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INTRODUCTION

Chapter 5 Introduction

This chapter covers the requirements related to domestic hot water systems for all dwelling units and common use areas in multifamily buildings for newly constructed buildings and additions or alterations to existing buildings.

Guidance on general requirements is included in the Multifamily Compliance Manual Chapter 1: General Requirements. Guidance on administrative requirements is included in the Multifamily Compliance Manual Chapter 2: Compliance and Enforcement. This chapter includes guidance on water-heating system requirements.

Table 5-1: Excerpt From Table 100.0-A Application of Standards provides an overview of the location of the water-heating requirements that apply to multifamily occupancies in the Energy Code.

Table 5-1: Excerpt From Table 100.0-A Application of Standards

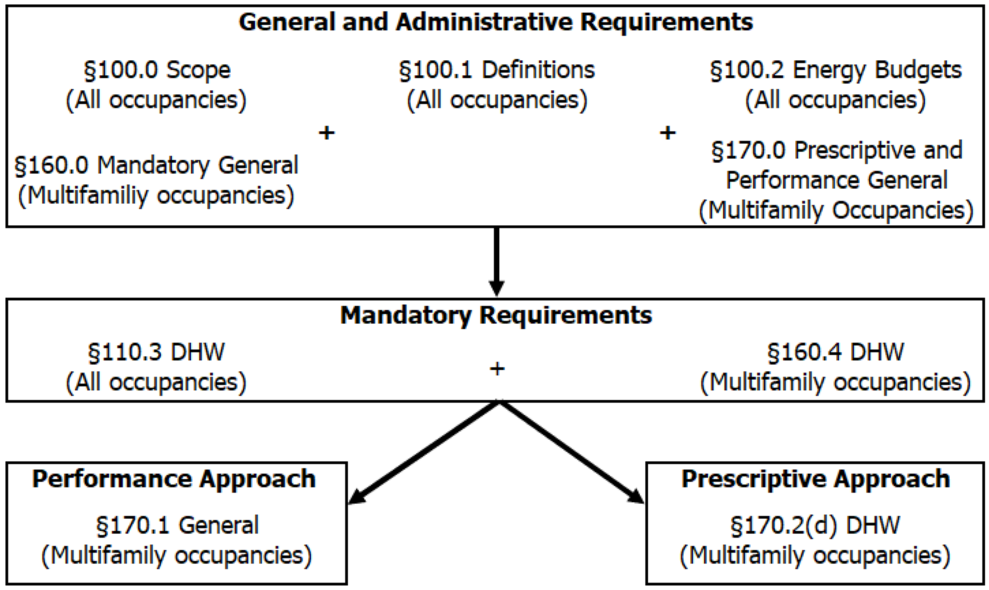
Application	Mandatory	Prescriptive	Performance	Additions/ Alterations
General[1]	160.0	170.0	170.0	180.0
Water-Heating	110.3, 160.4	170.2(d)	170.1	180.1, 180.2

1. Guidance on General Requirements from Sections 160.0, 170.0 and 180.0 are included in the Multifamily Compliance Manual Chapter 1 General Requirements. Guidance specific to multifamily water-heating is included in this chapter.

Source: California Energy Commission

Figure 5-1: Flowchart Guidance for Application of New Construction Multifamily Domestic Hot Water System Requirements and Figure 5-2: Flowchart Guidance for Application of Addition or Alteration Multifamily Domestic Hot Water System Requirements below illustrate the applicable sections for newly constructed buildings and additions or alterations to existing buildings.

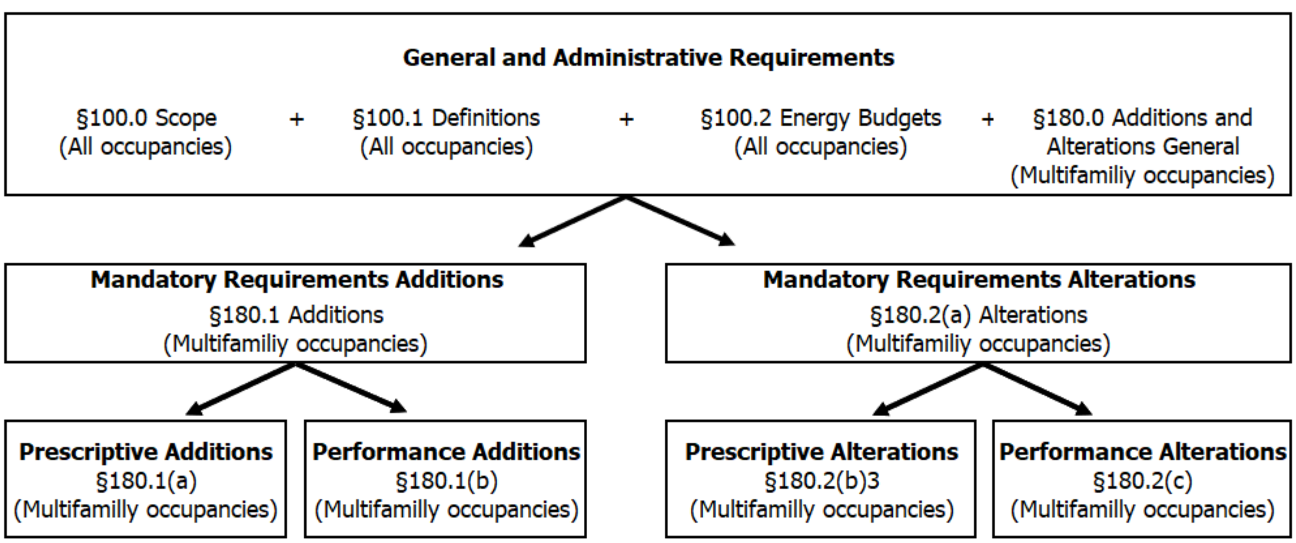
Figure 5-1: Flowchart Guidance for Application of New Construction Multifamily Domestic Hot Water System Requirements



Newly Constructed Buildings Compliance Approaches

Source: California Energy Commission

Figure 5-2: Flowchart Guidance for Application of Addition or Alteration Multifamily Domestic Hot Water System Requirements



Addition, Alteration Compliance Approaches

Source: California Energy Commission

SECTION 110.3 – MANDATORY REQUIREMENTS FOR SERVICE WATER-HEATING SYSTEMS AND EQUIPMENT

(a) Certification by manufacturers. Any service water- heating system or equipment may be installed only if the manufacturer has certified that the system or equipment complies with all of the requirements of this subsection for that system or equipment.

1. Temperature controls for service water-heating systems. Service water-heating systems shall be equipped with automatic temperature controls capable of adjustment from the lowest to the highest acceptable temperature settings for the intended use as listed in Table 3, Chapter 50 of the ASHRAE Handbook, HVAC Applications Volume or Table 613.1 of the California Plumbing Code for healthcare facilities.

   Exception to Section 110.3(a)1: Residential occupancies.

«» Commentary for Section 110.3(a)1:

Manufacturers must certify that their products comply with California's Title 20 Appliance Efficiency Regulations, Section 1605.1(f) at the time of manufacture. Regulated equipment must be listed in the California Energy Commission Appliance Efficiency Database. «»

(b) Efficiency. Equipment shall meet the applicable requirements of the Appliance Efficiency Regulations as required by Section 110.1, subject to the following:

1. If more than one standard is listed in the Appliance Efficiency Regulations, the equipment shall meet all the standards listed; and
2. If more than one test method is listed in the Appliance Efficiency Regulations, the equipment shall comply with the applicable standard when tested with each test method; and
3. Where equipment can serve more than one function, such as both heating and cooling, or both space heating and water heating, it shall comply with all the requirements applicable to each function; and
4. Where a requirement is for equipment rated at its "maximum rated capacity" or "minimum rated capacity," the capacity shall be as provided for and allowed by the controls, during steady-state operation.

«» Commentary for Section 110.3(b):

Water heaters are regulated under California's Title 20 Appliance Efficiency Regulations, Section 1605.1(f). These regulations align with the federal efficiency standards for water heaters. Consumer water heaters and residential-duty commercial water heaters are both rated in Uniform Energy Factor (UEF). The draw pattern is based on the water heater's design first hour rating for storage water heater or gallons per minute (GPM) for instantaneous water heaters. For commercial water heaters, unlike consumer water heaters, these water heaters are not rated in UEF. The required minimum energy efficiency for commercial water heaters is in terms of thermal efficiency and standby loss. «»

(c) Installation. Any service water-heating system or equipment may be installed only if the system or equipment complies with all of the applicable requirements of this subsection for the system or equipment.

1. **Outlet temperature controls.** On systems that have a total capacity greater than 167,000 Btu/hr, outlets that require higher than service water temperatures as listed in the ASHRAE Handbook, Applications Volume, shall have separate remote heaters, heat exchangers or boosters to supply the outlet with the higher temperature.

   Exception to Section 110.3(c)1: Systems covered by California Plumbing Code Section 613.0 shall instead follow the requirements of that section.

2. **Controls for hot water distribution systems.** Service hot water systems with circulating pumps or with electrical heat trace systems shall be capable of automatically turning off the system.

   Exception to Section 110.3(c)2: Systems serving healthcare facilities.

3. **Insulation.** Unfired service water heater storage tanks and backup tanks for solar water-heating systems shall have:

   A. External insulation with an installed R-value of at least R-3.5; or

   B. Internal and external insulation with a combined R-value of at least R-16; or

   C. The heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.

4. **Water heating recirculation loops serving multiple dwelling units, high-rise residential, hotel/motel, and nonresidential occupancies.** A water heating recirculation loop is a type of hot water distribution system that reduces the time needed to deliver hot water to fixtures that are distant from the water heater, boiler or other water heating equipment. The recirculation loop is comprised of a supply portion, connected to branches that serve multiple dwelling units, guest rooms, or fixtures and a return portion that completes the loop back to the water heating equipment. A water heating recirculation loop shall meet the following requirements:

   A. **Air release valve or vertical pump installation.** An automatic air release valve shall be installed on the recirculation loop piping on the inlet side of the recirculation pump and no more than 4 feet from the pump. This valve shall be mounted on top of a vertical riser at least 12 inches in length and shall be accessible for replacement and repair. Alternatively, the pump shall be installed on a vertical section of the return line.

«» Commentary for Section 110.3(c)4A:

The constant supply of new water in combination with the continuous operation of pumps creates the possibility of the pump cavitation because of the presence of air in the water. Cavitation is the formation of bubbles in the low-pressure liquid on the suction side of the pump. The cavities or bubbles will collapse when they pass into the higher regions of pressure, causing noise and vibration that may damage many components. In addition, there is a loss in capacity, and the pump can no longer build the same head (pressure). This reduction in pressure ultimately affects the efficiency and life expectancy of the pump. Cavitation must be minimized either by installing an air release valve or mounting the pump vertically. The air release valve must be located no more than 4 ft. from the inlet of the pump. The air release valve must also be mounted on a vertical riser with a length of at least 12 inches. See Figure 5-3: Mandatory Central Recirculation System Installation Requirements for illustration. **«»**

B. **Recirculation loop backflow prevention.** A check valve or similar device shall be located between the recirculation pump and the water heating equipment to prevent water from flowing backwards though the recirculation loop.

