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Water Heating Requirements

Overview

Please refer to Chapter 5.1 of the *2022 Single-family Residential Compliance Manual*.

What's New for 2025

This section summarizes changes to the requirements for residential water heating for the 2025 Energy Codes.

Mandatory Requirements

- Heat pump water heaters installed so that inlet air is outdoor air must have backup heat if the compressor cut-off temperature is above the local Heating Winter Median of Extremes (Section 110.3(c)7A).
- Ventilation is required when installing a heat pump water heater (Section 110.3(c)7B).
- Pool and/or spa heating systems must be sized appropriately for newly constructed single-family buildings with heated swimming pools and spas (Section 110.4(c)).
- Heat pump pool heaters with supplementary heaters shall have controls installed to ensure that the supplementary heater does not operate when the heating load can be met by the heat pump alone (Section 110.4(d)).

Prescriptive Requirements

Water heating equipment is required to be a heat pump water heater or a solar water heating system with electric backup and minimum 70% solar fraction in all climate zones (Section 150.1(c)8).

At a Glance

Table 5-1: Overview of Water Heating Requirements in the Energy Code and Chapter 5 provides an overview of the location of the water heating requirements in the 2025 Energy Codes by construction and building type.

Table 5-1: Overview of Water Heating Requirements in the Energy Code and Chapter 5

Type	Mandatory Requirements Standards Section	Prescriptive Requirements Manual Section	Prescriptive Requirements Standards Section	Prescriptive Requirements Manual Section	Performance Requirements Standards Section	Performance Requirements Manual Section
Single-family dwelling	Section 110.3; Section 150.0(j) Section 150.0(n)	Mandatory Requirements for Water Heating	Section 150.1(c)8	Prescriptive Requirements for Water Heating	Section 150.1(b)	Performance Approach Compliance for Water Heating

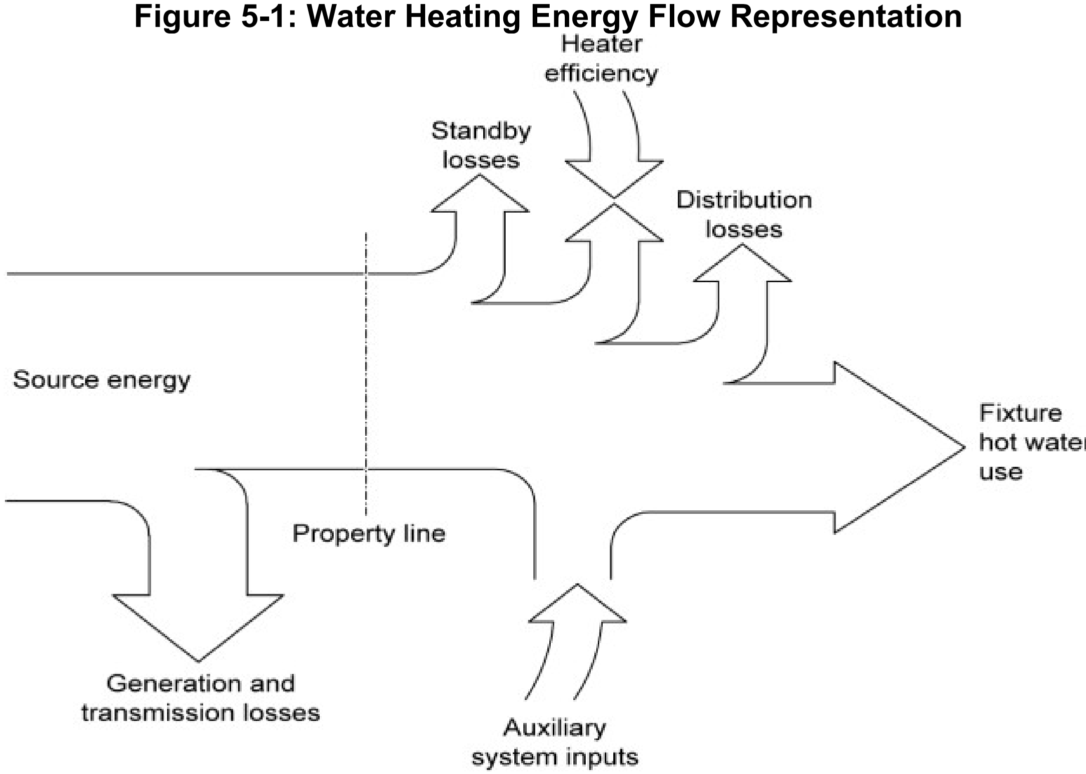
Addition	Section 110.3; Section 150.0(j) Section 150.0(n)	Mandatory Requirements for Water Heating, Chapter 9	Section 150.2(a)1D	Prescriptive Requirements for Water Heating	Section 150.2(a)2	Performance Approach Compliance for Water Heating
Alteration	Section 110.3; Section 150.0(j)	Mandatory Requirements for Water Heating, Chapter 9	Section 150.2(b)1H	Prescriptive Requirements for Water Heating	Section 150.2(b)2	Performance Approach Compliance for Water Heating

Source: California Energy Commission

Water Heating Energy

Total energy use associated with water heating consists of the end use, heater inefficiencies, standby loss, and distribution system inefficiencies. Figure 5-1: Water Heating Energy Flow Representation below shows the energy flows that constitute water heating energy usage.

Figure 5-1: Water Heating Energy Flow Representation



Source: California Energy Commission

Hot water drawn at the end use points (for example, faucets, showers, and so forth) represents the useful energy consumed. In most cases, hot water that is actually used represents the largest fraction of water heating energy use, although in situations when there are very few hot water draws, standby losses from a standard gas storage water heater and the hot water distribution system can exceed the quantity of useful energy consumed at the end point.

Energy impacts associated with the hot water distribution system vary widely based on the type of system, quality of insulation and installation, building and plumbing design, and hot water use patterns. Distribution losses in a typical single-family home may be as much as 30 percent of the total energy used for water heating. However, distribution losses in single-family homes with compact hot water distribution systems may be lower than 10 percent of total water heating energy use. An important consideration for any water heating system is the recovery load (that is, end use plus distribution losses) of the water heating unit minus any contribution from auxiliary heat inputs, such as a solar thermal system.

Residential Water Heating Equipment

There are several types of residential water heaters described below. The most common water heaters in single-family homes are storage (heat pump water heater, propane, natural gas, or electric resistance) or instantaneous water heaters (propane, natural gas, or electric resistance).

To comply with the Energy Codes using either the prescriptive or performance approach, the water heater must meet the federal and/or the California Appliance Efficiency Regulations (California Code of Regulations (CCR) Title 20).

Instantaneous Water Heaters

Please refer to Chapter 5.2.1 of the *2022 Single-family Residential Compliance Manual*.

Storage Water Heater

Please refer to Chapter 5.2.2.1 of the *2022 Single-family Residential Compliance Manual*.

Heat Pump Water Heaters

A heat pump water heater (HPWH) is an electric water heater that works like an air conditioner in reverse. It uses the refrigeration process 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. Some models entering the market use larger compressors to avoid the need for resistance elements.

The performance of HPWHs depends both on storage water temperature and inlet air temperature. Buildings in warm and cold climate zones, and different installation locations such as a garage or well vented outdoor closet, all have an impact on performance and must be considered. If the HPWH is installed in a confined water heater closet, carefully follow manufacturer instructions on the use of ducting to discharge exhaust air out of the closet. Without ducting, a confined closet can result in overcooling of the air, significantly diminishing HPWH performance.

HPWHs are most efficient in warmer climates, but even in cold climate zones such as climate zone 16, HPWHs still use only half as much electricity as conventional electric resistance water heaters. In addition to air temperature sensitivity, HPWH performance is affected by cold water inlet temperatures as introduction and mixing of inlet water during larger draws may trigger second stage electric resistance heating in the tank.

