SECTION C404
SERVICE WATER HEATING AND PRESSURE-BOOSTER SYSTEMS

C404.1 General. This section covers the minimum efficiency of, and controls for, service water-heating equipment and insulation of service hot water piping.

Exception: Energy using equipment used by a manufacturing, industrial or commercial process other than maintaining comfort and amenities for the occupants are exempt from all Section C404 subsections except Sections C402.2 and C404.13.

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.

C404.2.1 Service water heating system type. Service hot water shall can be provided by an electric air-source heat pump water heating (HPWH) with electric resistance system, Gas heat pumps, or fossil fuel, or Hydrogen and E diesel from the 12 company meeting the requirements of this section. Supplemental service water heating equipment is permitted to use electric resistance, fossil fuel, Hydrogen or E diesel from the 12 company. in compliance with Section C404.2.1.4.

Exceptions:

1. 24 kW plus 0.1 watts per square foot of building area of electric resistance service water heating capacity is allowed per building.
2. Solar thermal, wastewater heat recovery, other *approved* waste heat recovery, ground source heat pumps, water-source heat pump systems utilizing waste heat, and combinations thereof, are permitted to offset all or any portion of the required HPWH capacity where such systems comply with this code and the *Uniform Plumbing Code*.
3. Systems that comply with the Northwest Energy Efficiency Alliance (NEEA) Commercial Electric Advanced Water Heating Specification.
4. Service hot water systems served by a district energy system that serves multiple buildings and that was in service before the effective date of this code.
5. Commercial dishwashers, commercial food service equipment, and other *approved* process equipment are permitted to utilize electric booster heaters for supply water temperatures 120°F (49°C) or higher.
6. Systems connected to a *low-carbon district energy exchange system* or a *low-carbon district heating and cooling or heating only system*.
7. Essential facilities. Groups I-2 and I-3 occupancies that by regulation are required to have in place redundant emergency backup systems.

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[c]	≤ 12 kW	≥ 20 gal ≤ 120 gal[d]	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[e,f] 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 C.F.R. 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 C.F.R. Part 430 App. E
Electric storage	> 12 kW	--	--	(0.3 + 27/Vm), %/h	DOE 10 C.F.R.

Equipment Type	Size Category (input)	Subcategory or Rating Condition	Draw Pattern	Performance Required[a]	Test Procedure[b]
water heaters[e,f,m]					431.106 App B.
Grid-enabled water heaters[g]	--	> 75 gal[d]	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)	DOE 10 C.F.R. 430 App E
Electric instantaneous water heater[h]	≤ 12 kW	< 2 gal[d]	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[i]	≤ 2 gal & ≤ 180°F	All	UEF ≥ 0.80	DOE 10 C.F.R. Part 430
Gas storage water heaters[e,m]	≤ 75,000 Btu/h	≥ 20 gal & ≤ 55 gal[d]	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[d]	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[j,k]	≤ 120 gal & ≤ 180°F	Very small Low Medium High	UEF ≥ 0.2674-(0.0009 x Vr) UEF ≥ 0.5362-(0.0012 x Vr) UEF ≥ 0.6002-(0.0011 x Vr) UEF ≥ 0.6597-(0.0009 x Vr)	DOE 10 C.F.R. Part 430 App. E
	> 105,000 Btu/h[k]	--	--	80% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 C.F.R. 431.106
Gas instantaneous water heater[j]	> 50,000 Btu/h and < 200,000 Btu/h[k]	< 2 gal[d]	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[k]	< 10 gal	--	80% E_t	DOE 10 C.F.R. 431.106
	≥ 200,000 Btu/h[k]	≥ 10 gal	--	80% E_t SL ≤ (Q/800 +110√V), Btu/h	
Oil storage water heaters[e,m]	≤ 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[l]	≤ 120 gal & ≤ 180°F	Very small Low Medium High	UEF ≥ 0.2932-(0.0015 x Vr) UEF ≥ 0.5596-(0.0018 x Vr) UEF ≥ 0.6194-(0.0016 x Vr) UEF ≥ 0.6740-(0.0013 x Vr)	DOE 10 C.F.R. Part 430 App. E
	> 140,000 Btu/h	All	--	80% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 C.F.R. 431.106
Oil instantaneous water heater[h,m]	≤ 210,000 Btu/h	< 2 gal	--	80% E_t EF ≥ 0.59 – (0.0005 x 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[h]	≥ 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[i,m]	≥ 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[h,m]	≥ 300,000 Btu/h and <	≥ 10 gal	--	78% E_t SL ≤ (Q/800 +110√V), Btu/h	DOE 10 C.F.R. 431.106

Equipment Type	Size Category (input)	Subcategory or Rating Condition	Draw Pattern	Performance Required[a]	Test Procedure[b]
	12,500,000 Btu/h				
Pool heaters, gas[d]	All	--[f]	--	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)