«» Commentary for Section 110.3(c)4B:

Temperature and pressure differences in the water throughout a recirculation system can create backflow. Backflow can result in cooler water from the bottom of the water heater tank and water near the end of the recirculation loop flowing backward toward the hot water load and reducing the delivered water temperature. To prevent this from occurring, the Energy Code requires that a check valve or similar device be located between the recirculation pump and the water-heating equipment. See Figure 5-3: Mandatory Central Recirculation System Installation Requirements for illustration. **«»**

C. **Equipment for pump priming.** A hose bibb shall be installed between the pump and the water heating equipment. An isolation valve shall be installed between the hose bibb and the water heating equipment. This hose bibb is used for bleeding air out of the pump after pump replacement.

D. **Pump isolation valves.** Isolation valves shall be installed on both sides of the pump. These valves may be part of the flange that attaches the pump to the pipe. One of the isolation valves may be the same isolation valve as in Item C.

«» Commentary for Section 110.3(c)4C and D:

Repair labor costs can be reduced significantly by planning and designing for pump replacement when the pump fails. Provision for pump priming and pump isolation valves helps reduce maintenance costs.

To meet the pump priming equipment requirement, a hose bib must be installed between the pump and the water heater. In addition, an isolation valve must be installed between the hose bib and the water-heating equipment. This configuration will allow the flow from the water heater to be shut off, allowing the hose bib to be used for bleeding air out of the pump after pump replacement.

The requirement for the pump isolation valves will allow replacement of the pump without draining a large portion of the system, saving water. The isolation valves must be installed on both sides of the pump. These valves may be part of the flange that attaches the pump to the pipe. One of the isolation valves may be the same isolation valve as for pump priming. See Figure 5-3: Mandatory Central Recirculation System Installation Requirements for illustration. **«»**

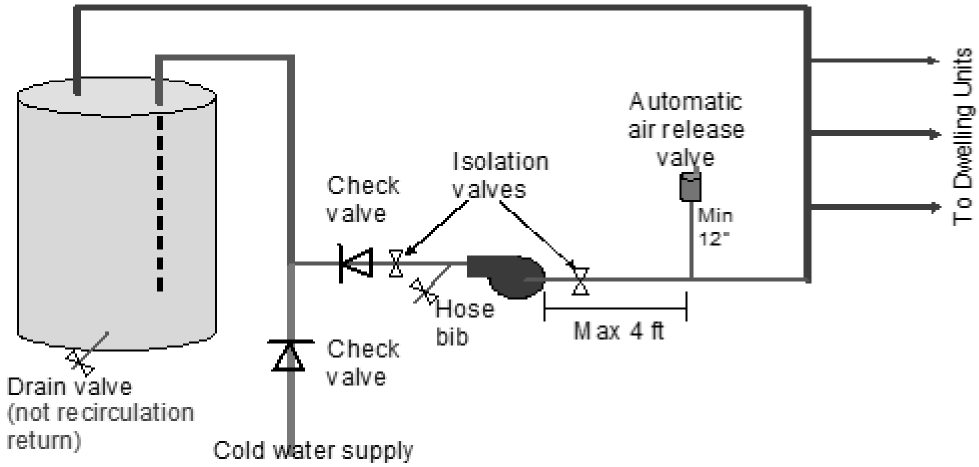
E. **Cold water supply and recirculation loop connection to hot water storage tank.** Storage water heaters and boilers shall be plumbed in accordance with the manufacturer’s specifications The cold water piping and the recirculation loop piping shall not be connected to the hot water storage tank drain port.

F. **Cold water supply backflow prevention.** A check valve shall be installed on the cold water supply line between the hot water system and the next closest tee on the cold water supply line. The system shall comply with the expansion tank requirements as described in the California Plumbing Code Section 608.3.

«» Commentary for Section 110.3(c)4E and F:

The dynamic between the water in the heater and the cold water supply are similar to those in the recirculation loop. Thermosiphoning can occur on this side of this loop, just as it does on the recirculation side of the system. To prevent this, the Energy Code requires a check valve to be installed on the cold water supply line. The valve should be located between the hot water system and the next closest tee on the cold water supply line. The system must comply with the expansion tank requirements as described in the California Plumbing Code.

Figure 5-3: Mandatory Central Recirculation System Installation Requirements



Source: California Energy Commission

«»

5. **Service water heaters in state buildings.** Any newly constructed building constructed by the State shall derive its service water heating from a system that provides at least 60 percent of the energy needed for service water heating from site solar energy or recovered energy, per the statutory requirement of California Public Resources Code Section 25498.

   Exception to Section 110.3(c)5: Buildings for which the state architect determines that service water heating from site solar energy or recovered energy is economically or physically infeasible.

6. **Isolation valves.** Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2 kW) shall have isolation valves on both the cold water supply and the hot water pipe leaving the water heater, and hose bibbs or other fittings on each valve for flushing the water heater when the valves are closed.

«» Commentary for Section 110.3(c)6:

All newly installed instantaneous water heaters (minimum input of 6.8 kBTU/hr) must have isolation valves on the incoming cold water supply and the hot water pipe leaving the water heater. Isolation valves assist in the flushing of the heat exchanger and help prolong the life of instantaneous water heaters. Instantaneous water heaters that have integrated drain ports for servicing are acceptable to meet the requirements of Section 110.3(c)6 and will not require additional isolation valves. «»

7. **Air-source** h**eat pump water heaters (HPWHs).** HPWH shall meet the following requirements:

   A. **Backup Heat.** Backup heat is required for systems when inlet air is unconditioned, unless the compressor cut-off temperature is below the Heating Winter Median of Extremes for the closest location listed in Table 2-3 from Reference Joint Appendix JA2. Backup heat may be internal or external to the HPWH.

«» Commentary for Section 110.3(c)7A:

Air-source Heat Pump Water Heaters (HPWHs) rely on the heat content of the surrounding air to produce high temperature refrigerant at the compressor outlet, which through a coil in the HPWH's storage volume generates hot water. System design and refrigerant type affect how low the ambient temperature can be while still extracting sufficient heat from the surrounding air. Below this minimum ambient temperature, the compressor is disabled, as it is no longer able to operate efficiently and begins to suffer rapid wear.

If the inlet air is unconditioned, there is a higher likelihood of the HPWH experiencing ambient temperature conditions below the compressor cutout temperature. If backup heat is not provided, then the HPWH will be unable to generate hot water.

In general, most R-134a based HPWH systems can only operate down to an ambient temperature of 40°F, while most R-744 (CO_2) based HPWH systems can operate down to temperatures below 0°F. For R-134a-based systems, the inclusion of backup heat is critical to provide adequate hot water. Most of California typically experiences winter temperatures below 40°F, and hot water demand is typically higher in the winter season.

However, if a HPWH is able to operate below the local Winter Median of Extremes, then the HPWH should be able to provide sufficient heat to generate hot water except in rare and brief extreme winter weather events. These systems therefore do not need backup heat.

If a HPWH does need backup heat, this backup heat can be external or internal to the HPWH system (such as the resistance heat elements built into the tank of consumer integrated HPWHs) and may use any permitted fuel (electric, natural gas, propane, etc.). **«»**

B. **Ventilation.** Consumer integrated HPWHs shall meet one of the ventilation requirements below. Minimum volume and opening size requirements shall be the sum of all HPWHs installed within the same space. Compressor capacity shall be determined using AHRI 540 Table 4 reference conditions for refrigeration with the "High" rating test point:

   ii. For HPWH installation without ducts, the installation space shall have a volume not less than the greater of 100 cubic feet per kBtu per hour of compressor capacity, or the minimum volume provided by the manufacturer for this method; or

iii. For HPWH installation without ducts, the installation space shall be vented to a communicating space via permanent openings, according to the following requirements:

a. Communicating space shall meet the minimum volume of Section 110.3(c)7B2 above, minus the volume of the HPWH installation space; and

b. Permanent openings shall consist of a single layer of fixed flat slat louvers or grilles, with a total minimum Net Free Area (NFA) the larger of 125 square inches plus 25 square inches per kBtu per hour of compressor capacity, or the minimum provided by the manufacturer for this method. The permanent openings shall be fully louvered doors or two openings of equal area, one in the upper half of the enclosure and one in the bottom half of the enclosure. The top of the upper opening must be 12 inches or less from the enclosure top and the bottom of the lower vent must be 12 inches or less from the enclosure bottom; or

iv. For HPWH installations with ducts, the following requirements shall be met:

a. The space joined to the installation space via ducts shall meet the minimum volume of Section 110.3(c)7B2 above, minus the volume of the HPWH installation space; and

b. All duct connections and building penetrations shall be sealed; and

c. Exhaust air ducts and all ducts which cross pressure boundaries shall be insulated to minimum of R-6; and

d. Where only the HPWH inlet or outlet is ducted, installation space shall include permanent openings that consist of a single layer of fixed flat slat louvers or grilles in the bottom half of the room, and/or a door undercut. With a ducted inlet, the minimum NFA shall be equal to the cross-sectional area of the duct. With a ducted exhaust, the minimum NFA shall be the larger of 20 square inches or the minimum NFA provided by the manufacturer for this method; and

e. Where the inlet and outlet ducts both terminate within the same pressure boundary, airflow from the termination points shall be diverted away from each other.

Note: Ducting only the inlet or the exhaust across the pressure boundary could interfere with balanced ventilation systems. This should be considered when specifying HPWH location and ventilation method.

«» Commentary for Section 110.3(c)7B:

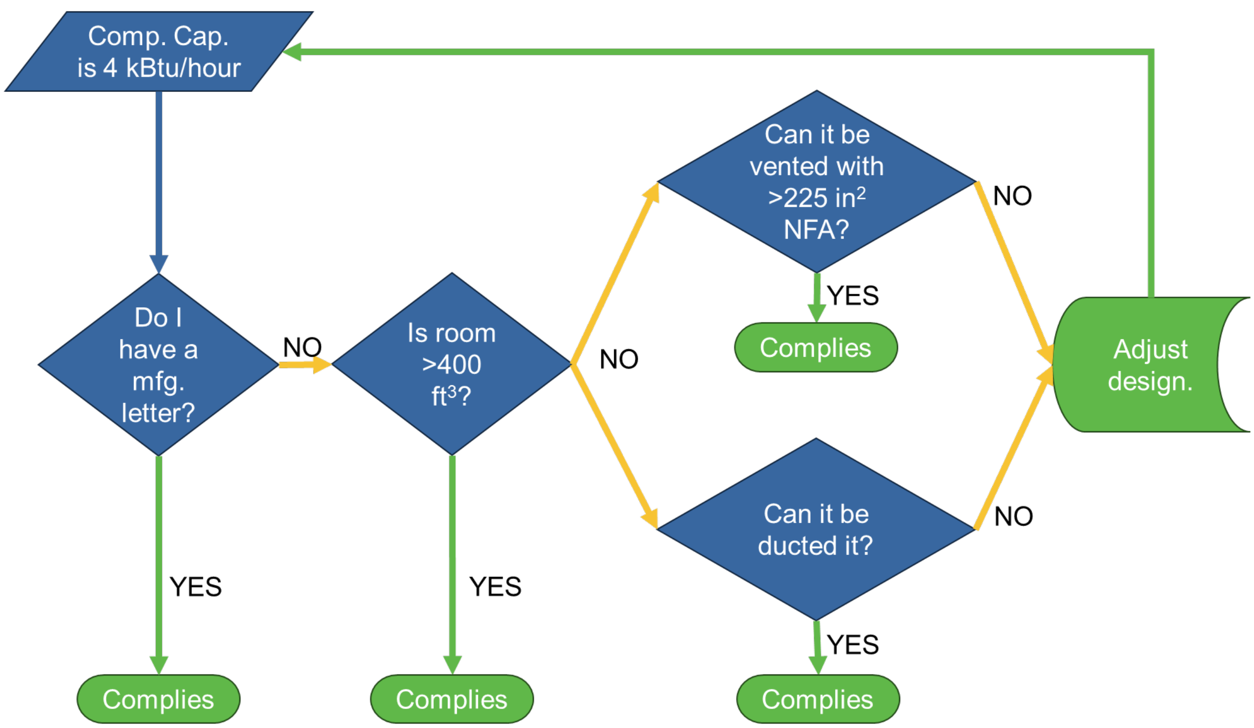
This section covers consumer-sized integrated air-source Heat Pump Water Heaters (referred to as "HPWHs" in this commentary). HPWHs rely on the heat content of the surrounding air to produce high temperature refrigerant at the compressor outlet, which through a coil in the HPWH's storage volume generates hot water. If the thermal resource of the air is not replenished through ventilation, the heat content and temperature of the ambient air will decrease until compressor cutout temperature is reached and the HPWH is unable to operate (see commentary for Section 110.3(c)7A).