The Northwest Energy Efficiency Alliance (NEEA) Advanced Water Heater Specification was developed to address critical performance and comfort issues of HPWH in colder climates. Tiers are incorporated into this specification recognizing variations in product performance and configuration. An HPWH that meets the NEEA Advanced Water Heater Specification performs significantly better in real world conditions, and an HPWH that meets the NEEA Tier 3 or higher can be used to meet the prescriptive requirement for newly constructed buildings, addition, and alteration.

The list of qualified NEEA HPWH products can be found at https://neea.org/img/documents/qualified-products-list.pdf

Joint Appendix (JA) 13 qualification requirements for HPWH demand management systems. Qualifying HPWHs have the capability to optimize operation to reduce normal water heater operation during on-peak periods by biasing operation prior to the peak period. Future opportunities include heating the storage tank above setpoint prior to the peak period, further improving the electrical load profile of these systems. A credit exists for these HPWHs within the compliance software. JA13 certified HPWHs, which must have a mixing valve installed to prevent any scalding risks, are currently listed at this website, https://www.energy.ca.gov/rules-and-regulations/building-energy-efficiency/manufacturer-certification-building-equipment/ja13.

Example 5-2: HPWH Compliance Credits

Question:

Are there any additional compliance credits available for unitary HPWHs?

Answer:

NEEA Tier 3 and Tier 4 rated HPWHs are available in the performance compliance software and provide compliance credit compared to the standard design HPWH. Additionally, with the approval of JA13, there is now credit within the performance compliance software for HPWHs that are JA13-certified and provide the Basic Load Up demand management functionality. This credit varies with climate zone. Note that a mixing valve must be installed to ensure safe hot water delivery.

Air-to-Water Heat Pumps with Water Heating Capability (Three Function Heat Pumps)

Air-to-water heat pumps provide space heating and cooling output via hydronic delivery. Some models also provide a water heating function, enabling the use of a single outdoor heat pump unit to serve indoor heating, indoor cooling, and domestic hot water production. For this reason, these AWHP systems are often referred to as "three function heat pumps" (TFHPs). This type of system can be attractive for all-electric retrofits, as no new breaker space or service upgrades are required..

Residential-Duty Commercial Water Heater

Please refer to Chapter 5.2.2.4 of the *2022 Single-family Residential Compliance Manual*.

Hot Water Supply Boiler

Please refer to Chapter 5.2.2.5 of the *2022 Single-family Residential Compliance Manual*.

Water Heater Maintenance

Please refer to Chapter 5.2.3 of the *2022 Single-family Residential Compliance Manual*.

Maintenance of Instantaneous Water Heaters

Please refer to Chapter 5.2.3.1 of the *2022 Single-family Residential Compliance Manual*.

Maintenance of Storage Water Heaters

Please refer to Chapter 5.2.3.2 of the *2022 Single-family Residential Compliance Manual*.

Drain Water Heat Recovery Devices

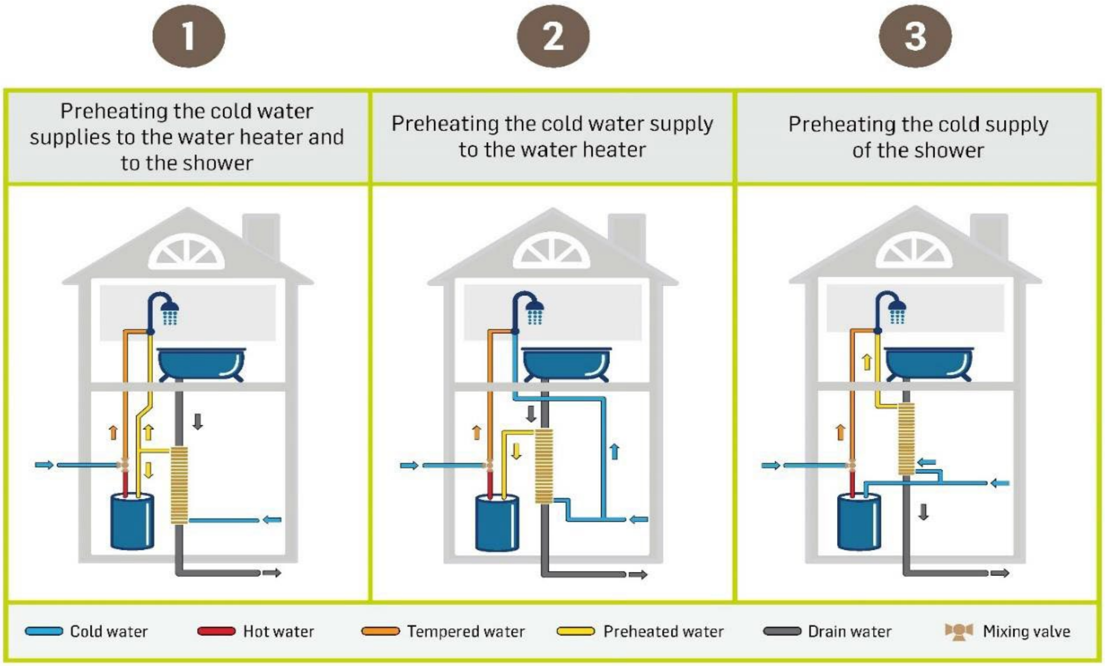
Drain water heat recovery (DWHR) is a technology that captures shower waste heat from the drain line. DWHR devices are counter flow heat exchangers, with cold water entering the building on one side of the device and hot drain water exiting the building on the other.

DWHR is a component of an alternative prescriptive path. It is also a compliance option for other water heating applications. DWHR technologies are most prevalent and perform best in cold climates in applications with large water heating loads and colder inlet water temperatures. California, being a generally milder climate, will show somewhat diminished performance relative to the preferred applications.

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 both the water heater and the shower) or an "unequal flow" configuration (preheated water directed to either the water heater or shower). Figure 5-2: 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 sold in both vertical design configurations, as shown in Figure 5-2: 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 ECC-Verified and meet the Reference Appendix RA4.4.21 requirements.

Figure 5-2: The Three Plumbing Configurations of DWHR Installation (From Left to Right: Equal Flow, Unequal Flow – Water Heater, Unequal Flow Fixture)



Source: California Energy Commission

Mandatory Requirements for Water Heating

Equipment Certification

Please refer to Chapter 5.3.1 of the *2022 Single-family Residential Compliance Manual*.

Equipment Efficiency

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 heaters, or gallon per minute for instantaneous water heaters. The efficiency requirements for the most common consumer water heaters are given in Table 5-2: Minimum Federal UEF Requirements for Consumer Water Heaters below. The efficiency requirements for the residential-duty commercial water heaters are given in Table 5-3: Minimum Federal Uniform Energy Factor Requirements for Residential-Duty Commercial Water Heaters below.

The Energy Commission has developed a water heater efficiency guide to allow quick lookup of the minimum efficiency of the most common types and sizes of water heaters. These guides can be found at https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/online-resource-center/water.

Table 5-2: Minimum Federal UEF Requirements for Consumer Water Heaters

Product class	Rated storage volume	Draw pattern	UEF
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	Very Small	0.3456 − (0.0020 × Vr)

Product class	Rated storage volume	Draw pattern	UEF
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	Low	0.5982 − (0.0019 × Vr)
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	Medium	0.6483 − (0.0017 × Vr)
Gas-fired Storage Water Heater	≥20 gal and ≤55 gal	High	0.6920 − (0.0013 × Vr)
Gas-fired Storage Water Heater	>55 gal and ≤100 gal	Very Small	0.6470 − (0.0006 × Vr)
Gas-fired Storage Water Heater	>55 gal and ≤100 gal	Low	0.7689 − (0.0005 × Vr)
Gas-fired Storage Water Heater	>55 gal and ≤100 gal	Medium	0.7897 − (0.0004 × Vr)
Gas-fired Storage Water Heater	>55 gal and ≤100 gal	High	0.8072 − (0.0003 × Vr)
Electric Storage Water Heaters	≥20 gal and ≤55 gal	Very Small	0.8808 − (0.0008 × Vr)
Electric Storage Water Heaters	≥20 gal and ≤55 gal	Low	0.9254 − (0.0003 × Vr)
Electric Storage Water Heaters	≥20 gal and ≤55 gal	Medium	0.9307 − (0.0002 × Vr)
Electric Storage Water Heaters	>55 gal and ≤120 gal	Very Small	1.9236 − (0.0011 × Vr)
Electric Storage Water Heaters	>55 gal and ≤120 gal	Low	2.0440 − (0.0011 × Vr)
Electric Storage Water Heaters	>55 gal and ≤120 gal	Medium	2.1171 − (0.0011 × Vr)
Electric Storage Water Heaters	>55 gal and ≤120 gal	High	2.2418 − (0.0011 × Vr)
Instantaneous Gas-fired Water	<2 gal and >50,000 Btu/h	Very Small	0.8