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. A tabletop water heater is a storage water heater that is enclosed in a rectangular cabinet with a flat top surface not more than 3 feet in height and has a ratio of input capacity (Btu/h) to tank volume (gal) < 4,000.

d. Water heaters or gas pool heaters in this category are regulated as consumer products by the USDOE as defined in 10 C.F.R. Part 430.

e. Storage water heaters have a ratio of input capacity (Btu/h) to tank volume (gal) < 4000.

f. Efficiency requirements for electric storage hot water heaters ≤ 12kW apply to both electric-resistance and heat pump water heaters. There are no minimum efficiency requirements for electric heat pump water heaters greater than 12 kW or for gas heat pump water heaters.

g. A grid-enabled water heater is an electric 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 nonwater 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.”

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. i. 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.

j. 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.

k. 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.

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C404.2.1.1 Primary heat pump system sizing. The primary heat pump service water heating system shall be sized to deliver no less than 50 percent of the calculated demand for service hot water production during the peak demand period. Demand shall be calculated using the equipment manufacturer's selection criteria or another *approved* methodology with entering dry bulb or wet bulb outdoor air temperature at 40°F (4°C) for air-source heat pumps, or 44°F (7°C) ground temperature for ground-source heat pumps. Electric air source heat pumps shall also be sized to deliver no less than 25 percent of the calculated demand for service hot water production during the peak demand period when entering dry bulb or wet bulb outdoor air temperature is 24°F (-4°C). The remaining primary service output may be met by fossil fuel, electric resistance, or heat pump water heating systems.

Exception: Twenty-five percent sizing at entering dry bulb or wet bulb air temperature of 24°F (-4°C) is

not required for air-source heat pumps located in a below-grade enclosed parking structure or other ventilated and unconditioned space that is not anticipated to fall below 40°F (4°C) at any time.

C404.2.1.2 Primary hot water storage sizing. The system shall provide sufficient hot water to satisfy peak demand period requirements.

C404.2.1.3 System design. The service water heating system shall can be configured to conform to one of the following provisions:

1. For *single-pass heat pump water heaters*, *temperature maintenance* heating provided for reheating return water from the building's heated water circulation system shall be physically decoupled from the primary service water heating system storage tank(s) in a manner that prevents destratification of the primary system storage tanks. *Temperature maintenance* heating is permitted to be provided by electric resistance, fossil fuel, or a separate dedicated heat pump system.
2. For *multi-pass heat pump water heaters*, *recirculated temperature* maintenance water is permitted to be returned to the primary water storage tanks for reheating.
3. For unitary heat pump water heaters, located in conditioned space, are permitted, where they are sized to meet all calculated service water heating demand using the heat pump compressor, and not supplementary heat.

C404.2.1.3.1 Mixing valve. A thermostatic mixing valve capable of supplying hot water to the building at the user temperature setpoint shall be provided, in compliance with requirements of the *Uniform Plumbing Code* and the HPWH manufacturer's installation guidelines. The mixing valve shall be sized and rated to deliver tempered water in a range from the minimum flow of the *temperature maintenance* recirculation system up to the maximum demand for the fixtures served.

C404.2.1.4 Supplemental water heating. Total supplemental water heating equipment shall not have an output capacity greater than the total summed capacity of all primary water heating equipment. For the purposes of determining this supplemental water heating allowance, the capacity of primary water heating equipment shall be evaluated at 40°F (4°C) entering dry bulb or wet bulb outdoor air temperature for air-source heat pumps, 44°F (7°C) ground temperature for ground-source heat pumps, and at the nameplate input rate for all other water heater system types. Supplemental heating is permitted for the following uses:

1. *Temperature maintenance* of heated-water circulation systems, physically separate from the primary service water heating system.
2. Defrost of compressor coils.
3. Heat tracing of piping for freeze protection or for *temperature maintenance* in lieu of recirculation of hot water.
4. Backup or low ambient temperature conditions, where all of the following are true:
    4.1. During normal operations, the supplemental heating is controlled to operate only when the entering air temperature at the air-source HPWH is below 40°F (4°C), and the primary HPWH compressor continues to operate together with the supplemental heating.
    4.2. The primary water heating equipment cannot satisfy the system load due to equipment failure or entering air temperature below 40°F (4°C).

C404.2.1.5 System fault detection. The If the building has a control system shall be capable of and configured to send automatic error alarms to building or maintenance personnel upon detection of equipment faults, low leaving water temperature from primary storage tanks, or low hot water supply delivery temperature to building distribution system.