Section 110.3(c)7B requires a minimum level of ventilation for HPWHs, regardless of building type and installation location. This can be provided in one of four ways:

1. Installation without ducts in a large room.
2. Installation without ducts in a smaller room that is vented.
3. Installation with ducts in any size room.
4. Installation using a method not covered above that is supported by the manufacturer.

Selection of ventilation method will depend on the building design and situation, but is up to the designer and installer. Below is a flow chart showing an example decision process with a HPWH with 4 kBtu/hour compressor capacity.

Figure 5-4: HPWH ventilation method selection process example, for a HPWH with a compressor capacity of 4 kBtu/hour.



Source: California Energy Commission

In this example, the process begins with checking whether the planned ventilation method is covered by code or is novel and must be certified by the manufacturer to the Energy Commission. It is highly recommended to include the certification documents with plan documents for reference by inspectors and in documentation provided to the building owner. If a certification is not required or obtained, then ventilation must be obtained by one of the other three covered methods. The simplest is the large room volume method. In this example, the minimum room volume would be 400 cubic feet. If 400 cubic feet is not available or not provided by the design, then either the 4 kBtu/hour HPWH's installation space must be vented with 225 square inches of net free area (NFA) or the HPWH must be ducted.

Ventilation grilles are affordable, can provide high NFA in small areas, and can be installed on doors and walls. Ducts can be very short and run through a closet wall, or even through the closet door. If none of these methods are feasible with the current equipment selection and design, then the design or equipment selection must be changed to comply with the requirements.

Requirements are the same for both interior and exterior installations, regardless of whether the HPWH uses conditioned or unconditioned inlet air, unless otherwise noted.

For all methods, if the manufacturer specifies a larger value for the same ventilation method, the manufacturer requirement becomes the minimum. For example, if installing a HPWH with a 4 kBtu/hour compressor, the minimum requirement for room volume with the large room method based on 100 cubic feet per kBtu/hour of compressor capacity is 400 cubic feet. However, if the manufacture installation manual specifies 700 cubic feet, the minimum requirement becomes 700 cubic feet.

As with all minimum requirements, the minimum values specified in Section 110.3(c)7B are minimums, and there are no specified maximums. More ventilation only improves HPWH performance. Designers and installers should consider providing increased ventilation, especially when there is very little cost difference, to the benefit of better customer satisfaction with the HPWH's performance.

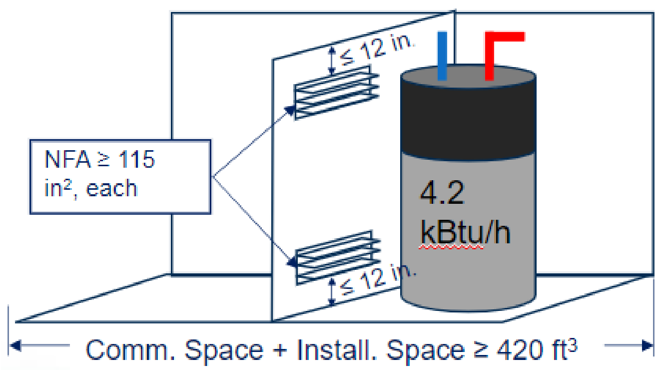
NFA is defined in Section 100.1(b) as the total open area in a vent through which air can freely flow. To calculate NFA for any vent with a series of equally sized louver gaps: (1) Measure the width of a louver gap and the thickness of the louver gap at the narrowest point. (2) Count the number of gaps. (3) Multiply the louver width by the louver thickness and by the number of gaps. The result is the NFA of the vent. For louvered closet doors, the area of the door undercut can be included in the total NFA for compliance. For example: A fully louvered door has 26 inch wide louvers. The gap between each louver is 3/16ths of an inch and there are 53 gaps. 26 x 0.1875 x 53 = 258.375 square inches. The door is also 30 inches wide and has a ¾ inch undercut. That undercut adds 22.5 square inches for a total NFA of 280.875 square inches. A closet with that door could accommodate a HPWH with a compressor capacity of 6.2 kBtu/hour.

When using the vented installation space or ducting methods, it is important to note that the communicating spaces joined to the installation space by the vents or ducts must be large enough that the combination of the installation space and the communicating space meet the minimum room volume requirements of Section 110.3(c)7B1.

When ducting HPWHs, care should be taken to consider the interactions with ventilation systems. For example, if a HPWH is installed inside the dwelling unit, but the exhaust is ducted and terminates outside the dwelling unit, the HPWH will negatively pressurize the dwelling unit whenever the HPWH is operating. This could result in increased infiltration from outside and adjacent dwelling units, and impact the operation of central and balanced ventilation systems. Ideally, HPWH air inlet and outlet termination points should be on the same side of the pressure boundary.

Figure 5-5: HPWH and Louvered Openings provides an example of a HPWH complying with Section 110.3(c)7B3.

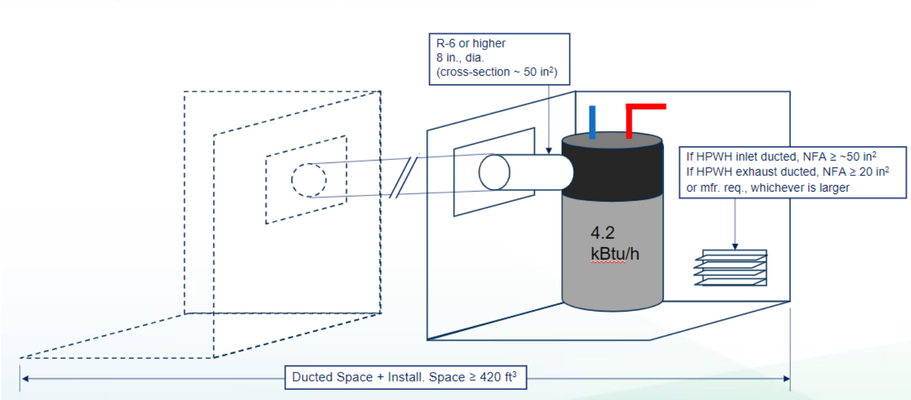
Figure 5-5: HPWH and Louvered Openings



Source: California Energy Commission

Figure 5-6: HPWH and Ducted Exhaust provides an example of a HPWH complying with Section 110.3(c)7B4.

Figure 5-6: HPWH and Ducted Exhaust



Source: California Energy Commission

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SECTION 160.4 – MANDATORY REQUIREMENTS FOR WATER HEATING SYSTEMS

(a) Water-heating recirculation loops serving multiple dwelling units shall meet the requirements of Section 110.3(c)4.

«» Commentary for Section 160.4(a):

A recirculation loop for multifamily buildings consists of a supply portion of larger diameter pipe connected to smaller diameter branches that serve multiple dwelling units, guest rooms, or common use area fixtures and a return portion that completes the loop back to the water-heating equipment. The large volume of water that is recirculated during high use periods creates situations that require the installation of certain controls and servicing mechanisms to optimize performance and allow for lower cost of maintenance and better energy performance. This section covers the mandatory requirements for system serving multiple dwelling units with recirculation loops. **«»**

(b) Solar water-heating systems and collectors shall be certified and rated by the Solar Rating and Certification Corporation (SRCC), the International Association of Plumbing and Mechanical Officials, Research and Testing (IAPMO R&T), or a listing agency that is approved by the Executive Director.

«» Commentary for Section 160.4(b):

For multifamily buildings, only systems with OG-100 collectors can be installed. For detailed instructions on installation of solar water heaters, refer to Reference Appendix RA4.4.20.

The database of Solar Rating and Certification Corporation (SRCC)-certified equipment is on the SRCC website at the following link: https://solar-rating.org/.

The database of IAPMO R&T-certified equipment is on the IAPMO R&T website at the following link: www.iapmort.org/Pages/SolarCertification.aspx. **«»**

(c) Instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2kW) shall meet the requirements of Section 110.3(c)6.

«» Commentary for Section 160.4(c):

All newly installed instantaneous water heaters (minimum input of 6.8 kBTU/hr) must have isolation valves on the incoming cold water supply and the hot water pipe leaving the water heater. Isolation valves assist in the flushing of the heat exchanger and help prolong the life of instantaneous water heaters. Instantaneous water heaters that have integrated drain ports for servicing are acceptable to meet the requirements of Section 110.3(c)6 and will not require additional isolation valves. **«»**

(d) Commercial boilers

1. Combustion air positive shut-off shall be provided on all newly installed boilers as follows:

   A. All boilers with an input capacity of 2.5 MMBtu/h (2,500,000 Btu/h) and above, in which the boiler is designed to operate with a nonpositive vent static pressure.

   B. All boilers where one stack serves two or more boilers with a total combined input capacity per stack of 2.5 MMBtu/h (2,500,000 Btu/h).

«» Commentary for Section 160.4(d)1:

Combustion air positive shutoff is a means of restricting air flow through a boiler combustion chamber during standby periods and is used to reduce standby heat loss. A flue damper and a vent damper are two examples of combustion air positive shut-off devices.

Installed dampers can be interlocked with the gas valve so that the damper closes and inhibits air flow through the heat transfer surfaces when the burner has cycled off, thus reducing standby losses. Natural draft boilers receive the most benefit from draft dampers because they have less resistance to airflow than forced draft boilers. Forced draft boilers rely on the driving force of the fan to push the combustion gases through an air path that has relatively higher resistance to flow than in a natural draft boiler. Positive shut off on a forced draft boiler is most important on systems with a tall stack height or multiple boiler systems sharing a common stack. **«»**

2. Boiler combustion air fans with motors 10 horsepower or larger shall meet one of the following for newly installed boilers:

   A. The fan motor shall be driven by a variable speed drive, or

   B. The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

«» Commentary for Section 160.4(d)2:

Electricity savings result from run time at part-load conditions. As the boiler firing rate decreases, the combustion air fan speed can be decreased. **«»**

3. Newly installed boilers with an input capacity 5 MMBtu/h (5,000,000 Btu/h) and greater shall maintain excess (stack-gas) oxygen concentrations at less than or equal to 5.0 percent by volume on a dry basis over firing rates of 20 percent to 100 percent. Combustion air volume shall be controlled with respect to firing rate or flue gas oxygen concentration. Use of a common gas and combustion air control linkage or jack shaft is prohibited.