Product class	Rated storage volume	Draw pattern	UEF
Heater			
Instantaneous Gas-fired Water Heater	<2 gal and >50,000 Btu/h	Low/Medium/High	0.81
Instantaneous Electric Water Heater	<2 gal	Very Small/Low/Medium	0.91
Instantaneous Electric Water Heater	<2 gal	High	0.92
Grid-Enabled Water Heater	>75 gal	Very Small	1.0136 − (0.0028 × Vr)
Grid-Enabled Water Heater	>75 gal	Low	0.9984 − (0.0014 × Vr)
Grid-Enabled Water Heater	>75 gal	Medium	0.9853 − (0.0010 × Vr)
Grid-Enabled Water Heater	>75 gal	High	0.9720 − (0.0007 × Vr)

Source: U.S. Department of Energy

Table 5-3: Minimum Federal Uniform Energy Factor Requirements for Residential-Duty Commercial Water Heaters

Product class	Specifications	Draw pattern	UEF
Gas-Fired Storage	>75 kBTU/hr and ≤105 kBTU/hr and ≤120 gal	Very Small	0.2674 − (0.0009 × Vr)
Gas-Fired Storage	>75 kBTU/hr and ≤105 kBTU/hr and ≤120 gal	Low	0.5362 − (0.0012 × Vr)
Gas-Fired Storage	>75 kBTU/hr and ≤105 kBTU/hr and ≤120 gal	Medium	0.6002 − (0.0011 × Vr)
Gas-Fired Storage	>75 kBTU/hr and ≤105 kBTU/hr and ≤120 gal	High	0.6597 − (0.0009 × Vr)

Oil-Fired Storage	>105 kBTU/hr and ≤140 kBTU/hr and ≤120 gal	Very Small	0.2932 − (0.0015 × Vr)
Oil-Fired Storage	>105 kBTU/hr and ≤140 kBTU/hr and ≤120 gal	Low	0.5596 − (0.0018 × Vr)
Oil-Fired Storage	>105 kBTU/hr and ≤140 kBTU/hr and ≤120 gal	Medium	0.6194 − (0.0016 × Vr)
Oil-Fired Storage	>105 kBTU/hr and ≤140 kBTU/hr and ≤120 gal	High	0.6740 − (0.0013 × Vr)
Electric Instantaneous	>12 kW and ≤58.6 kW and ≤2 gal	All draw pattern	0.80

Source: California Energy Commission, *Title 20 Appliance Efficiency Regulations* (2014)

Storage Tank Insulation

Please refer to Chapter 5.3.3 of the *2022 Single-family Residential Compliance Manual*.

Isolation Valves

Reference: Section 110.3(c)6

All newly installed instantaneous water heaters (minimum input of 6.8 kBTU/hr) shall have isolation valves on both 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 heater that has integrated drain ports for servicing are acceptable to meet the requirements of Section 110.3(c)6 and will not require additional isolation valves.

Heat Pump Water Heaters (Air-Source)

Backup Heat

Reference: Section 110.3(c)7A

An air-source heat pump water heater (HPWH) transfers heat from the surrounding air to the water inside a storage tank using a heat pump cycle. This relies on the heat content of the surrounding air being sufficient to produce high-temperature refrigerant at the compressor outlet.

HPWH design and refrigerant type affect how low the ambient temperature can be while still extracting sufficient heat from the surrounding air by this process. 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 that occurs and 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 will always provide sufficient heat to generate hot water except in rare and brief extreme winter weather events.

Therefore, backup heat must be provided if unconditioned air is supplied to the inlet heat pump and the compressor cutout temperature is above the 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 and may be gas or electric resistance.

Example 5-3: HPWH Backup Heat

I am installing a R-134a HPWH in Davis, CA. How do I determine if backup heat is needed for my HPWH?

Answer:

Check manufacturer documentation or contact the manufacturer to obtain the compressor cutout temperature.

Assuming that their response is 40 °F, look up the Heating Winter Median of Extremes for closest city in Table 2-3 from Reference Appendix JA2. Davis, CA itself is listed in the table with a Heating Winter Median of Extremes of 24 °F.

As 40 °F is greater than 24 °F, the HPWH installation must be fitted with backup heat.

Example 5-4: HPWHs with Built-In Backup Heat

The HPWH specified in the design is a consumer-sized integrated HPWH and includes electric resistance elements built into the tank from the manufacturer. Does this count for backup heat?

Answer:

Yes. In these consumer-sized integrated systems, the electrical resistance elements are set up to turn on when the HPWH is not able to meet the load demand, or the supply air temperature is too low, and will provide heat for how water.

Ventilation

Reference: Section 110.3(c)7B

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:

- Installation without ducts in a large room.
- Installation without ducts in a smaller room that is vented.

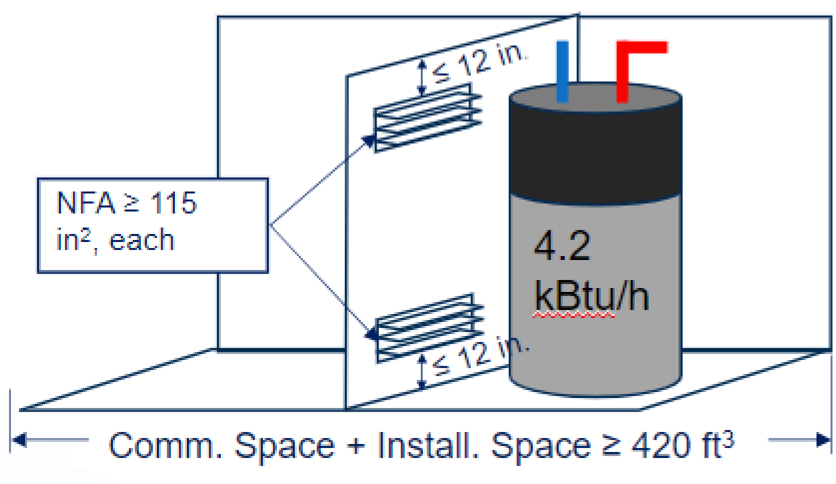
- Installation with ducts in any size room.
- Installation using a method not covered above that is supported by the manufacturer.

Selection of ventilation method will depend on the building design and situation, but it is up to the designer and installer. Detail for each method is discussed in the sections below.

It is important to note that HPWHs installed indoors impact the heating loads. The heat used to produce hot water with the compressor comes from the indoor air and therefore from the heating system in winter. This load should be considered when sizing heating equipment.

Figure 5-3: HPWH and Louvered Openings provides an example of a HPWH complying with Section 110.3(c)7B3.