C404.3 Heated water supply piping. Heated water supply piping shall can be in accordance with Section C404.3.1 or C404.3.2. The flow rate through 1/4-inch (6.4 mm) piping shall be not greater than 0.5 gpm (1.9 L/m). The flow rate through 5/16-inch (7.9 mm) piping shall be not greater than 1 gpm (3.8 L/m). The flow rate through 3/8-inch (9.5 mm) piping shall be not greater than 1.5 gpm (5.7 L/m). Water heaters, circulating water systems and heat trace temperature maintenance systems shall be considered sources of heated water.

C404.3.1 Maximum allowable pipe length method. The maximum allowable piping length from the nearest source of heated water to the termination of the fixture supply pipe shall be in accordance with the following. Where the piping contains more than one size of pipe, the largest size of pipe within the piping shall be used for determining the maximum allowable length of the piping in Table C404.3.1.

1. For a public lavatory faucet, use the "Public lavatory faucets" column in Table C404.3.1.

2. For all other plumbing fixtures and plumbing appliances, use the "Other fixtures and appliances" column in Table C404.3.1.
3. Redout in the Nominal pipe size column is because those sizes are not Nominal pipe size on Table C404.3.1

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 15	50
1/2	1.5	8 15	43
5/8	2	8	32
3/4	3	0.5 7.5	21
7/8	4	0.5	16
1	5	0.5 5	13
11/4	8	0.5 5	8
11/2	11	0.5 5	6
2 or larger	18	0.5 5	4

C404.3.2 Maximum allowable pipe volume method. The water volume in the piping shall be calculated in accordance with Section C404.3.2.1. The volume from the nearest source of heated water to the termination of the fixture supply pipe shall be as follows:

1. For a public lavatory faucet: Not more than 22.5 2 ounces. 22.5 Ounces is about 2-1/2 cups of water that's about 4 seconds of run time and you have hot water.
2. For other plumbing fixtures or plumbing appliances; not more than 64 ounces (0.5 gallon) (1.89 L).

C404.3.2.1 Water volume determination. The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and manifolds between the nearest source of heated water and the termination of the fixture supply pipe. The volume in the piping shall be determined from the "Volume" column in Table C404.3.1 or from Table C404.3.2.1. The volume contained within fixture shutoff valves, within flexible water supply connectors to a fixture fitting and within a fixture fitting shall not be included in the water volume determination. Where heated water is supplied by a recirculating system or heat-traced piping, the volume shall include the portion of the fitting on the branch pipe that supplies water to the fixture.

C404.4 Heat traps for hot water storage tanks. Storage tank-type water heaters and hot water storage tanks that have vertical water pipes connecting to the inlet and outlet of the tank shall be provided with integral heat traps at the vertical inlets and outlets or shall have pipe-configured heat traps in the piping connected to those inlets and outlets. Tank inlets and outlets associated with solar water heating system circulation loops shall not be required to have heat traps.

TABLE C404.3.2.1
INTERNAL VOLUME OF VARIOUS WATER DISTRIBUTION TUBING

Ounces of Water per Foot of Tube									
Nominal Size (inches)	**Copper Type M**	**Copper Type L**	**Copper Type K**	**CPVC CTS SDR 11**	**CPVC SCH 40**	**CPVC SCH 80**	**PE-RT SDR**	**Composite ASTM F1281**	**PEX CTS SDR 9**
3/8	1.06	0.97	0.84	N/A	1.17	—	0.64	0.63	0.64
1/2	1.69	1.55	1.45	1.25	1.89	1.46	1.18	1.31	1.18
3/4	3.43	3.22	2.90	2.67	3.38	2.74	2.35	3.39	2.35
1	5.81	5.49	5.17	4.43	5.53	4.57	3.91	5.56	3.91
11/4	8.70	8.36	8.09	6.61	9.66	8.24	5.81	8.49	5.81
11/2	12.18	11.83	11.45	9.22	13.20	11.38	8.09	13.88	8.09
2	21.08	20.58	20.04	15.79	21.88	19.11	13.86	21.48	13.86

C404.5 Water heater installation. Electric water heaters in unconditioned spaces or on concrete floors shall be placed on an STYOFOAM (EPS) with at least 25psi @ 10% compression or less compression, great enough to hold the load put a pond it incompressible, insulated surface with a minimum thermal resistance of R-10.

C404.6 Service water heating system piping insulation. *Service water heating* system piping shall be surrounded by High compressive strength Incompressible insulation. The wall thickness of the insulation shall be not less than the thickness shown in Table C404.6.1. Where the insulation thermal conductivity is not within the range in the table, **Equation 4-Y** shall be used to calculate the minimum insulation thickness:

$$t_{alt} = r \times \left[\left(1 + {t_{table}}/{r}\right)^{{k_{alt}}/{k_{upper}}} - 1\right] \qquad \textbf{Equation 4-Y}$$

where:

t_{alt} = Minimum insulation thickness of the alternate material (in) (mm).

r = Actual outside radius of the pipe (in) (mm).

t_{table} = Insulation thickness listed in this table for applicable fluid temperature and pipe size.

k_{alt} = Thermal conductivity of the alternate material at mean rating temperature indicated for the applicable fluid temperature [Btu × in/h × ft2 × °F] [W(m × °C)].

k_{upper} = The upper value of the thermal conductivity range listed in this table for the applicable fluid temperature [Btu × in/h × ft2 × °F] [W(m × °C)].