   Exception to Section 160.4(d)3: Boilers with steady state full-load thermal combustion efficiency 90 percent or higher.

«» Commentary for Section 160.4(d)3:

One way to meet this requirement is with parallel position control. Boilers mix air with fuel (usually natural gas although sometimes diesel or oil) to supply oxygen during combustion. Stoichiometric combustion is the ideal air/fuel ratio where the mixing proportion is correct, the fuel is completely burned, and the oxygen is entirely consumed. Boilers operate most efficiently when the combustion air flow rate is slightly higher than the stoichiometric air-fuel ratio. However, common practice almost always relies on excess air to ensure complete combustion, avoid unburned fuel and potential explosion, and prevent soot and smoke in the exhaust. The drawbacks of excess air are increased stack heat loss and reduced combustion efficiency.

Parallel positioning controls optimize the combustion excess air based on the firing rate of the boiler to improve the combustion efficiency of the boiler, allowing the fuel supply valve and the combustion air damper to operate independently of each other. This system relies on preset fuel mapping (i.e. a pre-programmed combustion curve) to establish proper air damper positions (as a function of the fuel valve position) throughout the full range of burner fire rate.

Developing the combustion curve is a manual process. It is performed in the field with a flue-gas analyzer in the exhaust stack, determining the air damper positions as a function of the firing rate/fuel valve position. The combustion curve is developed at multiple points (firing rates), typically 10 to 25 points. Parallel positioning controls allow excess air to remain relatively low throughout the firing range of a burner. Maintaining low excess air levels at all firing rates provides significant fuel and cost savings while maintaining a safe margin of excess air to ensure complete combustion.

The other method of control of combustion air volume is by measuring the flue gas oxygen concentration to optimize combustion efficiency. This method of control is commonly called oxygen trim control. Oxygen trim control can also account for relative humidity of the combustion air. This control strategy relies on parallel positioning hardware and software as the basis but takes it a step further to allow operation closer to stoichiometric conditions. Oxygen trim control converts parallel positioning to a closed-loop control configuration with the addition of an exhaust gas analyzer and proportional-integral-derivative (PID) controller. This strategy continuously measures the oxygen content in the flue gas and adjusts the combustion air flow, thus continually tuning the air-fuel mixture. **«»**

(e) Pipe Insulation

All piping for multifamily domestic hot water systems shall be insulated and meet the applicable requirements 1 through 3 below:

1. **General Requirements.**

   A. The first 8 feet of inlet cold water piping from the storage tanks, including piping between a storage tank and a heat trap shall be insulated.

   B. Insulation on the piping and domestic hot water system appurtenances shall be continuous.

C. Pipe supports, hangers, and pipe clamps shall be attached on the outside of rigid pipe insulation to prevent thermal bridges.

D. All pipe insulation seams shall be sealed.

E. Insulation for pipe elbows shall be mitered, preformed, or site fabricated with PVC covers.

F. Insulation for tees shall be notched, preformed, or site fabricated with PVC covers.

G. Extended stem isolation valves shall be installed.

H. All plumbing appurtenances on hot water piping from a heating source to heating plant, at the heating plant, and distribution supply and return piping shall be insulated to meet the following requirements:

i. Where the outer diameter of the appurtenance is less than the outer diameter of the insulated pipe that it is attached to, the appurtenance shall be insulated flush with the insulation surrounding the pipe.

ii. Where the outer diameter of the appurtenance is greater than the outer diameter of the insulated pipe that it is attached to, the appurtenance shall be insulated with a minimum thickness of 1 inch.

iii. The insulation shall be removable and re-installable to ensure maintenance or replacement services can be completed.

iv. Valves shall be fully functional without impediment from the insulation.

«» Commentary for Section 160.4(e)1:

This section specifies the insulation requirements for piping in multifamily domestic hot water systems to ensure continuous insulation and minimize pipe heat losses as shown below. Proper insulation significantly reduces energy consumption at the heating plant and improves hot water delivery performance.

Figure 5-7: Continuous Pipe Insulation

Source: California Energy Commission, TRC Companies, Inc.

Previously, there was no explicit code language detailing the insulation requirements for various piping components such as valves, elbows, and tees. As a result, these components were often left uninsulated, leading to heat loss through convection to the surrounding air. The detailed requirements in this section address this issue by mandating that all parts of the piping system be insulated, including the first 8 feet of inlet cold water piping, and ensuring that insulation is continuous and sealed at all seams.

Additional measures include attaching pipe supports, hangers, and clamps on the outside of rigid pipe insulation to prevent direct metal (copper pipe) to metal (steel support/hanger) contact causing highly conductive heat flow paths known as thermal bridges as shown in Figure 5-8: Various types of hot water plumbing appurtenances. Also requiring that insulation for elbows and tees be mitered, preformed, or site-fabricated with PVC covers, the use of extended stem isolation valves and properly insulated plumbing appurtenances further enhance the system's thermal efficiency. These measures are essential for maintaining the integrity of the insulation and ensuring that the system operates efficiently.

Figure 5-8: Various types of hot water plumbing appurtenances

Source: California Energy Commission, TRC Companies, Inc.

It is important that the insulation be removable and re-installable to facilitate maintenance and replacement of valves and other piping components, and that valves (e.g. isolation valves, y strainers) remain fully functional without being impeded by the insulation. By following these requirements, installation and maintenance contractors can ensure that the hot water distribution system in multifamily buildings operates efficiently and with minimal energy loss over the life of the system.

A new definition for domestic hot water (DHW) appurtenances has been added to Section 100.1. DHW appurtenances include components such as valves, fittings, and other devices associated with the hot water piping system. Understanding this definition is critical for ensuring all relevant parts of the system are properly insulated according to the code requirements. Refer to section 100.1 for more detailed information. «»

2. **Insulation Thickness.** All piping for multifamily domestic hot water systems shall meet the insulation thickness requirements specified in Table 160.4-A.

   A. For insulation conductivity in the range shown in Table 160.4-A for the applicable fluid temperature range, the insulation shall have the applicable minimum thickness or R-value shown in Table 160.4-A.

   B. if the insulation conductivity falls outside the range provided in Table 160.4-A applicable fluid temperature range, the insulation shall meet a minimum R-value as indicated in Table 160.4-A. Or, it can have a thickness determined using Equation 160.4-A"

$$T = PR\left[\left(1+\frac{t}{PR}\right)^{\frac{K}{k}} - 1\right]$$

(Equation 160.4-A)

WHERE:

T = Minimum insulation thickness for material with conductivity K, inches.

PR = Pipe actual outside radius, inches.

t = Insulation thickness from TABLE 160.4-A, inches.

K = Conductivity of alternate material at the mean rating temperature indicated in TABLE 160.4-A for the applicable fluid temperature range, in Btu-inch per hour per square foot per °F.

k = The lower value of the conductivity range listed in TABLE 160.4-A for the applicable fluid temperature range, Btu-inch per hour per square foot per °F.

   C. Insulation conductivity shall be determined in accordance with ASTM C335 at the mean temperature listed in Table 160.4-A, and shall be rounded to the nearest 1/100 Btu-inch per hour per square foot per °F.

Exception 1 to Section 160.4(e): Piping that penetrates framing members shall not be required to have pipe insulation for the distance of the framing penetration. Piping that penetrates metal framing shall use grommets, plugs, wrapping or other insulating material to ensure that no contact is made with the metal framing. Insulation shall abut securely against all framing members.

Exception 2 to Section 160.4(e): Piping installed in interior or exterior walls shall not be required to have pipe insulation if all of the requirements are met for compliance with quality insulation installation (QII) as specified in Reference Residential Appendix RA3.5.

Exception 3 to Section 160.4(e): Piping surrounded with a minimum of 1 inch of wall insulation, 2 inches of crawl space insulation or 4 inches of attic insulation shall not be required to have pipe insulation.

TABLE 160.4-A PIPE INSULATION THICKNESS – Multifamily Domestic Hot Water Systems

Fluid Operating Temperature Range (°F)	Insulation Conductivity (Btu·in/h·ft² °F)	Insulation Conductivity Mean Rating Temp. (°F)	Nominal Pipe Diameter (in inches) < 1	Nominal Pipe Diameter (in inches) 1 to <1.5	Nominal Pipe Diameter (in inches) 1.5 to < 4	Nominal Pipe Diameter (in inches) 4 to < 8	Nominal Pipe Diameter (in inches) 8 and larger
105-140[1]	0.22-0.28	100	1.0 (R 7.7)	1.5 (R 12.5)	2.0 (R 16)	2.0 (R 12.5)	2.0 (R 11)

Footnote to TABLE 160.4-A:

1. Multifamily and hotel/motel domestic hot water systems with water temperature above 140°F shall use the row in table 120.3-A for the applicable water temperature.

«» Commentary for Section 160.4(e)2:

Most piping conveying mechanically heated or chilled fluids for space conditioning or water-heating must be insulated. The required thickness of piping insulation depends on the temperature of the fluid passing through the pipe, the pipe diameter, the function of the pipe within the system, and the thermal conductivity of the insulation. Table 160.4-A specifies the requirements in terms of inches of insulation with conductivity within a specific range. These conductivities are typical for fiberglass or foam pipe insulation. «»

3. **Insulation Protection.** Pipe Insulation shall be protected from damage due to sunlight, moisture, equipment maintenance and wind. Protection shall, at minimum, include the following:

   A. Pipe and appurtenance insulation exposed to weather shall be protected by a cover suitable for outdoor service. The cover shall be water retardant and provide shielding from solar radiation that can cause degradation of the material. Appurtenance insulation covers shall be removable and able to be reinstalled. Adhesive tape shall not be used to provide this protection.

   B. Pipe insulation covering chilled water piping and refrigerant suction piping located outside the conditioned space shall include, or be protected by, a Class I or Class II vapor retarder. All penetrations and joints shall be sealed.

   C. Pipe insulation buried below grade must be installed in a waterproof and noncrushable casing or sleeve.

«» Commentary for Section 160.4(e)3:

All piping insulation is required to be protected from damage from environmental elements. If hot water piping insulation is exposed to weather, it must be protected from physical damage, ultraviolet light deterioration, and moisture. Insulation is typically protected by aluminum, sheet metal, painted canvas, plastic cover, or a water-retardant coating that shields from solar radiation. Adhesive tape should not be used as insulation cover because removal of the tape will damage the integrity of the original insulation during preventive maintenance.

All DHW pipes that are buried below grade must be installed in a waterproof and non-crushable casing or sleeve. «»

NOTE: Authority: Sections 25213, 25218, 25218.5, 25402 and 25402.1, Public Resources Code. Reference: Sections 25007, 25008, 25218.5, 25310, 25402, 25402.1, 25402.4, 25402.5, 25402.8 and 25943, Public Resources Code.