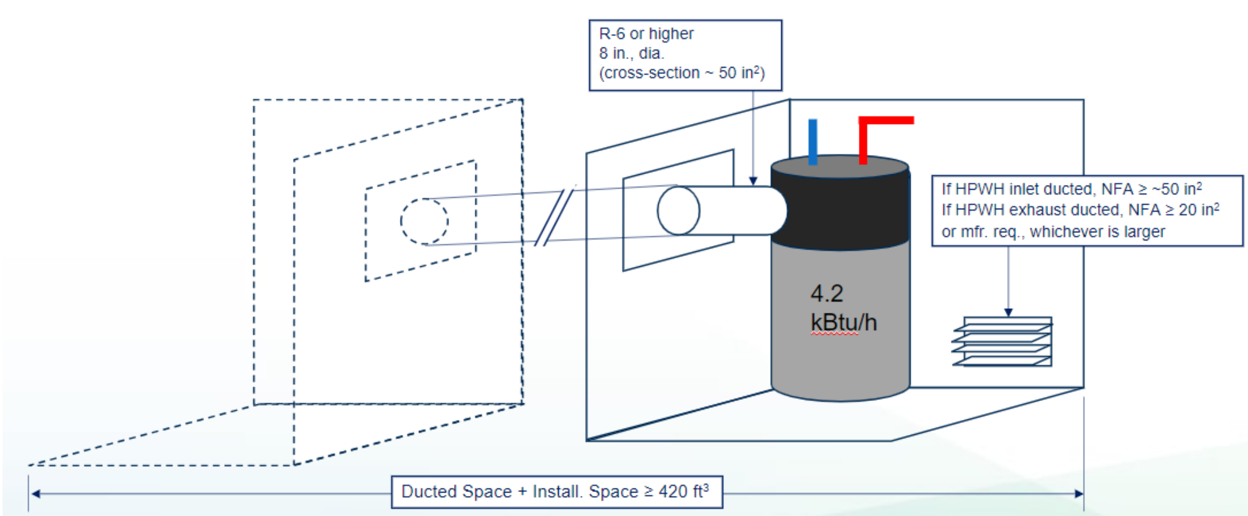
Figure 5-3: HPWH and Louvered Openings



Source: California Energy Commission

Figure 5-4: HPWH and Ducted Exhaust provides an example of a HPWH complying with Section 110.3(c)7B4.

Figure 5-4: HPWH and Ducted Exhaust



Source: California Energy Commission

Example 5-5: HPWHs Ventilation Method Selection

Question:

A consumer-sized integrated HPWH has been specified for installation. How do I determine the appropriate ventilation method and ventilation requirements?

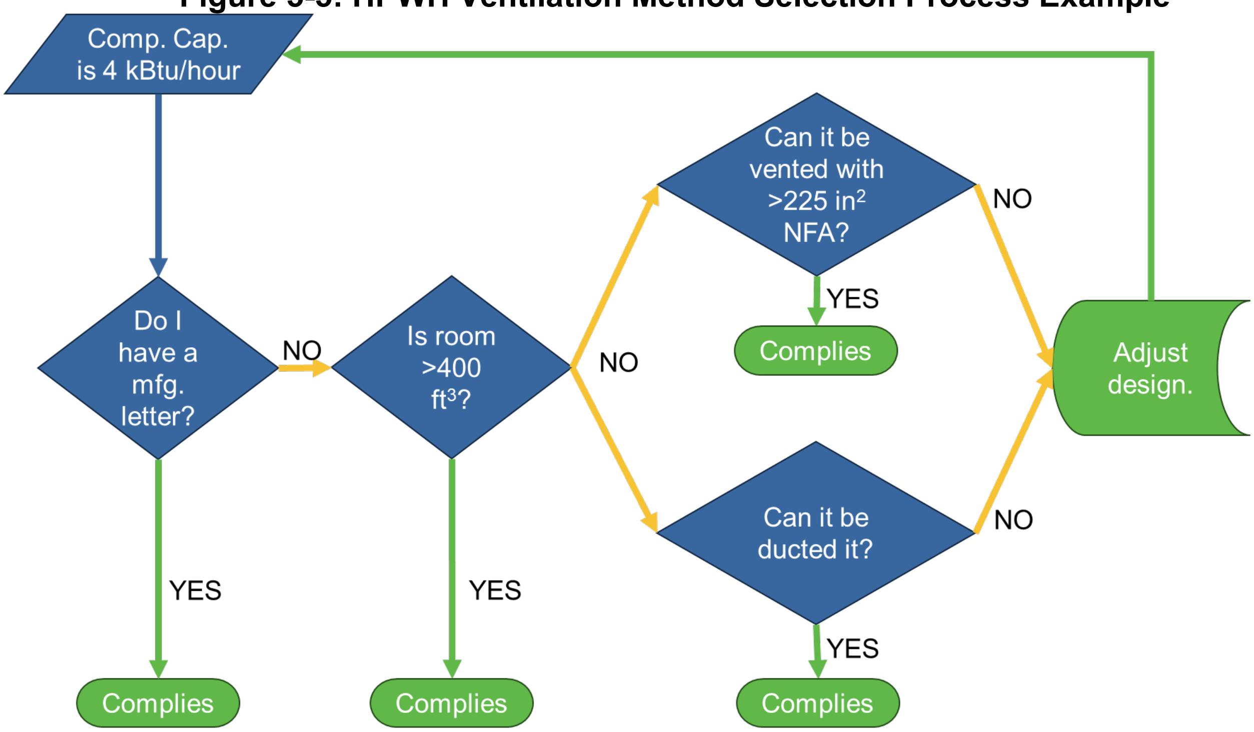
Answer:

The first step is to determine the compressor capacity. This can be obtained from manufacturer documentation or by contacting the manufacturer and requesting it. Most consumer-sized integrated HPWHs currently on the market have a compressor capacity of approximately 4 kBtu/hour, which will be used to continue this example.

This value is used to determine the minimum ventilation characteristics for each ventilation method. In all cases, if the installation manual specifies a minimum ventilation characteristic that is larger than required by code, then the manufacturer specified minimum must be used.

The flow chart below shows an example decision process for a HPWH with 4 kBtu/hour compressor capacity. This example assumes that the installation manual specifies the same requirements or less, making the minimums in the chart the mandatory minimums.

Figure 5-5: HPWH Ventilation Method Selection Process Example



Source: California Energy Commission

The process begins with checking whether the planned ventilation method is covered by code or is novel and requires a manufacturer letter. If a letter is needed and obtained, then the system complies. It is highly recommended to include the manufacturer letter with plan documents for reference by inspectors and in documentation provided to the building owner.

If a manufacturer letter 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 installation space must be vented with 225 square inches of net free area (NFA) or the HPWH must be ducted. There are additional requirements for these two methods which must also be met.

Example 5-6: HPWHs Ventilation Method Priority

Question:

I am installing a consumer-sized integrated HPWH in a garage with more volume than required by both Section 110.3(c)7B and the installation manual, but I want to duct the unit anyway. Is this still allowed?

Answer:

Yes. Each of the four methods for providing ventilation to HPWHs in Section 110.3(c)7B are independently valid methods and the availability or feasibility of one does not cause it to supersede the others.

Manufacturer Provided Ventilation Method

If the manufacturer provides a ventilation installation method that provides at least the same performance as the other ventilation methods, such method may be used. If no such method is provided, use of another method in Section 110.3(c)7B is required.

Installation in an Unvented Room

If the HPWH is to be installed without ducting in an unvented room, that room must have a volume equal to the greater of 100 cubic feet per kBtu per hour of compressor capacity or the minimum volume provided by the manufacturer for installation in an unvented room, whichever is greater.

Example 5-7: Determining Unvented Room Size

Question:

My consumer-sized integrated HPWH has a compressor capacity of 4 kBtu per hour. The manufacturer installation manual specifies a minimum room volume of 350 cubic feet. What is the minimum room volume required to meet the ventilation requirements of Section 110.3(c)7B?

Answer:

The minimum room volume per Section 110.3(c)7Bii is calculated using the compressor capacity:

4 kBtu per hour x 100 cu. ft. per kBtu per hour = 400 cu. ft.

This is larger than the manufacturer requirement of 350 cu. ft. Therefore, the minimum room volume required to meet the ventilation requirements of Section 110.3(c)7B is 400 cu. ft.

Installation with Ventilation

If the HPWH is to be installed without ducting in a vented room, that room’s openings for ventilation must meet the following requirements:

- Vent directly to a neighboring space that meets the minimum volume requirement for an install in an unvented room without ducts, minus the volume of the HPWH installation space.
- Ventilation openings must consist of a single layer of fixed flat slat louvers or grilles, with a total minimum 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.
- Ventilation openings must be either 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.