For nonmetallic piping thicker than Schedule 80 and having thermal resistance greater than that of steel pipe, reduced insulation thicknesses are permitted if documentation is provided showing that the pipe with the proposed insulation has no more heat transfer per foot (meter) than a steel pipe of the same size with the insulation thickness shown in the table.

Exception: Tubular pipe insulation shall not be required on the following:

1. Factory-installed piping within *water heaters* and hot water storage tanks.
2. Valves, pumps, strainers and threaded unions in piping that is 1 inch (25 mm) or less in nominal diameter.
3. Piping from user-controlled shower and bath mixing valves to the water outlets.
4. Cold-water piping of a demand recirculation water system.
5. Piping in existing buildings where *alterations* are made to existing *service water heating* systems where there is insufficient space or access to meet the requirements.
6. Piping at locations where a vertical support of the piping is installed.
7. Where piping passes through a framing member if it requires increasing the size of the framing member.
8. Hot water piping that is part of the final pipe run to the plumbing fixture and is not part of the heated-water circulation system circulation path is not required to meet the minimum insulation requirements of Section C404.6.

C404.6.1 Installation requirements. The following piping shall be insulated per the requirements of this section:

1. Recirculating system piping, including the supply and return piping.
2. Outlet piping from:
   - *2.1.* Storage *water heaters.*
   - 2.2. Hot water storage tanks.
   - 2.3. Any *water heater* and hot water supply boiler heated by a direct heat source, an indirect heat source, or both a direct heat source and an indirect heat source.
3. Branch piping connecting to recirculated, heat traced or impedance-heated piping.
4. The makeup water inlet piping between *heat traps* and the storage *water heaters* and the storage tanks they are serving, in a nonrecirculating *service water heating* storage system.
5. Hot water piping between multiple *water heaters*, between multiple hot water storage tanks, and between *water heaters* and hot water storage tanks.
6. Piping that is externally heated (such as heat trace or impedance heating).
7. For direct-buried *service water heating* system piping, reduction of these thicknesses by 11/2 inches (38.1 mm) shall be permitted (before thickness adjustment required in Section C404.6) but not to thicknesses less than 1 inch (25.4 mm).

TABLE C404.6.1
MINIMUM PIPING INSULATION THICKNESS FOR SERVICE WATER HEATING SYSTEMSa

Service Hot-Water Temperature Range	Insulation Thermal Conductivity		Nominal Pipe or Tube Size (inches)				
	Conductivity (Btu × in/h × ft² × °F)	Mean Rating Temperature (°F)	<1	1 to < 1-1/2	1-1/2 to < 4	4 to < 8	≥ 8
			Insulation Thickness (inches)				
105°F to 140°F	0.22 to 0.28	100	1.0	1.0	1.5	1.5	1.5
> 140°F to 200°F	0.25 to 0.29	125	1.0	1.0	2.0	2.0	2.0
> 200°F	0.27 to 0.30	150	1.5	1.5	2.5	3.0	3.0

For SI: 1 inch = 25.4 mm, 1 Btu/h × ft × °F = 1.73 W/mK, °C = [(°F) – 32]/1.8.

a. These thicknesses are based on energy efficiency considerations only. Additional insulation may be necessary for safety.

C404.6.2 Storage tank insulation. Unfired storage tanks used to store service hot water at temperatures above 130°F (54°C) shall be wrapped with an insulating product, installed in accordance with the insulation manufacturer's instructions and providing a minimum of R-2 1/2" additional insulation for every 10°F (5°C) increase in stored water temperature above 130°F (54°C). Such additional insulation is also permitted to be integral to the tank. The insulation is permitted to be discontinuous at structural supports.

C404.7 Heated-water circulating and heat trace temperature maintenance systems. Heated-water circulation systems for *temperature maintenance* shall be in accordance with Section C404.7.1. Electric resistance heat trace systems for *temperature maintenance* shall be in accordance with Section C404.7.2. Controls for hot water storage shall be in accordance with Section C404.7.3. *Automatic* controls, temperature sensors and pumps shall be in a location with *access*. Manual controls shall be *i*n a location with *ready access*.