SECTION 170.1 – PERFORMANCE APPROACH

A building complies with the performance approach if the energy consumption calculated for the proposed design building is no greater than the energy budget calculated for the standard design building using Commission-certified compliance software as specified by Sections 10-109, 10-116 and the Alternative Calculation Method Reference Manual.

(a) Energy budget. The Energy budget is expressed in terms of long-term system cost (LSC) and source energy:

1. **Long-term system cost (LSC).** The LSC energy budget is determined by applying the mandatory and prescriptive requirements of the standard design to the proposed design building and has two components, the Efficiency LSC and the Total LSC.
   A. The Efficiency LSC energy is the sum of the LSC energy for space-conditioning, water heating, mechanical ventilation, lighting and the self-utilization credit.
   B. The Total LSC energy is the sum of the Efficiency LSC energy and LSC energy from the photovoltaic system, battery energy storage systems (BESS), and demand flexibility.
2. **Source energy.** The source energy budget is determined by applying the mandatory and prescriptive requirements of the standard design, except with a consumer gas or propane water heater, to the proposed design building.

«» Commentary for Section 170.1(a):

The standard design system for the performance approach are described in the *2025 Nonresidential and Multifamily Alternative Calculation Method Reference Manual*.

Systems designed with other options are allowed, and some of them are subject to HERS field verification.

Joint Appendix 14 Qualification Requirements for Central Heat Pump Water Heater Systems sets the requirements for central HPWH systems in multifamily buildings using the performance approach.

JA 14.3 requires that central HPWH equipment shall be certified by the Energy Commission, which includes submitting required performance data to the Commission. The process of data submission can be found on the Energy Commission website, https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment.

Each basic model that is claimed on the performance certificate of compliance must be certified. Manufacturers must determine performance data for each basic model, which means all units of a given type of product manufactured by one manufacturer, have the same primary energy sources, and have essentially identical electrical, physical, and functional (hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency. JA 14.3 further details the acceptable methods to determine performance data and the data reporting requirement:

1. When simulation is used, an alternative efficiency determination method (AEDM) as described in 10 CFR part 429.70(a)-(c) must be used to generate performance data required in JA 14.3.2.
2. When lab testing is used, testing must be conducted as described in Appendix E to Subpart G of 10 CFR Part 431 for each of the test conditions described in JA14.3.3.

JA 14.4 design condition documentation requirements are applicable for central HPWH designs using prescriptive and performance approach.

When the proposed DHW system is a central DHW system that uses electricity as the primary fuel source, the standard design is a central HPWH system that is based on the prescriptive requirement of a central HPWH in Section 170.2(d)2. The standard design central HPWH system has a recirculation system with single-pass compressors with primary storage tank that is decoupled from the recirculation loop storage tank.

For Central HPWH design, refer to the 2025 Nonresidential and Multifamily Alternative Calculation Method Reference Manual.

JA 13 provides qualification requirements for HPWH demand management systems. Qualifying HPWHs can optimize operation to reduce normal water heater operation during on-peak periods by biasing operation before the peak period. Future opportunities include overheating the storage tank above setpoint before the peak period, thus improving the electrical load profile of these systems. The compliance software includes a credit for this type of HPWH. JA13-certified HPWHs, which must have a mixing valve installed to prevent any scalding risks, are listed on the Energy Commission's website, https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment/ja13.

For water-heating systems serving individual dwelling units, any type or number of water heaters supported by the software can be installed, but the standard design is a single HPWH. The calculated energy use of the proposed design is compared to the standard design energy budget, based on either a single gas instantaneous water heater for gas water heaters with a standard distribution system or a HPWH with compact distribution system and DWHR, where applicable. Individual gas or propane water heaters must also meet the electric-ready requirements of section 160.9(e).

The compliance software does not include a hot water recirculation pump for the standard distribution system serving a single dwelling unit and does not allow credit for any additional DHW design features.

Alternative distribution systems are compared to the standard design by using distribution system multipliers, which effectively rate alternative options. Table 5-2: Applicability of Distribution Systems Options lists all the recognized distribution systems that can be used in the performance approach with the assigned distribution multiplier. The standard distribution system has a multiplier of 1.0. Distribution systems with a multiplier less than 1.0 represent an energy credit, while distribution systems with a multiplier greater than 1.0 are an energy penalty. For example, pipe insulation with HERS inspection required (PIC-H) has a multiplier of 0.8. That means that it is modeled at 20 percent less distribution loss than the standard distribution system.

Table 5-2: Applicability of Distribution Systems Options

Distribution System Types	Assigned Distribution System Multiplier	Systems Serving a Single Dwelling Unit	Central Recirculation Systems Serving Multiple Dwelling Units
No HERS Inspection Required			
Trunk and Branch -Standard (STD)	1.0	Yes	Yes
Parallel Piping (PP)	1.1	Yes	
Point of Use (POU)	0.3	Yes	
Recirculation: Nondemand Control Options (R-ND)	9.8	Yes	
Recirculation with Manual Demand Control (R-Dmn)	1.75	Yes	
Recirculation with Motion Sensor Demand Control (R-DAuto)	2.6	Yes	
HERS Inspection Required			
Pipe Insulation (PIC-H)	0.85	Yes	Yes
Parallel Piping with 5’ maximum length (PP-H)	1	Yes	
Recirculation with Manual Demand Control (R-DRmc-H)	1.6	Yes	
Recirculation with Sensor Demand Control (RDRsc-H)	2.4	Yes	

Source: California Energy Commission

Solar water-heating systems with a solar fraction higher than the specified prescriptive minimum can be used as a tradeoff under the performance approach. Users now input collector and system component specifications to calculate a corresponding solar fraction for the proposed system.

Buildings with uncontrolled recirculation systems will need other efficiency features to offset the less efficient method.

Dual-loop recirculation systems are a performance option. In a dual loop recirculation system, each recirculation branch loop serves roughly half of the dwelling units. Pipe diameters can be downsized in a dual-loop system compared to a single-loop system serving all dwelling units while still following California Plumbing Code requirements. The total pipe surface area is effectively reduced with smaller distribution pipe diameters, even though total pipe length remains similar to that of a single-loop system.

For example, for simple building footprints, locating the water-heating equipment at the center of the building footprint rather than at one end of the building helps minimize the pipe length. If a water-heating system serves several building sections, the water-heating equipment would preferably nest between these sections. **«»**

(b) Compliance demonstration requirements for performance standards.

1. Certificate of Compliance and Application for a Building Permit. The application for a building permit shall include documentation pursuant to Sections 10-103(a)1 and 10-103(a)2 that demonstrates, using an approved calculation method, that the building has been designed so that its source energy and LSC energy consumption do not exceed the standard design energy budgets for the applicable climate zone.
2. Field verification of individual dwelling unit systems. When performance of installed features, materials, components, manufactured devices or systems above the minimum specified in Section 170.2 is necessary for the building to comply with Section 170.1, or is necessary to achieve a more stringent local ordinance, field verification shall be performed in accordance with the applicable requirements in the following subsections, and the results of the verification(s) shall be documented on applicable Certificates of Installation pursuant to Section 10-103(a)3 and applicable Certificates of Verification pursuant to Section 10-103(a)5.

    D. Thermal Balancing Valve. When performance compliance requires installation of thermal balancing valves with variable speed circulation pump(s), the installation shall meet the procedures specified in Reference Residential Appendix RA4.4.3.

«» Commentary for Section 170.1(b)1.D:

RA4.4.3 provides qualification requirements for thermostatic balancing valves (TBV) installed in multi-riser systems. Qualifying multi-riser hot water distribution systems benefit from a performance credit and also benefit from lower first costs and better hot water delivery performance than systems with manual balancing valves, which are often not balanced at all or poorly balanced. Poorly balanced multi-riser systems are less efficient than well balanced systems, while un-balanced multi-riser systems suffer from additional problems with hot water system performance due to significant variance of temperatures within the distribution system which cause complaints, health and safety risks.

A key qualification requirement is that the total length of each section of return piping cannot exceed 160 feet. This qualification requirement is related to the construction of certain TBV which cannot close fully and have high minimum flow values. The valve flow coefficient (Cv) characterizes this aspect of the valve performance and relates valve pressure drop to flow rate. Several product manufacturers report minimum and maximum Cv values for their valves. Although the code language does not limit qualifying TBV products based on their Cv values, designers should consider these reported Cv values when selecting TBV.

The qualification requirements also specify a circulator pump control method and hot water system startup procedure that is required to claim the performance credit. The control method and procedures are required to ensure that the actual temperatures achieved by the thermostatic balancing valves do not exceed 120 °F as verified at the last riser, resulting in energy savings. «»

SECTION 170.2 – PRESCRIPTIVE APPROACH

Multifamily buildings, including both dwelling units and common use areas, that comply with the prescriptive standards shall be designed, constructed and equipped to meet all of the requirements for the appropriate climate zone shown in Table 170.2-A. In Table 170.2-A, NA (not allowed) means that feature is not permitted in a particular climate zone and NR (no requirement) means that there is no prescriptive requirement for that feature in a particular climate zone. Installed components shall meet the following requirements:

TABLE 170.2-K MECHANICAL COMPONENT PACKAGE – Multifamily Standard Building Design

Component	**CZ 1**	**CZ 2**	**CZ 3**	**CZ 4**	**CZ 5**	**CZ 6**	**CZ 7**	**CZ 8**	**CZ 9**	**CZ 10**	**CZ 11**	**CZ 12**	**CZ 13**	**CZ 14**	**CZ 15**	**CZ 16**
Water Heating - All Buildings System Shall meet Section 170.2(d)	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ

(d) Domestic Hot Water Systems Water-heating systems shall meet the applicable requirements of 1 or 2 below:

1. **Individual Systems.** For systems serving individual dwelling units, the water-heating system shall meet the requirement of either A, or B, or shall meet the performance compliance requirements of Section 170.1. For recirculation distribution systems serving individual dwelling units, only demand recirculation systems with manual on/off control as specified in the Reference Appendix RA4.4.9 shall be used.

«» Commentary for Section 170.2(d)1:

Installation of a demand recirculation control to minimize pump operation and heat loss from pipes is a prescriptive requirement when a recirculation distribution system is used to serve individual dwelling units. This requirement is applicable regardless of fuel source.

A demand-control recirculation system uses brief pump operation in response to a hot water demand signal (manual push button) to circulate hot water through the recirculation loop. The system must have a temperature sensor to turn off the pump when the sensed temperature rises. This sensor is typically located at the most remote point of the recirculation loop, but some water heaters have internal temperature sensors. «»

A. A single 240 volt heat pump water heater. In addition, meet the following:

i. A compact hot water distribution system as specified in Reference Appendix RA4.4.6 in climate zones 1 and 16; and

ii. A drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9 in Climate Zone 16.

«» Commentary for Section 170.2(d)1A:

There are several types of water heaters for multifamily buildings, as described below. The most common water heaters serving individual dwelling units are consumer gas storage, instantaneous gas water heaters, and heat pump water heaters. To comply with the Energy Code using either the prescriptive or performance approach, the water heater must meet the federal or the California Appliance Efficiency Regulations (Title 20) or both. Central gas or propane water heaters must also meet the electric-ready requirements of section 160.9(f), and individual gas or propane water heaters must also meet the electric-ready requirements of 160.9(e). Approved water heaters can be found in the Modernized Appliance Efficiency Database Systems (MAEDBS) found here, https://cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx.