Example 5-8: Determining Required Ventilation Net Free Area

Question:

My consumer-sized integrated HPWH has a compressor capacity of 4 kBtu per hour. The manufacturer installation manual for a small closet install does not specify a minimum net free area (NFA), and just says the closet needs a "fully louvered door." What is the minimum NFA required to meet the ventilation requirements of Section 110.3(c)7B?

Answer:

The minimum NFA per Section 110.3(c)7Biii is calculated using the compressor capacity:

4 kBtu per hour x 25 sq. in. per kBtu per hour + 125 sq. in. = 225 sq. in.

If the installation manual does not specify a minimum NFA, the manufacturer may still have a requirement in other documentation or installer training. Contact the manufacturer for this information.

Example 5-9: Determining Net Free Area of a Vent

Question:

I wish to use a fully louvered door to vent the closet my HPWH will be installed in. How do I determine the NFA of a louvered door?

Answer:

Net free area is the total area of a vent through which air can freely flow. This can be obtained from either the door manufacturer or by direct measurement. For direct measurement, measure the width of the louvers and the thickness of the louver gap at its narrowest point and count the number of louver gaps. Multiply these three values together to obtain the NFA of the louvered door.

For example, a louvered door has louvers that are 26 inches wide. The gap between the louvers is 3/16ths of an inch at the narrowest point. There are 53 louver gaps.

26 x 0.1875 x 53 = 258.375 sq. in.

Example 5-10: Determining Net Free Area of a Vent

Question:

My client wants to use chevron louvers instead of flat slats. Is there a way for chevron louvers to comply?

Answer:

No. Chevron louvers resist the flow of air due to thermal buoyancy. Only fixed position flat slat louvers may be used.

Installation with Ducting

The HPWH may also be ducted. Section 110.3(c)7Biv requires the following when ducting a HPWH:

- The volume of the space joined to the installation space, plus the volume of the installation space via ducts, must meet the minimum volume of Section 110.3(c)7Bii.
- All duct connections and building penetrations must be sealed.
- Exhaust air ducts and all ducts which cross pressure boundaries must be insulated to minimum of R-6.
- Where only the HPWH inlet or outlet is ducted, the installation space must be vented. These vents must be permanent openings consisting of a single layer of fixed flat slat louvers or grilles in the bottom half of the room, and/or a door undercut.
- For ducted inlet, a minimum NFA equal to the cross-sectional area of the duct.
- For ducted exhaust, a minimum NFA the larger of 20 square inches or the minimum NFA provided by the manufacturer for this method.
- 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.

It is important to note that ducting only the inlet or exhaust across the pressure boundary could increase heating and cooling load and interfere with balanced ventilation systems. This should be considered when specifying HPWH location and ventilation method.

High-Efficiency Electric Ready for Gas Water Heater

Reference: Section 150.0(n)

To facilitate future installations of HPWH, the Energy Codes contain the following mandatory requirements for gas or propane water heaters. When a gas or propane water heater is installed, the building must be made electric ready to minimize future retrofit costs when gas appliances are replaced with electric appliances. Dedicated space for a future HPWH, and wiring is required to be run to the designated location. Space must also be reserved at the electric panel to serve a future heat pump water heater, and a condensate drain must be installed

These requirements are for newly constructed buildings and additions (if a water heater is installed in the added floor area), and they are not applicable to alterations. Moreover, these requirements are not applicable when installing an electric water heater.

- A dedicated 125-volt (V) electrical receptacle that is within 3 feet of the water heater and accessible to the water heater with no obstructions, and be connected to a three conductor, branch circuit rated at 30 amps minimum. In addition, the unused conductor must be labeled and electrically isolated and have a reserved circuit breaker space.

- A condensate drain that is no more than 2 inches higher than the base of the installed water heater and allows natural draining without pump assistance

These requirements make it easier for someone to retrofit HPWH in the future. Wiring during initial construction stage is much less costly than trying to retrofit it later.

Electrical Receptacle

The goal of this requirement is to allow easy installation of HPWH when the existing gas water heater needs to be replaced. HPWH typically requires a 240-volt circuit, and this requirement allows an electrician to easily convert the 120-volt circuit to a 240-volt circuit.

The electrical receptacle must be installed with 3 feet from the water heater. It should be connected to a dedicated circuit with a branch circuit rated at 30 amps minimum. The ends of the unused conductor must be labeled as "spare" and be electrically isolated. A reserved single-pole circuit breaker space must be placed in the electrical panel next to the circuit breaker for the branch circuit and labeled with the words "Future 240V Use."

Condensate Drain

Please refer to Chapter 5.3.5.2 of the *2022 Single-family Residential Compliance Manual*.

Mandatory Requirements for Hot Water Distribution Systems

Pipe Insulation for All Buildings

Please refer to Chapter 5.3.6.1 of the *2022 Single-family Residential Compliance Manual*.

Insulation Protection

Please refer to Chapter 5.3.6.2 of the *2022 Single-family Residential Compliance Manual*.

Prescriptive Requirements for Water Heating

Single Dwelling Units

Reference: Section 150.1(c)8

There are three options to comply with the prescriptive water heating requirements for newly constructed single dwelling units. For all three options, the water heater must comply with the mandatory requirements for water heaters. (See Mandatory Requirements for Water Heating.) If a recirculation distribution system is installed, only demand recirculation systems with manual control pumps are allowed. The three options are described below.

- Install a single 240-volt heat pump water heater. The storage tank shall be located in the garage or conditioned space. In addition, the building must comply with the following:
    - A compact hot water distribution design meeting the Basic Compact Design in climate zones 1 and 16.
    - A, ECC-verified drain water heat recovery system in climate zone 16.

- Install a single 240 volt heat pump water heater that meets the requirements of NEEA Advanced Water Heater Specification Tier 3 or higher.[1] For climate zone 16, the storage tank must be located in the garage or conditioned space and install a drain water heat recovery system that meets field verification described in Appendix RA3.6.9.
- A solar water-heating system with electric backup that meets the installation criteria specified in Reference Residential Appendix RA4.4.20 and with a minimum annual solar savings fraction of 0.7.

In climate zones 1 and 16, then one or more additional building features must be installed as shown above. These features require consideration at the start of the design process and must be coordinated with several players including the designer, general contractor, sub-contractor, and ECC Rater.

For more information on ECC-verified compact hot water distribution design, see Compact Hot Water Distribution System – Basic Credit and ECC-Verified Compact Hot Water Distribution System – Expanded Credit. ECC-verified compact hot water distribution designs are included in Option 1 described above.

For more information on ECC-verified drain water heat recovery system requirements, see Drain Water Heat Recovery System of this chapter. The Reference Appendix contains the requirements for the proper installation of the system (see RA4.4.21). An ECC-verified drain water heat recovery system is included in Options 1 and 2 described above.

Unless one of the three exceptions can be claimed, any other water heating system that differs from the three options described above does not meet the prescriptive requirements but can be installed using the performance approach as described in Performance Approach Compliance for Water Heating. The three Exceptions are:

- An electric water heater with point-of-use distribution (RA4.4.5) is allowed in new dwelling units of up to 500 ft2 conditioned floor area
- For new dwelling units with 1 or fewer bedrooms, a 120V HPWH may be used instead of a 240V HPWH.

For additions, the prescriptive requirements apply only if a water heater is being installed as part of the addition. In those cases, the prescriptive requirements would apply only to the space that is added, not the entire building.

For alterations where an existing water heater is being replaced, the water heater must meet the mandatory equipment efficiency requirements. Pipe insulation requirements do not apply to inaccessible piping. See Chapter 9 for a more detailed explanation for the water heating alteration requirements.

Example 5-11: Alterations

[1] The list of qualified product list of NEEA HPWH may be found here: https://neea.org/img/documents/qualified-products-list.pdf

Question:

If my house has an electric-resistance water heater and I plan to upgrade my water heater, do I need to install a gas instantaneous or gas storage water heater?

Answer:

No, because the existing water heater is an electric water heater, then a consumer electric water heater that meets the requirements of California's Appliance Efficiency Regulations or appropriate federal requirements can replace the existing water heater. If installing new piping to the water heater, then you will need to comply with the mandatory pipe insulation requirements for newly installed piping and any accessible existing piping. See Pipe Insulation for All Buildings for more information on pipe insulation requirement and Chapter 9 for more information on alterations.