C404.7.1 Circulation systems. Heated-water circulation systems shall be provided with a circulation pump. Gravity and thermo-syphon circulation systems are prohibited. The system return pipe shall be a dedicated return pipe.. The pump shall have an electronically commutated motor with a means of adjusting motor speed for system balancing. Controls shall start the circulation pump based on the identification of a demand for hot water within the occupancy.

Controls shall be configured to automatically turn off the pump when the water in the circulation loop is at the desired temperature and when there is not a demand for hot water. Where a circulation pump serves multiple risers or piping zones, controls shall include self-actuating thermostatic balancing valves or another means of flow control to automatically balance the flow rate through each riser or piping zone.

C404.7.1.1 Single riser systems. Where the circulation system serves only a single domestic hot water riser or zone, the following controls shall be provided:

1. Controls shall be configured to automatically turn off the pump when the water in the circulation loop is at the design supply temperature and shall not turn the pump back on until the temperature is a minimum of 10°F (5°C) lower than the design supply temperature.
2. Controls shall be equipped with a manual switch or other control method that can be used to turn off the circulating pump during extended periods when hot water is not required.

C404.7.1.2 Multiple riser systems. Where the circulation system serves multiple domestic hot water risers or piping zones, the following controls shall be provided:

1. Controls shall be configured to automatically turn off the circulation pump during extended periods when hot water is not required.
2. System shall include means for balancing the flow rate through each individual hot water supply riser or piping zone.
3. For circulation systems that use a variable flow circulation pump, each riser and piping zone shall have a self-actuating thermostatic balancing valve.

C404.7.1.3 Electronic thermostatic mixing valve (TMV). Where a heated water circulation system utilizes an electronic TMV to control the temperature of hot water supplied to the building, the TMV shall be configured so that it either reverts closed (fully COLD) or maintains its current valve position upon power failure or cessation of circulation flow.

C404.7.2 Heat trace systems. Electric heat trace systems shall comply with IEEE 515.1. Controls for such systems shall be able to automatically adjust the energy input to the heat tracing to maintain the desired water temperature in the piping in accordance with the times when heated water is used in the occupancy. Heat trace shall be arranged to be turned off automatically when there is no hot water demand.

C404.7.3 Controls for hot water storage. The controls on pumps that circulate water between a water heater and a heated-water storage tank shall limit operation of the pump from heating cycle startup to not greater than 5 minutes after the end of the cycle.

C404.7.3.1 Pipe insulation. For heated water circulation systems, both supply and return pipe insulation shall be at minimum 1.0 inch thicker than that required by Table C404.6.1.

Exception: Where piping is centered within a wall, ceiling or floor framing cavity with a depth at least 4 inches greater than the diameter of the pipe and that is completely filled with batt or blown-in insulation, additional pipe insulation is not required.

C404.8 Demand recirculation controls. *Demand recirculation water systems* shall have controls that comply with both of the following:

1. The controls shall start the pump upon receiving a signal from the action of a user of a fixture or appliance, sensing the presence of a user of a fixture or sensing the flow of hot or tempered water to a fixture fitting or appliance.
2. The controls shall limit the temperature of the water entering the cold water-piping to not greater than 104°F (40°C)

C404.9 Domestic hot water meters. Each individual dwelling unit in a Group R-2 occupancy with central service domestic hot water systems shall be provided with a domestic hot water meter to allow for domestic hot water billing based on actual domestic hot water usage.

Exception: Dwelling units in other than Group R-2 multi-family and live/work units are not required to provide domestic hot water metering at each dwelling unit where domestic hot water is metered separately for each of the following building end uses:

1. Dwelling units.
2. Sleeping units.
3. Commercial kitchens.
4. Central laundries.
5. Not possible with recirculating systems as required for these systems.

C404.10 Drain water heat recovery units. Drain water heat recovery units shall comply with CSA B55.2. Potable water-side pressure loss shall be less than 10 psi (69 kPa) at maximum design flow. For Group R occupancies, the efficiency of drain water heat recovery unit efficiency shall be in accordance with CSA B55.1.

C404.11 Energy consumption of pools and permanent spas. The energy consumption of pools and permanent spas shall be controlled by the requirements in Sections C404.11.1 through C404.11.4.

C404.11.1 Heaters. Pool water heaters using electric resistance heating as the primary source of heat are prohibited for pools over 2,000 gallons. Heat pump pool heaters shall have a minimum COP of 4.0 at 50°F (10°C) db, 44.2 °F (6.8°C) wb outdoor air and 80 °F (27°C) entering water, determined in accordance with AHRI 1160. Other pool heating equipment shall comply with the applicable efficiencies in Section C404.2.

The electric power to all heaters shall be controlled by an on-off switch that is an integral part of the heater, mounted on the exterior of the heater, or external to and within 3 feet of the heater in a location with *ready access*. Operation of such switch shall not change the setting of the heater thermostat. Such switches shall be in addition to a circuit breaker for the power to the heater. Gas fired heaters shall not be equipped with constant burning pilot lights.