An HPWH is an electric water heater that works like an air conditioner cycle in reverse. It uses a compressor to transfer heat from the surrounding air to the water tank. It includes all necessary auxiliary equipment such as fans, storage tanks, pumps, or controls. Typically, HPWHs include backup electric resistance elements to ensure hot water delivery when the air temperature is too cold, or the hot water demand is too high. A few models use larger compressors to avoid the need for resistance elements.

The performance of HPWHs depends heavily on air temperature because they rely on extracting heat from the air. Climate conditions and different installation locations, such as a garage or a vented outdoor closet, affect performance. In addition to air temperature sensitivity, HPWH performance is affected by cold water inlet temperatures, as introducing and mixing of inlet water during larger draws may trigger second stage electric resistance heating in the tank.

There are two basic configurations of the storage tank and heat pump of an HPWH system.

1. Unitary heat pump with integrated storage (commonly used for individual systems): A simple and readily available solution is unitary heat pump with integrated storage. These units are single-package and resemble the size and form of traditional residential tank-type gas water heaters. Most integrated heat pumps are sized for individual or multiple dwelling unit applications.
2. Split heat pump with separate storage tank(s): Split heat pumps with separate storage tanks are larger capacity products suitable for multifamily central HPWH applications. These heat pumps range in heating capacity from 15,000 Btu/hr to 250,000 Btu/hr.

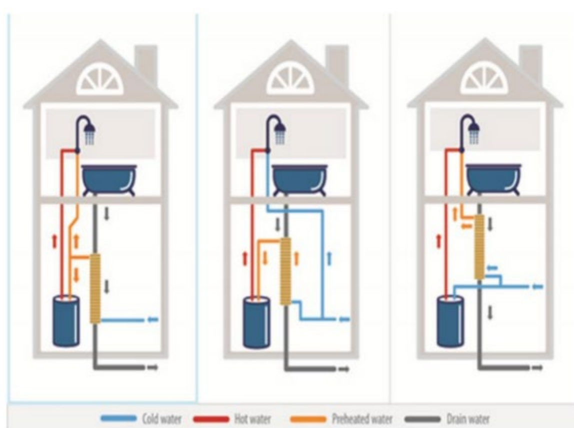
The intent of a compact hot water distribution system design is to reduce the size of the plumbing layout by bringing the water heater closer to hot water use points than in typical trunk-and-branch systems. Qualification for both credits is based on using a plan view, straight-line measurement to calculate a weighted distance to key hot water use points including the master bath, kitchen, and remaining farthest hot water fixture from the water heater, such as clothes washing. (In some multifamily situations, there may not be another use point beyond the master bath and kitchen, resulting in the third term being ignored). If this resulting weighted distance is less than a qualification distance (dependent on floor area, number of stories in the dwelling unit, and number of water heaters), the plan is eligible for the Basic Credit. The Basic Credit does not require any further verification steps to secure the compliance credit.

Drain water heat recovery (DWHR) is a technology that captures shower waste heat from the drain line. DWHR devices are counter flow heat exchangers, with cold water entering the building on one side of the device and hot drain water exiting the building on the other.

A DHWR device uses the reclaimed heat to preheat potable cold water that is then delivered either to the shower or the water heater. The device can be installed in either an equal flow configuration (with preheated water being routed to the water heater and the shower) or an unequal flow configuration (preheated water directed to either the water heater or shower). Figure 5-9: The Three Plumbing Configurations of DWHR Installation (From Left to Right: Equal Flow, Unequal Flow - Water Heater, Unequal Flow - Fixture) schematically shows the three installation configurations. The energy harvested from a DWHR device is maximized in an equal-flow configuration. They are available in both vertical design configurations, as shown in Figure 5-9: The Three Plumbing Configurations of DWHR Installation (From Left to Right: Equal Flow, Unequal Flow - Water Heater, Unequal Flow - Fixture), and in horizontal configurations. The two forms each have advantages and disadvantages, which should be evaluated for each potential installation.

To use these systems to comply with Energy Code, the design and installation must be HERS-verified and meet the Reference Appendix RA4.4.21 requirements for buildings with three stories or fewer and be field verified for buildings with four stories or more.

Figure 5-9: The Three Plumbing Configurations of DWHR Installation (From Left to Right: Equal Flow, Unequal Flow - Water Heater, Unequal Flow - Fixture)



Source: Frontier Energy

«»

B. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher. In addition, for climate zone 16, a drain water heat recovery system that is field verified as specified in Reference Appendix RA3.6.9.

«» Commentary for Section 170.2(d)1B:

The Northwest Energy Efficiency Alliance (NEEA) Advanced Water Heater Specification (AWHS) was developed to address critical performance and comfort issues of individual HPWH in colder climates. The NEEA AWHS incorporates tiers of various product performances and configurations. A NEEA Tier 3 or higher HPWH can be used to meet the prescriptive requirements. «»

Exception 1 to Section 170.2(d)1: Multifamily buildings four habitable stories or greater may install a gas or propane instantaneous water heater with an input of 200,000 Btu per hour or less and no storage tank.

«» Commentary for Section 170.2(d)1 Exception 1: Instantaneous water heaters, commonly referred to as tankless or on-demand, heat water using natural gas, electricity, or propane. These units do not have a tank for storing heated water, but instead use a sensor that detects the flow of water over the heat exchanger that initiates the heating element (typical volumes around 0.5 gallons). Instantaneous units can deliver water at a controlled temperature of less than 180ºF. The input rating for gas instantaneous water heaters ranges between 50,000 and 200,000 BTU per hour (at least 4,000 BTU per hour per gallon of stored water) with a storage capacity of less than two gallons.

To comply prescriptively with the Energy Code, a user can choose to install a gas or propane instantaneous water heater serving individual dwelling units in multifamily buildings with four or more habitable stories that meets the minimum efficiency requirements of California's Title 20 Appliance Efficiency Regulations. The equipment is limited to a maximum input of 200,000 BTU per hour and no storage tank. Approved water heaters can be found in the MAEDBS found here, https://cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx. «»

Exception 2 to Section 170.2(d)1: A 120V HPWH may be installed in place of a 240V HPWH for new dwelling units with one bedroom or less.

2. **Central Systems.** For systems serving multiple dwelling units, the water-heating system shall meet the applicable requirement of A through F, or shall meet the performance compliance requirements of Section 170.1:

   A. For heat pump water-heating systems serving multiple dwelling units, the water-heating system shall be installed according to the manufacturer's design and installation guidelines and meet the following requirements, or meet the requirements of NEEA Advanced Water Heater Specification for commercial heat pump water heater Tier 2 or higher:

«» Commentary for Section 170.2(d)2A:

A central system is any one water heater serving two or more dwelling units. The Northwest Energy Efficiency Alliance (NEEA) Advanced Water Heater Specification (AWHS) was developed to address critical performance and comfort issues of individual HPWH in colder climates. The NEEA AWHS incorporates tiers of various product performances and configurations. A NEEA AWHS for commercial HPWHs Tier 2 or higher can be used to meet the prescriptive requirements. HPWHs configured as multi-pass systems can either comply prescriptively, if meeting the requirements of NEEA Tier 2 or higher, or using the performance approach.«»

i. The primary heat pump water heater shall be a single-pass heat pump water heater.

«» Commentary for Section 170.2(d)2Ai:

Heat pump water heaters can be configured into either single-pass or multi-pass systems, with single-pass systems heating water once to the desired storage temperature and multi-pass systems heating water multiple times until the target temperature is achieved. Single-pass configurations, typically drawing cold water from the bottom of the storage tank and delivering hot water at the desired temperature to the top of the storage tank, result in highly stratified tanks and are usually more efficient than multi-pass configurations. Single-pass is required for CO2-based HPWHs due to refrigerant characteristics. In multi-pass piping configuration, the HPWH draws water from the bottom third of the tank, incrementally heating the hot water, typically 5 -10°F at each pass, resulting in less tank stratification. Equipment using refrigerants such as R513a, R134s and R410a can accommodate either single-pass or multi-pass configurations due to their ability to handle a wide range of temperature rise. Designers must carefully configure plumbing systems to maintain optimal HPWH operation depending on the selected model, ensuring efficiency and performance in diverse applications.

To use the prescriptive approach, the primary HPWH must be configured as a single-pass system. «»

ii. The hot water return from the recirculation loop shall connect to a recirculation loop tank and shall not directly connect to the primary heat pump water heater inlet or the primary thermal storage tanks.

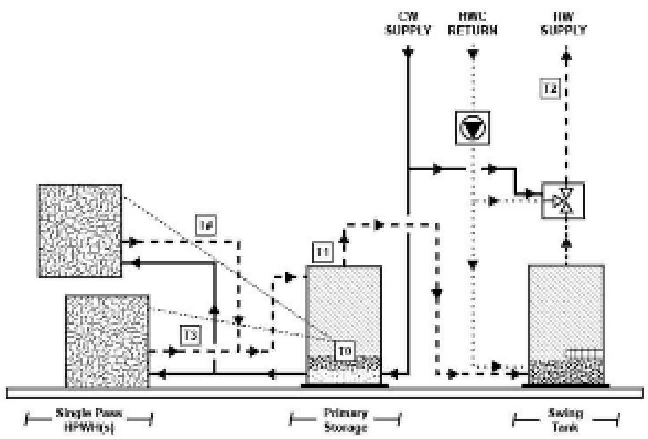
«» Commentary for Section 170.2(d)2Aii:

To use this prescriptive approach, the central HPWH system design must use a temperature maintenance system that is decoupled from the primary system to meet the DHW temperature maintenance load. A temperature maintenance system consists of a recirculation pump, a storage tank (the loop tank), and a temperature maintenance heat source. The hot water return from the recirculation loop must connect to the loop tank and cannot connect directly to the primary storage tanks or the inlet of the primary HPWH equipment. This design approach can prioritize delivering cool water to the HPWHs for peak performance while maintaining thermal stratification in the primary tanks.

For HPWHs, most single-pass heat pumps do not operate well with warm incoming water temperatures (above approximately 110°F). A critical design feature of central HPWH systems with hot water circulation systems is separation of the two distinct building DHW loads. The first load is primary water heating. The second is temperature maintenance of recirculating hot water due to heat loss in the distribution loop. The HPWHs in the primary loop is referred to as the primary HPWH. In separating the loads, the DHW system design can prioritize delivering cool water to the primary HPWHs for peak performance while maintaining thermal stratification in the primary tanks. Separating primary heating load and temperature maintenance load can improve equipment efficiency, lessen heating equipment cycling, and yield better system reliability.