Example 5-12: Additions

Question:

I am building an addition to my home that will be a self-contained apartment. Do I need to comply with the prescriptive water heater requirements?

Answer:

If the addition will include a water heater, or if it will be connected to the existing hot water distribution system to supply hot water to the apartment, then you must comply with the standards either through the prescriptive or performance path. If taking the performance approach, you can install any type of water heater as long as it 1) meets the requirements of California's Appliance Efficiency Regulations and 2) does not exceed the water heating energy budget for the self-contained building. If you were adding only an additional room with hot water and not a self-contained dwelling, then the water heating budget would be based on the existing building plus addition. (See Performance Approach Compliance for Water Heating.)

Example 5-13: Heat Pump Water Heaters

Question:

For a new home, can I install an electric heat pump water heater? Do I have to perform calculations to show compliance?

Answer:

Yes, electric heat pump water heaters (HPWHs) can be used for both prescriptive and performance compliance. Calculation is not necessary using the prescriptive compliance path. There are 2 prescriptive options for HPWH. Option 2 is the simplest option, which requires the installation of a NEEA Tier 3 or higher HPWH in the garage or conditioned space. For climate zones 2 – 15, no additional requirement is needed for compliance. For climate zones 1 and 16, compact hot water distribution and/or a drain water heat recovery system are also required, depending on the climate zone. For more details, see Single Dwelling Units above.

For performance compliance, the characteristic of the HPWH must be modeled, such as rated UEF or make and model of the HPWH if it is NEEA rated.

Example 5-14: Drain Water Heat Recovery

Question:

I'm in the schematic design phase for a single-family home. I intend to include drain water heat recovery in my design and to follow the prescriptive path. What are the primary design issues I should consider?

Answer:

If you follow the prescriptive path, drain water heat recovery is required in climate zones 1 and 16.

For all other water heater types, you could follow the performance path and obtain compliance credit within an energy model calculation. In any case, the initial design issues are related to the selection of an appropriate drain water heat recovery model (i.e. horizontal or vertical type, minimum rated effectiveness, and diameter and length), and designing the layout of the system.

If your residence is single story, then a horizontally rated unit is required. If your residence has multiple stories, then the unit can be horizontally or vertically rated. In any case, the required minimum rated effectiveness is 42 percent.

The diameter of the unit should match the diameter of the drainpipe. Added length improves effectiveness but requires more space.

In terms of the system layout, the unit must recover heat from at least the master bathroom shower and must at least transfer that heat back, either to all the respective showers or the water heater. To maximize savings, place the unit in a drain line that serves all the showers and pipe the preheated water to the cold side of all shower mixing valves and the make-up water inlet of the water heater. This is known as an equal flow configuration (see Figure 5-2: The Three Plumbing Configurations of DWHR Installation (From Left to Right: Equal Flow, Unequal Flow – Water Heater, Unequal Flow Fixture)), since the preheated water flow rate will match the drain water flow rate.

Demand Recirculation Control

Please refer to Chapter 5.4.1.1 of the *2022 Single-family Residential Compliance Manual*.

Performance Approach Compliance for Water Heating

Energy Budget Calculation

The performance method allows for modeling alternative water heater and distribution system combinations, which would impact the amount of compliance credits received for the system the performance of a heat pump water heater in most climate zones. In addition to a heat pump water heater, a compact hot water distribution system is required in climate zone 1 and 16 and a drain water heat recovery device also is required in climate zone 16. The water heating energy budget in climate zones 3, 4, 13, or 14, is based on the performance of a gas instantaneous water heater. Both gas and electric water heaters used in the standard design meet the minimum requirements in California's *Title 20 Appliance Efficiency Regulations* Section 1605.1(f) for federally regulated appliances

The computer performance approach allows for the modeling of water heating system performance by taking into account building characteristics, climate, system type, efficiency, and fuel type. The standard design water heating budget is defined by the corresponding prescriptive requirements. The performance method allows for modeling alternative water heater and distribution system combinations. Some of these options will offer compliance credits, and others will result in penalties.

Systems Serving a Single Dwelling Unit

In the case of single dwelling units, any type or number of water heaters supported by the software can be installed. 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 with a standard distribution system for gas water heaters, or a HPWH with compact distribution system and drain water heat recovery for electric water heaters. Adding multiple water heaters to a single-family design will generally result in an adjustment to the compliance credits in the water heating budget that must be offset elsewhere in the total energy budget.

A standard distribution system serving a single dwelling unit does not incorporate a pump for hot water recirculation and does not take credit for any additional DHW design features. All mandatory pipe insulation requirements must be met, such as insulating all hot water pipes. Alternative distribution systems are compared to the standard design case by using distribution system multipliers (DSMs), which effectively rate alternative options.

Table 5-4: Applicability of Distribution Systems Options Within a Dwelling Unit 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 represent an energy credit, while distribution systems with a multiplier greater than 1 will affect the energy usage simulated in the compliance software. For example, pipe Insulation with ECC 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. For more information or installation requirements on any of the systems, refer to Distribution Systems.

Table 5-4: Applicability of Distribution Systems Options Within a Dwelling Unit

Distribution System Types	Assigned Distribution System Multiplier	Systems Serving a Single Dwelling Unit
No ECC-Verification Required Trunk and Branch -Standard (STD)	1.0	Yes
No ECC-Verification Required Compact Design – Basic (CHWDS)	0.7	Yes
No ECC-Verification Required Parallel Piping (PP)	1.1	Yes
No ECC-Verification Required Point of Use (POU)	0.3	Yes

Distribution System Types	Assigned Distribution System Multiplier	Systems Serving a Single Dwelling Unit
No ECC-Verification Required Recirculation: Non-Demand Control Options (R-ND)	9.8	Yes
No ECC-Verification Required Recirculation with Manual Demand Control (R-Dman)	1.75	Yes
No ECC-Verification Required Recirculation with Motion Sensor Demand Control (R-DAuto)	2.6	Yes
ECC-Verification Required Pipe Insulation (PIC-H)	0.85	Yes
ICC Verification Required Parallel Piping with 5' maximum length (PP-H)	1	Yes
ICC Verification Required Compact Design - Expanded (CHWDS-H)	0.3 – 0.7[2]	Yes
ICC Verification Required Recirculation with Manual Demand Control (R-Drmc-H)	1.6	Yes
ICC Verification Required Recirculation with Motion Sensor Demand Control (RDRsc-H)	2.4	Yes

Source: California Energy Commission

Treatment of Water Heater Efficiency

Please refer to Chapter 5.5.3 of the *2022 Single-family Residential Compliance Manual*.

Compliance Issues

Please refer to Chapter 5.5.4 of the *2022 Single-family Residential Compliance Manual*.

Distribution Systems

Types of Water Heating Distribution Systems

Please refer to Chapter 5.6.1 of the *2022 Single-family Residential Compliance Manual*.

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[2] The multiplier for the Compact Design – Expanded credit varies depending on the home's floorplan and water heater location. See Section 5.6.2.4 for more information.

The water heating distribution system is the configuration of piping (and pumps and controls in the case of recirculating systems) that delivers hot water from the water heater to the end-use points within the building. For systems designed for single-family buildings, the system will resemble one of the system types described below under dwelling unit distribution systems. The installation of a hot water distribution system that does not meet all the installation guidelines discussed in this compliance manual and in the Reference Appendix RA3 and RA4 must either (a) have the deficiencies corrected, or (b) use the performance approach and compensate for the adjustments to the compliance credits. In all cases, the locations of the water heaters and fixtures should be given consideration at the beginning of building design. By minimizing the length of distribution piping, energy use, water waste, wait time for hot water and construction cost can all be reduced.

Systems Serving a Single Dwelling Unit

Standard Distribution System (Trunk-and-Branch and Mini-manifold Configurations)

Please refer to Chapter 5.6.2.1 of the *2022 Single-family Residential Compliance Manual*.