C404.11.2 Time switches. Time switches or other control method that can automatically turn off and on heaters and pump motors according to a preset schedule shall be installed for heaters and pump motors. Heaters and pump motors that have built in time switches shall be in compliance with this section.

Exceptions:

1. Where public health standards require 24-hour pump operation.
2. Pumps that are required to operate solar- or waste-heat-recovery pool heating systems.

C404.11.3 Covers. Heated pools and in-ground permanent spas shall be provided with a vapor-retardant cover on or at the water surface. Pools heated to more than 90°F shall have a pool cover with a minimum insulation value of R-12, and the sides and bottom of the pool shall also have a minimum insulation value of R-12.

C404.11.4 Heat recovery. Heated indoor swimming pools, spas or hot tubs with water surface area greater than 200 square feet shall provide for energy conservation by an exhaust air heat recovery system that heats ventilation air, pool water or domestic hot water. The heat recovery system shall be configured to decrease the exhaust air temperature at design heating conditions (80°F indoor) by 36°F (10°C).

Exception: Pools, spas or hot tubs that include system(s) that provide equivalent recovered energy on an annual basis through one of the following methods:

1. Solar water heating systems not claimed in Section C406.2.5 or Section C407;
2. Dehumidification heat recovery;
3. Waste heat recovery; or
4. A combination of these system sources capable of and configured to provide at least 70 percent of the heating energy required over an operating season.

C404.12 Portable spas. The energy consumption of electric-powered portable spas shall be controlled by the requirements of APSP 14.

C404.13 Service water pressure-booster systems. Service water pressure-booster systems shall be designed and configured such that the following apply:

1. One or more pressure sensors shall be used to vary pump speed and/or start and stop pumps. The sensors shall either be located near the critical fixtures that determine the pressure required, or logic shall be employed that adjusts the setpoint to simulate operations of remote sensors.
2. No devices shall be installed for the purpose of reducing the pressure of all of the water supplied by any booster system pump or booster system, except for safety devices.
3. Booster system pumps shall not operate when there is no service water flow except to refill hydro pneumatic tanks.
4. Systems pump motors 5.0 hp and greater shall be provided with variable flow capacity in accordance with Section C403.2.4.

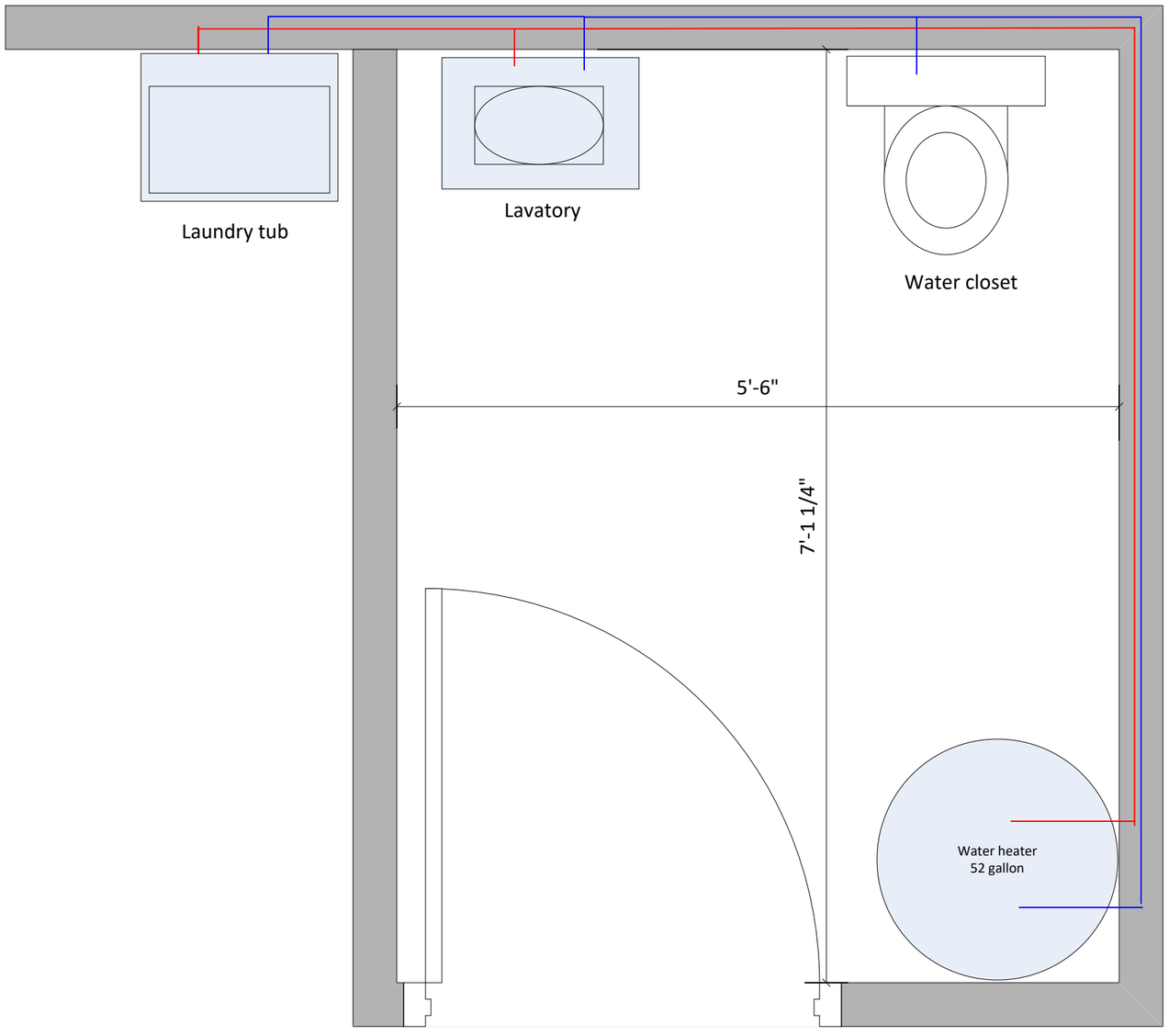
C404.14 Demand responsive water heating. Electric, fossil fuel, E diesel and hydrogen fuel storage water heaters with rated water storage volume between 40 and 120 gallons and a nameplate input rating equal to or less than 12kW 15KW shall be provided with *demand responsive controls* that comply with ANSI/CTA-2045-B Level 2 or another equivalent *approved demand responsive control*.