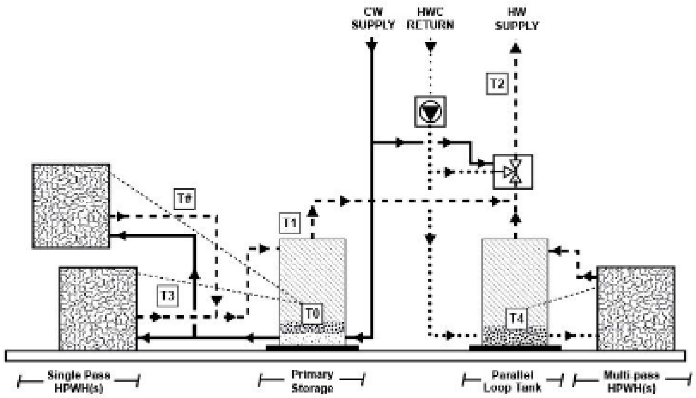
To separate the two loads, a key design practice is to use a temperature maintenance system separated from the thermally stratified primary storage volume. The NEEA AWHS specifies two different types of temperature maintenance systems. First, a swing tank design which uses a loop tank piped in series with the primary storage, illustrated in Figure 5-10: Single-Pass HPWH (s) With Swing Tank. Second, a parallel loop tank design which uses a loop tank piped in parallel with the primary storage, illustrated in Figure 5-11: Single-Pass HPWH (s) with Parallel Loop Tank.

Figure 5-10: Single-Pass HPWH (s) With Swing Tank



Source: Ecotope

Figure 5-11: Single-Pass HPWH (s) with Parallel Loop Tank



Source: Ecotope

For system design without a recirculation system, the hot water heater(s) must be located close to each hot water point-of-use such that a recirculation loop is not needed. This strategy is most easily applicable to buildings with up to three stories where the designer can locate the system on the roof and feed hot water to the dwelling units below with straight hot water piping. «»

iii. The fuel source for the recirculation loop tank shall be electricity.

iv. The primary storage tank temperature setpoint shall be at least 135°F.

v. The recirculation loop tank temperature setpoint shall be at least 10°F lower than the primary thermal storage tank temperature setpoint.

«» Commentary for Section 170.2(d)2Aiv and v:

To effectively increase storage capacity and leverage the load shifting capability of hot water storage, the prescriptive approach requires the primary hot water storage temperature must be at least 135°F. In addition, the loop tank temperature setpoint must be controlled to be at least 10°F lower than the primary thermal storage tank setpoint. Since the loop tank heater, which could be an electric resistance heater or a multi-pass HPWH, operates less efficiently than the primary HPWH, lowered loop tank setpoint can ensure that the loop heater is engaged only when additional heat is needed for temperature maintenance purposes. «»

vi. The minimum heat pump water heater compressor cut-off temperature shall be equal to or lower than 40°F ambient air temperature.

«» Commentary for Section 170.2(d)2vi:

Operation of an HPWH compressor must be able to meet all control requirements stated above when the ambient air temperature is equal to or higher than 40°F. «»

vii. Design documentation shall be provided in accordance with JA14.4.

«» Commentary for Section 170.2(d)2Avii:

In addition to the plumbing configuration and control requirements, the prescriptive approach requires presentation of specified information in the design documentation. JA 14.4 specifies the following information must be included.

1. Minimum and maximum ambient air temperature designed for the HPWH to operate. HPWH performance is impacted by the ambient air conditions. Designers must consider the climate conditions and where to locate the HPWHs for equipment selection.
2. Minimum and maximum cold-water temperature.
3. Minimum and maximum building demand at design draw and recovery conditions and duration. Designers must consider these parameters to properly size for HPWH and storage tank, regardless of if load shifting is considered.
4. Recirculation loop heat loss: designers must determine the recirculation loop heat loss to properly size the loop tank and determine whether a heater is needed. **«»**

B. For gas or propane systems serving multiple dwelling units, the water-heating system that includes the following components shall be installed:

  i. For Climate Zones 1 through 9, gas service water-heating systems with a total installed gas water-heating input capacity of 1 MMBtu/h or greater shall have gas service water-heating equipment with a minimum thermal efficiency of 90 percent. Multiple units are allowed to meet this requirement with an input capacity-weighted average of at least 90 percent.

  Exception 1 to Section 170.2(d)Bi: Individual gas water heaters with input capacity at or below 100,000 Btu/h shall not be included in the calculations of the total system input or total system efficiency.

  Exception 2 to Section 170.2(d)Bi: If 25 percent of the annual water-heating requirement is provided by site-solar energy or site-recovered energy.

«» Commentary for Section 170.2(d)Bi:

To use the prescriptive path with gas or propane central water-heating systems, water heaters with input capacity at or greater than 1 MMBtu/h must have a minimum thermal efficiency of 90 percent. When multiple water heaters are used in the system, a capacity weighted average is used to determine the minimum thermal efficiency. Water heaters with a lower capacity rate are exempt from the thermal efficiency requirement. Additional exemption is allowed when 25 percent or more of the annual water-heating load is met by an on-site solar system or site-recovered energy. **«»**

ii. A solar water-heating system meeting the installation criteria specified in Reference Residential Appendix RA4 and with a minimum solar savings fraction of either a. or b. below:

a. A minimum solar savings fraction of 0.20 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.35 in Climate Zones 10 through 16; or

b. A minimum solar savings fraction of 0.15 in Climate Zones 1 through 9 or a minimum solar savings fraction of 0.30 in Climate Zones 10 through 16. In addition, a drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9.

«» Commentary for Section 170.2(d)2Bii:

When a central gas or propane water-heating system is installed, a solar water-heating system with a minimum solar fraction is also required. A central system is any one water heater serving two or more units. The minimum solar savings fraction requirement is climate zone-dependent; the minimum is 0.2 for climate zones 1 – 9 and 0.35 in Climate Zones 10 through 16. If a drain water heat recovery (DWHR) device meeting the requirements specified in the Reference Appendix RA 3.6.9 is installed, moderately lower solar savings fraction levels are required instead. The minimums become 0.15 for climate zones 1 – 9 and 0.30 for climate zones 10 through 16.

Table 5-3: Minimum Solar Fraction Requirements for Solar Water-Heating Systems

	Climate Zones 1 – 9	**Climate Zones 10 – 16**
Minimum Solar Fraction	0.2	0.35
Minimum Solar Fraction if meeting RA 3.6.9	0.15	0.30

Source: California Energy Commission

The water-heating calculation method allows water-heating credits for solar water heaters. Solar thermal systems save energy by using renewable resources to offset the use of conventional energy sources. For detailed instructions on installation of solar water heaters, refer to Reference Appendix RA4.4.20. The database of SRCC-certified equipment is on SRCC website at the following link: https://solar-rating.org/.

The database of IAPMO R&T-certified equipment is on the IAPMO R&T website at the following link: www.iapmort.org/Pages/SolarCertification.aspx. «»

C. All hot water piping shall be sized in accordance with the California Plumbing Code Appendix M.

«» Commentary for Section 170.2(d)2C:

This section prescriptively requires that all hot water distribution piping be sized following the guidelines set forth in the California Plumbing Code (CPC) Appendix M. CPC Appendix M introduces an alternative methodology for pipe sizing, known as the Water Demand Calculator

(WDC), which is designed to reflect the lower water usage rates of contemporary high-efficiency fixtures.

The California Plumbing Code Appendix M replaces the outdated sizing methods from Appendix A, which were based on the Hunter's Curve—a model developed in the 1940s when water flow rates were significantly higher. This older methodology often resulted in oversized pipes, sometimes by a factor of 10 to 20 times the necessary size. Such oversizing led to unnecessary material costs, higher energy consumption, stagnant water, higher water consumption from increased hot water wait times and inefficiencies in water delivery systems.

In contrast, Appendix M employs updated probability curves and flow rate data, resulting in more accurate and efficient pipe sizing. By recognizing that modern fixtures use less water, Appendix M typically leads to smaller pipe diameters, often only 2-3 times larger than required for peak demands, compared to the much larger sizes recommended by the older methods. This approach not only reduces initial installation costs due to reduced pipe diameters of piping and plumbing appurtenances, it also reduces water age and improves hot water delivery performance. Using CPC Appendix M may reduce water and sewer costs related to meter size reduction depending on if the provider bases their monthly fixed charges on water meter size. While CPC Appendix M is an alternative pipe sizing methodology in the plumbing code, it is a prescriptive requirement in the Energy Code since there are significant energy efficiency benefits by lowering the energy required to overcome pipe heat losses at the heating plant and recirculation loop. For more detailed information on the CPC Appendix M Peak Water Demand Calculator, refer to Title 24, Part 5. **«»**

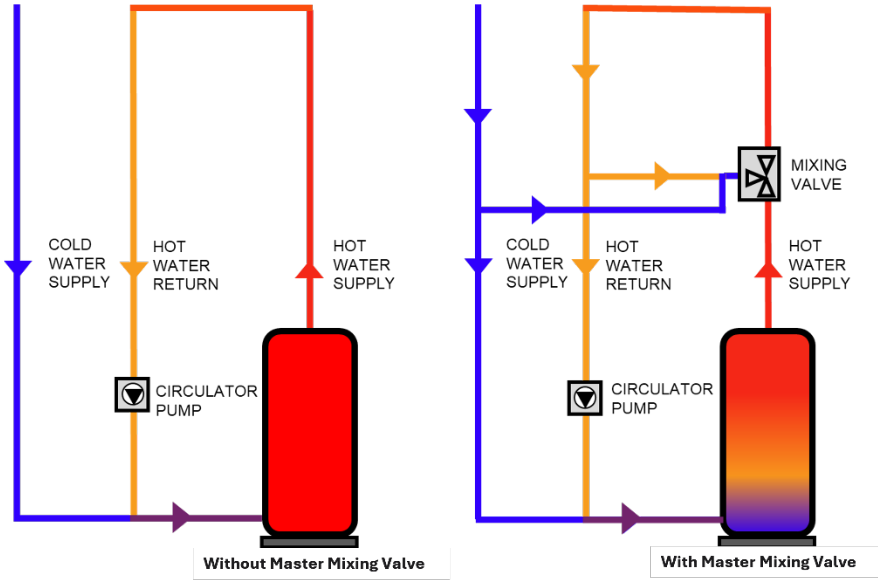
D. The central system shall have a recirculation system with a mechanical or digital thermostatic master mixing valve on each distribution supply and return loop, and meet the requirements specified in the Residential Reference Appendix RA4.4.19.

   Exception to Section 170.2(d)2D: Buildings with eight or fewer dwelling units.

«» Commentary for Section 170.2(d)2D:

This section prescriptively requires that a central domestic hot water system incorporates a recirculation system equipped with a mechanical or digital master mixing valve on each distribution supply and return loop. These valves are crucial for maintaining consistent water temperatures and ensuring the efficiency of the hot water system. Figure 5-12: Domestic Hot water System with and without a Master Mixing Valve shows a system without a master mixing valve (left) and a system with a master mixing valve (right).

Figure 5-12: Domestic Hot water System with and without a Master Mixing Valve



Source: California Energy Commission, TRC Companies, Inc.

Mechanical mixing valves, also known as thermostatic mixing valves (TMVs), are mainly designed for use in high volume distribution systems with mostly static flow conditions. These valves mix hot and cold water to a predetermined temperature and maintain this temperature regardless of fluctuations in pressure and flow. This is difficult to achieve with one large master mixing valve to meet the theoretical peak flow design condition. While physically larger and more costly, a two-valve High/Low (1 large and 1 small) combination TMV, shown in Figure 5-13: Image of a Two-Valve High Low Combination Thermostatic Mixing Valve is more effective. These valves are more complex to install and commission compared to simpler single valve systems. The complexity arises from the need to precisely adjust the mixing parameters to ensure optimal performance and safety. Other concerns with TMVs are they are commonly oversized in the specification, which impacts their performance, and it is critical to follow manufacturers' installation, commissioning and maintenance instructions comprehensively.