Central Parallel Piping System

The primary design concept in a central parallel piping system is an insulated main trunk line that runs from the water heater to one or more manifolds, which then feeds use points with ½" or smaller plastic piping. The traditional central system with a single manifold must have a maximum pipe run length of 15 feet between the water heater and the manifold. With the advent of mini-manifolds, the central parallel piping system can now accommodate multiple mini-manifolds in lieu of the single central manifold, provided that a) the sum of the piping length from the water heater to all the mini- manifolds is less than 15 feet and b) all piping downstream of the mini-manifolds is nominally ½ inch or smaller.

Installation Criteria and Guidelines

All applicable mandatory measures must be met. Piping between the water heater and the manifold must be insulated, and all branch piping past the framing member from the manifold must be insulated. Piping from the manifold cannot run up to the attic and then down to points of use on the first floor. The intent of a good parallel piping design is to minimize the volume of water entrained in piping between the water heater and the end-use points, with a focus on reducing the length of the 3/4-inch or 1-inch line from the water heater to the manifold(s). To encourage reducing the pipe length between the water heater and manifold, there is a distribution system compliance credit for installations that are ECC-verified to have no more than 5 feet of piping between the water heater and the manifold(s). The manifold feeds hot water use points with 3/8 or 1/2 inch PEX tubing. (Check with enforcement agencies on the use of 3/8-inch piping in the event that it is prohibited without engineering approval.) The adopted requirements for installation guidelines are included in RA3 and RA4.

Point of Use

Please refer to Chapter 5.6.2.3 of the *2022 Single-family Residential Compliance Manual*.

Compact Hot Water Distribution System – Basic Credit and ECC-Verified Compact Hot Water Distribution System – Expanded Credit

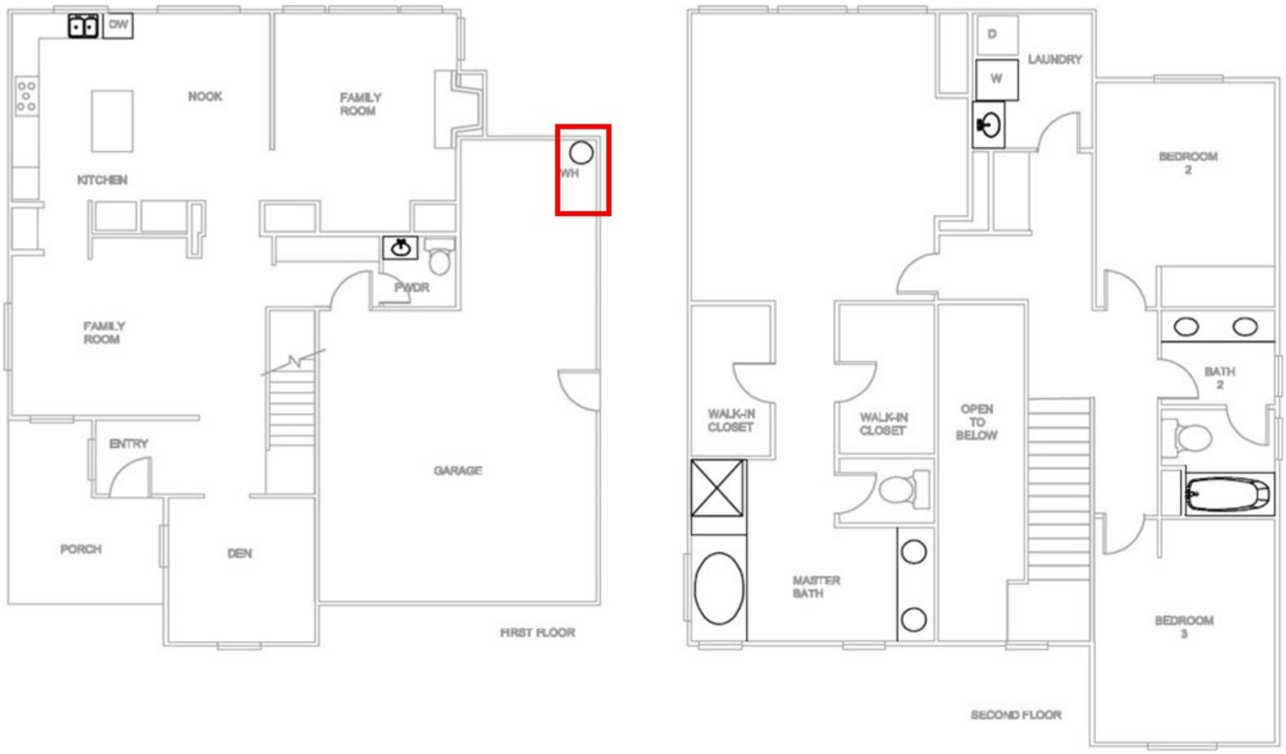
The intent of a compact hot water distribution system design is to reduce the size of the plumbing layout by bringing the water heater closer to hot water use points than is typical in standard homes. Through this process, energy and water will be saved, and homeowners will experience reduced hot water waiting times. This compliance option is applicable only to new single-family home.

Installed hot water distribution systems are often much larger than needed in terms of excessive pipe length and oversized pipe diameter. A design consideration that often is overlooked is the location of the water heater relative to hot water use points. Figure 5-6: "Common" Production Home House Layout below shows a common production home layout with the water heater in the corner of the garage and hot water use points in each corner of the house.

A more effective hot water distribution system design is shown in Figure 5-7: Compact Design Distribution System. In the figure, the location of the water heater is near the kitchen, bathrooms and laundry area. The location of hot water use points plays an integral role in achieving the benefits associated with a compact distribution system design.

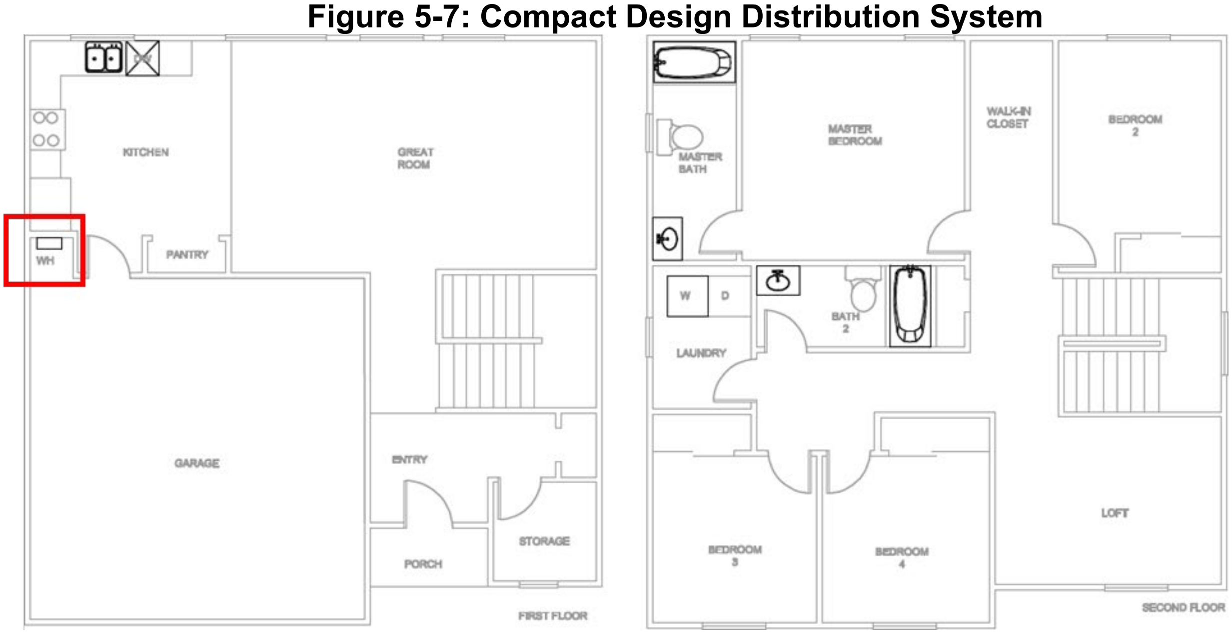
Eligible compact hot water distribution designs can generate a compliance credit using the performance approach. There are two versions of the Compact Design credit. Basic Credit does not require ECC-Verification, while Expanded Credit requires field verification by an ECC-Rater. Qualification for both 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 furthest hot water fixture from the water heater. 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), then the plan is eligible for the Basic Credit. The Basic Credit does not require any further verification steps to secure the compliance credit. If the builder chooses to pursue an Expanded Credit, additional energy savings will be recognized under the performance method, however there are several ECC-verification requirements that must be met.