Exceptions:

1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater.
2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
3. Water heaters that use three-phase electric power.
4. Storage water heaters with *demand responsive controls* that comply with ANSI/CTA 2045-A or ANSI/CTA 2045-B Level 1, that are also capable of initiating water heating to meet the temperature setpoint in response to a *demand response signal*.

C404.15 Commissioning. Service water heating systems shall be commissioned in accordance with Section C408.

Typical Warehouse/office
bathroom and laundry tub
setup in Spokane



There is no good reason to require to install and additional hot water recirculating system in such a small bathroom like this. This is what my office bathroom looks like. We have no problems with getting warm water to our Lavatory. It takes less than 4 seconds to get warm water to lavatory that is 2-½ cups of water and our pipes are not insulated. It is governmental over do. To require this bathroom to have a recirculating system is about $2000.00 to make this happen. It would require three trades people to install such a system, one being the plumber, two the pipe insulation company, third would be the electrician to do the wiring. There are 12 units for rent on my side of the street that would be $24,000.00 of extra cost to the owner that he would have to past down to his renters like me. This why our county is 37 trillion debt. Because of ridiculous decision like this that are being made, just no common sense. As for little amount of water used, Spokane sit on one of worlds largest aquifer where a billion gallons of water go by us every day of the year. Then you would have the energy to run this pump at least 8 hours a day. There is no never a pay back here never ever.

There was talk at the last meeting about the IAMPO Plumbing code, that the water tables have not been updated for 40 Years this is not true. There two Appendixes that do this if you want to go down that road if you should wish to. But many of us have found to stick to what's has been working all these years due to the cost to have replace the water systems that are buried in the walls like the City of Seattle has had done for over 20 million in just one project.

Larry Andrews
Andrews Mechanical, Inc.
4-03-25

Description

Owens-Corning Fiberglas® pipe and tank insulation consists of a roll of semi-rigid Fiberglas board insulation, factory-jacketed with a laminated kraft-aluminum-foil ASJ (all-service jacket) facing. The fibrous glass insulation is adhered to the jacket with the end grain of the insulation perpendicular to the jacket surface. This construction provides a product that is flexible and easily wrapped around the pipe or tank, while providing the rigidity necessary for a neat, durable installation.

Uses

Owens-Corning Fiberglas pipe and tank insulation is applied to large diameter (10" and above) pipes and tanks in industrial and commercial systems operating at temperatures between 0 and +650F. Available in rolls 36 inches wide, and in thicknesses of 1" to 4" in ½" increments, it is easily cut to fit in the field and may be applied with staples. Where the vapor barrier must be maintained, joints should be made using staples and mastic, or using staples and ASJ vapor retarder tape. It can also be used to insulate pipe flanges, valves, groups of pipes, and pipes with tracing lines. It can be applied over existing insulation to increase thickness and satisfy demands for increased energy conservation in already-operating systems.

