gallons and V_m is the measured volume in gallons. In the SL equation for oil and gas water heaters and boilers, V is the rated volume in gallons.
- c. Instantaneous water heaters with input rates below 200,000 Btu/h must comply with these requirements if the water heater is designed to heat water to temperatures 180°F or higher.
- d. Electric water heaters with an input rating of 12kW (40,950 Btu/h) or less that are designed to heat water to temperatures of 180°F or greater shall comply with the requirements for electric water heaters that have an input rating greater than 12 kW.
- e. A tabletop water heater is a water heater that is enclosed in a rectangular cabinet with a flat top surface not more than three feet (0.91 m) in height.
- f. A grid-enabled water heater is an electric resistance water heater that meets all of the following:
 - 1. Has a rated storage tank volume of more than 75 gallons.
 - 2. Is manufactured on or after April 16, 2015.
 - 3. Is equipped at the point of manufacture with an activation lock.
 - 4. Bears a permanent label applied by the manufacturer that complies with all of the following:
 - 4.1 Is made of material not adversely affected by water.
 - 4.2 Is attached by means of non-water soluble adhesive.
 - 4.3 Advises purchasers and end-users of the intended and appropriate use of the product with the following notice printed in 16.5 point Arial Narrow Bold font: "IMPORTANT INFORMATION: This water heater is intended only for use as a part of an electric thermal storage or demand response program. It will not provide adequate hot water unless enrolled in such a program and activated by your utility company or another program operator. Confirm the availability of a program in your local area before purchasing or installing this product."
- g. %/h is the energy consumed to replace the heat lost from the tank while on standby, expressed as a percentage of the total energy in the stored water per hour.
- h. Unfired storage tanks used to store service hot water at temperatures above 130°F, except those used to store water for heat pump water heater systems, shall include a minimum of R-4 additional insulation for every 10°F increase in stored water temperature above 130°F.

Purpose of code change:

The proposed change exempts heat pump water heater systems from additional insulation requirements. When higher temperature water is created by a HPWH in the Primary Storage it can be used to offset heat loss that would otherwise be made up with electric resistance heating in the temperature maintenance tank. The higher efficiency of the HPWH saves more energy than is lost through the higher storage water tank temperature by introducing more energy directly into the swing tank with hotter water, and preventing the electric resistance swing tank element from turning on. See figure 1 for a HPWH system schematic.

In a 30-unit apartment building with 50 occupants a total hot water energy usage for this building with an electric resistance system would be about 300,000 kBtu. The recirculation load would be about 90,000 kBtu per year (about 30% of total hot water energy usage) with typical distribution losses of 100 watts per apartment. Assuming the storage tank is in a garage with an average temperature of 50°F, the heat loss from a tank with R-12.5 insulation at 150°F would be about 7,000 kBtu over the course of the year (7.7% of the total recirculation losses). Heat loss from the same storage tank with R-20.5 insulation would be about 4,300 kBtu, a saving of 2,700 kBtu per year. In the same location heat loss from a tank with R-12.5 insulation at 120°F would be about 5,000 kBtu (5.5% of the total recirculation losses).

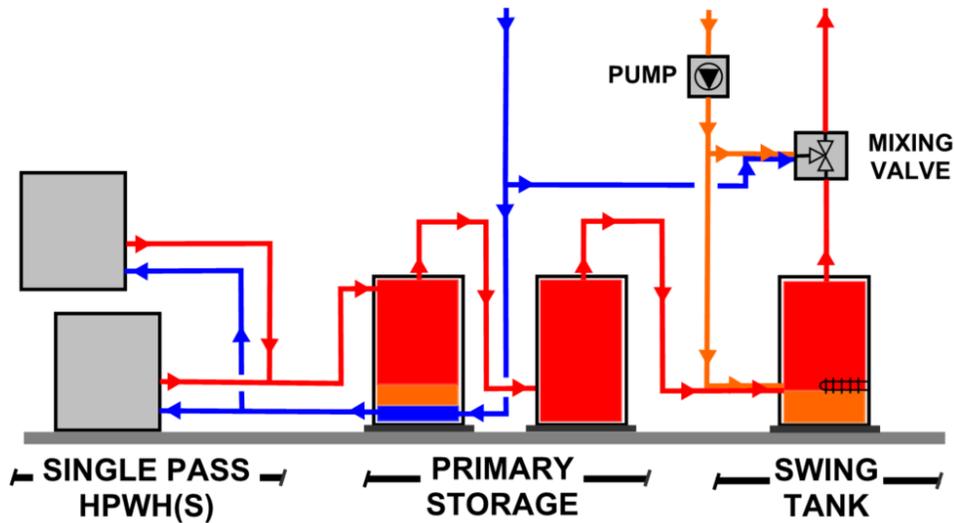


Figure 1. Swing Tank Schematic

Now consider a single-pass heat pump water heating system that offsets recirculation energy usage with high temperature thermal storage. The heat pump operates at a COP of 3 and analysis has shown that at 150°F hot water storage, ~50 watts per apartment of recirculation losses can be offset through heat pump heating instead of electric resistance heating. This means 45,000 kBtu of recirculation load will be heated at a COP of 3, which saves 30,000 kBtu of energy (a factor of 10 higher savings than the increased insulation).

This saving of 30,000 kBtu when using a HPWH more than compensates for reduced insulation, which would only save 2,700 kBtu per year. Additionally, the 30,000 kBtu savings is only recirculation loss savings and a total of 170,000 kBtu per year would be saved with the HPWH system when primary heating is included.

The added cost of extra insulation may hinder the adoption of heat pump water heater technologies. The proposed change will exempt HPWH systems from the additional insulation requirements making them a more attractive technology and saving energy overall.