Figure 5-13: Image of a Two-Valve High Low Combination Thermostatic Mixing Valve

Source: California Energy Commission, TRC Companies, Inc.

Digital master mixing valves offer a more advanced solution by providing precise electronic control over the mixing process with much faster response to dynamic flow conditions. The desired temperature is selected and the valve does the rest of the work based on the pre-programmed algorithm. These valves can be programmed for pathogen mitigation and monitored more easily than their mechanical counterparts, allowing for greater flexibility and accuracy in maintaining desired water temperatures. Many digital valves have a daily descaling feature that exercises the valve over the full open and closed range to remove scale before it can build up.

Reference Appendix RA4.4.20 provides detailed installation and commissioning requirements for these thermostatic valves, particularly mechanical ones. These requirements ensure that the valves are properly set up to function effectively within the system. Key installation and commissioning considerations include:

1. Ensuring the valves are correctly calibrated to maintain the desired water temperature.
2. Verifying that the valves respond appropriately to changes in flow and pressure conditions.
3. Regularly testing and maintaining the valves to ensure long-term reliability and performance.

By adhering to the guidelines in RA4.4.20, installers can ensure that the thermostatic valves operate efficiently and safely, providing consistent hot water temperatures throughout the distribution system.

This requirement aims to enhance the performance and energy efficiency of central hot water systems in residential buildings. Properly installed and commissioned thermostatic valves help minimize heat loss, reduce energy consumption, and improve the overall reliability of the hot water supply. «»

E. Insulation for hot water pipes and plumbing appurtenances shall be field verified as specified in Residential Reference Appendix RA3.6.3.

«» Commentary for Section 170.2(d)2E

A key new pipe insulation requirement has been added for the 2025 Standards. This section outlines the requirement for field verification of insulation quality for hot water pipes and plumbing appurtenances. Refer to Residential Reference Appendix RA3.6.3 for detailed instructions on compliance.

As a prescriptive requirement, third party field verification allows flexibility for performance-based approaches and adjustments, accommodating any potential energy offsets needed if pipe insulation verification is not performed. It is crucial to ensure that this verification is not overlooked during the design and construction phases to maintain energy efficiency and system performance. **«»**

SECTION 180.0 – GENERAL

Additions, alterations and repairs to existing attached dwelling units and common use areas in multifamily buildings, existing outdoor lighting for these occupancies, and internally and externally illuminated signs shall meet the requirements specified in Sections 100.0 through 110.10, 160.1, and 160.3 through 170.2 that are applicable to the building project, and either the performance compliance approach (energy budgets) in Section 180.1(b) (for additions) or 180.2(c) (for alterations), or the prescriptive compliance approach in Section 180.1(a) (for additions) or 180.2(b) (for alterations), for the climate zone in which the building is located. Climate zones are shown in Figure 100.1-A.

Covered process requirements for additions, alterations and repairs to existing multifamily buildings are specified in Section 141.1.

Nonresidential occupancies in mixed occupancy buildings shall comply with nonresidential requirements in Sections 120.0 through 141.1.

NOTE: For alterations that change the occupancy classification of the building, the requirements specified in Section 180.2 apply to the occupancy after the alterations.

«» Commentary for Section 180.0:

Additions and alterations to existing individual water-heating systems are subject to mandatory requirements and select prescriptive requirements. These requirements apply to systems serving multiple dwelling units. Examples of instances that trigger requirements include:

1. Increasing the number of water heaters serving individual dwelling units (as part of an addition).
2. Replacing the existing water-heating or adding water heaters or adding hot water piping or both.
3. Replacing a heating element in a water heater but not replacing the entire water heater.

«»

SECTION 180.1 – ADDITIONS

Additions to existing multifamily buildings shall meet the applicable requirements of Sections 110.0 through 110.9; Sections 160.0, 160.1, and 160.2(c) and (d); Sections 160.3 through 160.7; and either Section 180.1(a) or 180.1(b).

Exception 3 to Section 180.1: Existing inaccessible piping shall not require insulation as defined under Section **160.4(f)2**Aiii.

«» Commentary for Section 180.1:

Water heater systems that serve one or more dwelling units as part of an addition will meet the prescriptive requirements specified in Section 170.2(d) on both water heater and distribution system. **«»**

(a) Prescriptive approach. The envelope and lighting of the addition; any newly installed space-conditioning or ventilation system, electrical power distribution system, or water-heating system; any addition to an outdoor lighting system; and any new sign installed in conjunction with an indoor or outdoor addition shall meet the applicable requirements of Sections 110.0 through 110.12**;** 160.0, 160.1, and 160.2(c) and (d); and 160.3 through 170.2.

«» Commentary for Section 180.1(a):

Altered or replaced water-heating systems or components serving dwelling units must meet mandatory pipe insulation and insulation protection requirements. For a replacement water heater, there are separate requirements for the distribution system and the water heater. The requirements for pipe insulation are mandatory and cannot be traded off. For the distribution system and the water heater, if the prescriptive requirements cannot be met, then the performance approach can be used to comply. **«»**

3. **Water heater.** When additional water-heating equipment is installed to serve a dwelling unit as part of the addition, one of the following types of water heaters shall be installed:

   A. A water-heating system that meets the requirements of Section 170.2(d); or

   B. A water-heating system determined by the Executive Director to use no more energy than the one specified in Item A above.

(b) Performance approach. Performance calculations shall meet the requirements of Sections 170.0 through 170.2(a), pursuant to the applicable requirements in Items 1, 2 and 3 below.

1**. For additions alone.** The addition complies if the addition alone meets the energy budgets expressed in terms of Long-Term System Cost (LSC) energy.

«» Commentary for Section 180.1(b)1:

Modeling an addition alone requires meeting the same requirements as newly constructed buildings. The prescriptive requirements apply only to the space that is added, not the entire building. **«»**

2. **Existing plus alteration plus addition.** The standard design for existing plus alteration plus addition energy use is the combination of the existing building's unaltered components to remain; existing building altered components that are the more efficient, in LSC energy, of either the existing conditions or the requirements of Section 180.2(c); plus the proposed addition's energy use meeting the requirements of Section 180.1(a). The proposed design energy use is the combination of the existing building's unaltered components to remain and the altered components' energy features, plus the proposed energy features of the addition.

«» Commentary for Section 180.1(b)2:

For altered or replaced water-heating systems, the calculated energy use of the proposed design is compared to the standard design energy budget. The standard design system is described in the 2025 Nonresidential and Multifamily Alternative Calculation Method Reference Manual.**«»**

SECTION 180.2 – ALTERATIONS

Alterations to components of existing multifamily buildings, including alterations made in conjunction with a change in building occupancy to a multifamily occupancy, shall meet Item (a), and either Item (b) or (c) below:

Exception 1 to Section 180.2: When heating, cooling or service water heating for an alteration is provided by expanding existing systems, the existing systems and equipment need not comply with Sections 110.0 through 110.10; Sections 160.0 through 160.7; and Section 170.2(c) or 170.2(d).

Exception 2 to Section 180.2: When existing heating, cooling or service water-heating systems or components are moved within a building, the existing systems or components need not comply with Sections 110.0 through 110.10; Sections 160.0 through 160.7; and Section 170.2(c) or 170.2(d).

(b) Prescriptive approach. The altered component and any newly installed equipment serving the alteration shall meet the applicable requirements of Sections 110.0 through 110.9 and all applicable requirements of Sections 160.0, 160.1, 160.2(c) and (d), 160.3(a) through 160.3(b)5J, 160.3(b)6, 160.3(c) and 160.5; and

3. **Hot water systems**. Altered or replacement water-heating systems or components serving individual dwelling units shall meet the applicable requirements below:

   A. **Pipe insulation.** For newly installed piping and existing accessible piping, the insulation requirements of Section 160.4(e) shall be met.

«» Commentary for Section 180.2(b)3A:

Altered or replaced water-heating systems or components serving dwelling units must meet mandatory pipe insulation and insulation protection requirements. For a replacement water heater, there are separate requirements for the distribution system and the water heater. The requirements for pipe insulation are mandatory and cannot be traded off. For the distribution system and the water heater, if the prescriptive requirements cannot be met, then the performance approach can be used to comply. «»

   B. **Distribution system.** For recirculation distribution system serving individual dwelling units, only demand recirculation systems with manual on/off control as specified in Reference Appendix RA4.4.9 shall be installed.

   C. **Water-heating system.** The water-heating system shall meet one of the following:

      i. A natural gas or propane water-heating system; or

ii. A single heat pump water heater. The storage tank shall not be located outdoors and shall be placed on an incompressible, rigid insulated surface with a minimum thermal resistance of R-10. The water heater shall be installed with a communication interface that either meets the requirements of Section 110.12(a) or has an ANSI/CTA-2045-B communication port; or

iii. A single heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher; or

iv. If the existing water heater is an electric resistance water heater, a consumer electric water heater.

v. A water-heating system determined by the Executive Director to use no more energy than the one specified in Sections 180.2(b)3Ci through iii above; or if no natural gas is connected to the existing water heater location, a water-heating system determined by the Executive Director to use no more energy than the one specified in Section 180.2(b)3Civ above.

(c) Performance approach. The altered component(s) and any newly installed equipment serving the alteration shall meet the applicable requirements of Subsections 1, 2 and 3 below. The energy budget for alterations is expressed in terms of Long-Term System Cost (LSC) energy.

1. The altered components shall meet the applicable requirements of Sections 110.0 through 110.9, 160.0, 160.1, 160.2(c) and (d), 160.3(a) through 160.3(b)5J, 160.3(b)6, 160.3(c), and 160.5. Entirely new or complete replacement mechanical ventilation systems as these terms are used in Section 180.2(b)5A shall comply with the requirements in Section 180.2(b)5A. Altered mechanical ventilation systems shall comply with the requirements of Sections 180.2(b)5B. Entirely new or complete replacement space-conditioning systems, and entirely new or complete replacement duct systems, as these terms are used in Sections 180.2(b)2Ai and 180.2(b)2Aiia, shall comply with the requirements of Sections 160.2(a)1 and 160.3(b)5L.
2. The standard design for an altered component shall be the higher efficiency of existing conditions or the requirements of Section 180.2(b). For components not being altered, the standard design shall be based on the unaltered existing conditions such that the standard and proposed designs for these components are identical. When the third-party verification option is specified, all components proposed for alteration for which the additional credit is taken, must be verified by a certified ECC-rater.
3. The proposed design shall be based on the actual values of the altered components.

NOTES TO SECTION 180.2(c):

1. If an existing component must be replaced with a new component, that component is considered an altered component for the purpose of determining the standard design altered component energy budget and must meet the requirements of Section 180.2(c)2.
2. The standard design shall assume the same geometry and orientation as the proposed design.
3. The "existing efficiency level" modeling rules, including situations where nameplate data is not available, are described in Section 10-109(c) and Section 10-116.

«» Commentary for Section 180.2(c):

For altered or replaced water-heating systems, the calculated energy use of the proposed design is compared to the standard design energy budget. For system serving individual dwelling units, the standard design is based on either a single gas instantaneous water heater for gas water heaters or an HPWH system with a standard distribution system. For systems serving multiple dwelling units, the standard design is based on the existing efficiency level. **«»**