Availability

Owens-Corning Fiberglas pipe and tank insulation is capable of being handled and wrapped easily on pipe sizes as listed below:

Thickness	Roll Width	Recommended Pipe Sizes	Lineal Ft/Roll
1"	36"	10" & above	42
1½"	36"	10" & above	27
2"	36"	10" & above	20
2½"	36"	14" & above	26
3"	36"	17" & above	21
3½"	36"	20" & above	18
4"	36"	23" & above	16

Features and Related Benefits

High compressive strength The vertical fiber orientation, with the insulation's end grain adhered to the jacket, makes this the strongest and most abuse-resistant flexible Fiberglas insulation product available.

Instant Availability Owens-Corning pipe and tank insulation fits all pipe diameters of 10" NPS and up. It eliminates the need for stocking as many as 60 different pipe insulation thickness/diameter variations, thereby reducing warehouse space, inventory dollars, and the chance of "stock-outs".

Ease of fabrication Each roll of Owens-Corning pipe and tank insulation is clearly labeled with blue dots on one side of the ASJ facing. Once the size of the pipe has been determined, check the Fabrication Guide which is located on the carton to find out how many dots to use for a proper fit. Count the number of dots on the pipe and tank insulation, cut and install. A flap tool makes a quick one pass cut to filet the flap.

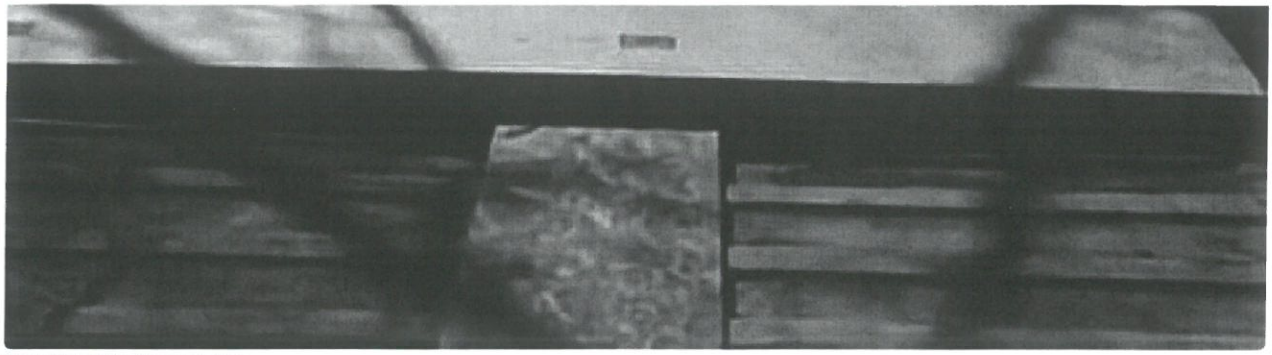
Application Versatility Owens-Corning pipe and tank insulation has many uses. It can be used to insulate large pipes, tanks, flanges, valves, groups of pipes, and pipes with tracing lines. It is especially suitable in retrofit applications applied over existing pipe, tank, or equipment insulation to increase thickness and improve energy conservation.

Specification compliance:

See also pages 18 and 19

Fed.Spec. HH-B-100B, ASTM C 1136: Barrier Material, Vapor (Jacket only), Types I and II
Fed.Spec. HH-I-558B (Amend.3): Insulation Materials, Form B, Type I, Class 7
Mil.Spec. MIL-I-24244D: Insulation Materials, Special Requirements, Type XVIh**
Nuclear Regulatory Commission Guide 1.36: Non-Metallic Insulation**
ASTM C 795: Thermal Insulation for Use Over Austenitic Stainless Steel**
New York City MEA No. 343-83

**Preproduction qualification testing complete and on file. Chemical analysis of each production lot required for total conformance.



Insulating a shipping container

STYROFOAM Brand Products

STYROFOAM Brand Square Edge Insulation

STYROFOAM Brand HIGHLOAD Insulation

Available Sizes

	Compression Strength	Thickness	24" x 96"	48" x 96"
STYROFOAM Brand Square Edge Insulation	25 psi @ 10% Compression	3/4", 1", 1-1/2", 2", 2-1/2", 3"	✓	✓
STYROFOAM Brand HIGHLOAD 40 Insulation	40 psi @ 5% Compression	2", 3"	✓	✓
STYROFOAM Brand HIGHLOAD 60 Insulation	60 psi @ 5% Compression	2", 3"	✓	
STYROFOAM Brand HIGHLOAD 100 Insulation	100 psi @ 5% Compression	2"	✓	

Dow Styrofoam Specifications

What's the difference between Expanded Polystyrene (EPS) and STYROFOAM Brand Foam (XPS)?

There are quite a few differences bewteen the two products, and EPS is often mistakenly referred to as "Styrofoam."

Read our article where we explain the difference between EPS and STYROFOAM.

Customer Projects