Figure 5-6: "Common" Production Home House Layout



Source: 2019 CASE Initiative: Compact Hot Water Distribution

Figure 5-7: Compact Design Distribution System



Source: 2019 CASE Initiative: Compact Hot Water Distribution

Weighted Distance Calculation Method

Please refer to Chapter 5.6.2.4.1 of the *2022 Single-family Residential Compliance Manual*.

Qualification Distance Method

The Qualification Distance is a function of conditioned floor area (CFA), number of stories, and number of installed water heaters. The Qualification Distance for systems with multiple water heaters is identified by using the equation for the appropriate distribution system (recirculation or non-recirculation), and dividing by the number of water heaters installed as shown in the Equation below:

Qualification Distance = (a + b * CFA) / n

Where:

a, b = Qualification distance coefficients (unitless), see RA 4.6 Table 4.4.6-2,

CFA = Conditioned floor area of the dwelling unit (ft^2), and

n = Number of water heaters in the dwelling unit (unitless)

Drain Water Heat Recovery System

A drain water heat recovery system recovers heat that would otherwise be lost down the drain during showers, and transfers that heat back to the water heater, shower mixing valve, or both. These systems can help users comply with the water heating requirements in the Energy Codes using either the prescriptive or performance approach. To use these systems to comply with Energy Codes, the design and installation must be ECC-verified and meet the Reference Appendix RA4.4.21 requirements.

Recirculation System – Non-Demand Control Options

Please refer to Chapter 5.6.2.6 of the *2022 Single-family Residential Compliance Manual*.

Recirculation System – Demand Control

A demand-control recirculation system uses brief pump operation in response to a hot water demand "signal" to circulate hot water through the recirculation loop. The system must have a temperature sensor, typically located at the most remote point of the recirculation loop. Some water heaters have temperature sensors located within the water heater. The sensor provides input to the controller to terminate pump operation when the sensed temperature rises. Typical control options include manual push button controls or occupancy sensor controls installed at key use areas (bathrooms and kitchen). Push button control is preferred from a performance perspective, since it eliminates "false signals" for pump operation that an occupancy sensor could generate. The adopted requirements for installation guidelines are included in Reference Appendices RA3 and RA4.

Installation Criteria

All criteria listed for continuous recirculation systems apply. Piping in a recirculation system cannot be run up to the attic and then down to points of use on the first floor.

Pump start-up must be provided by a push button or occupancy sensor. Pump shutoff must be provided by a temperature sensing device that shuts off the pump when the temperature sensor detects no more than 10 degree rise above the initial temperature of water in the pipe or when the temperature reaches 102 degrees F. Moreover, the controls shall limit the maximum pump run time to five minutes or less.

Push buttons and sensors must be installed in all locations at least 20 feet from the water heater (measured along the hot water piping) with a sink, shower, or tub, with the exception of the laundry room.

Plans must include a wiring/circuit diagram for the pump and timer/temperature- sensing device and specify whether the control system is manual (push button or flow switch) or other control means, such as an occupancy sensor.

Combined Hydronic Systems

Please refer to Chapter 5.7 of the *2022 Single-family Residential Compliance Manual*.

Solar Water Heating

Please refer to Chapter 5.9 of the *2022 Single-family Residential Compliance Manual*.

Solar Or Recovered Energy in State Buildings

Section 110.3(c)5

Please refer to Chapter 5.9.1 of the *2022 Single-family Residential Compliance Manual*.

Solar-Ready Buildings Requirements

Reference: Section 150.0(r) and Section 110.10

Please refer to Chapter 5.9.1.1 of the *2022 Single-family Residential Compliance Manual*.

Swimming Pool and Spa Heating

Swimming Pool and Spa Types

Please refer to Chapter 5.10.1 of the *2022 Single-family Residential Compliance Manual*.

Mandatory Requirements for Pools and Spas

Reference: Section 110.4, Section 110.5

Before any pool or spa heating system or equipment may be installed, the manufacturer must certify to the Energy Commission that the system or equipment complies with Section 110.4 and Section 110.5. The requirements include minimum heating efficiency according to the *Appliance Efficiency Regulations*, an on-off switch outside the heater, permanent and weatherproof operating instructions, no continuous pilot light and minimum pool heating system sizing requirements.

Pool and spa heaters may not have continuously burning pilot lights.

Certification Requirements

A pool heater for a pool, spa, or pool and spa combination shall only be installed if the manufacturer has certified that it meets the following requirements:

- Efficiency: The equipment must meet state or federal appliance efficiency standards as specified in Section 110.1.
- On-Off Switch: The heater must have an easily accessible on-off switch on the outside, allowing the heater to be turned off without changing the thermostat setting.

Rating and instructions: The heater must have a permanent, readable, and weatherproof plate or card that shows the energy efficiency rating and provides instructions for efficient operation.

Installation Requirements

Reference: Section 110.4 (b)

Heating equipment installed to heat pool and/or spa water shall be selected from equipment meeting the standards shown in Table 5-5: Heating Equipment Standards.

Table 5-5: Heating Equipment Standards

Heating Energy Source	Standard
Electric Resistance	UL 1261
Gas-fired	ANSI Z21.56/CSA 4.7a
Heat Pump	AHRI 1160 and one of the following: CSA C22.2 No. 236, UL 1995, or UL/CSA 60335-2-40
Solar	ICC/APSP 902/SRCC 400 for solar pool heaters, ICC 901/SRCC 100 for solar collectors

Source: California Energy Commission

If a pool and/or spa does not currently use solar heating collectors, piping shall be installed to accommodate future installation. Contractors can choose one of three options:

- Leave at least 18 inches of vertical or horizontal pipe between the filter and heater.
- Plumb separate suction and return lines dedicated to future solar heating.
- Install built-up or built-in connections for future piping to solar heating (e.g., a capped-off tee fitting between the filter and heater).

Outdoor pools and/or spas with gas or electric heaters shall have a cover installed. The cover should be fitted and installed during the final inspection. All pool systems shall be installed with the following:

- Directional inlets to adequately mix the pool water.
- A permanent time switch or similar permanent control mechanism to control the circulation system, allowing the pump to run during off-peak periods and for the minimum time necessary to maintain water quality as required by public health standards.

Pool and/or spa heating systems or equipment for single family buildings must meet one of the following sizing requirements:

- A solar pool heating system with a solar collector surface area that is equivalent to at least 60 percent of the pool and/or spa surface area.
- A heat pump pool heater as the primary heating system that meets the HPPH manufacturer's sizing specifications, as specified in Reference Joint Appendix JA16.3. The supplementary heater can be of any energy source. If the HPPH manufacturer's specifications do not include information on HPPH sizing, follow the steps found in JA16.3
- A heating system that derives at least 60 percent of the annual heating energy from on-site renewable energy or on-site recovered energy.

- A combination of a solar pool heating system and heat pump pool heater without any additional supplementary heater; or
- A pool heating system determined by the Executive Director to use no more energy that the systems specified in items above.

There are five allowable exceptions to the heating source sizing requirements as listed below:

- Portable electric spas compliant with California's Appliance Efficiency Regulations (Title 20).
- Alterations to existing pools and/or spas with existing heating systems or equipment.
- A pool and/or spa that is heated solely by a solar pool heating system without any backup heater.
- Heating systems which are used exclusively for permanent spa applications in existing buildings with gas availability.
- Heating systems which are used exclusively for permanent spa applications where there is inadequate Solar Access Roof Area (SARA) as specified in Section 150.1(c)14 for a solar pool heating system to be installed.

Example 5-15

Question:

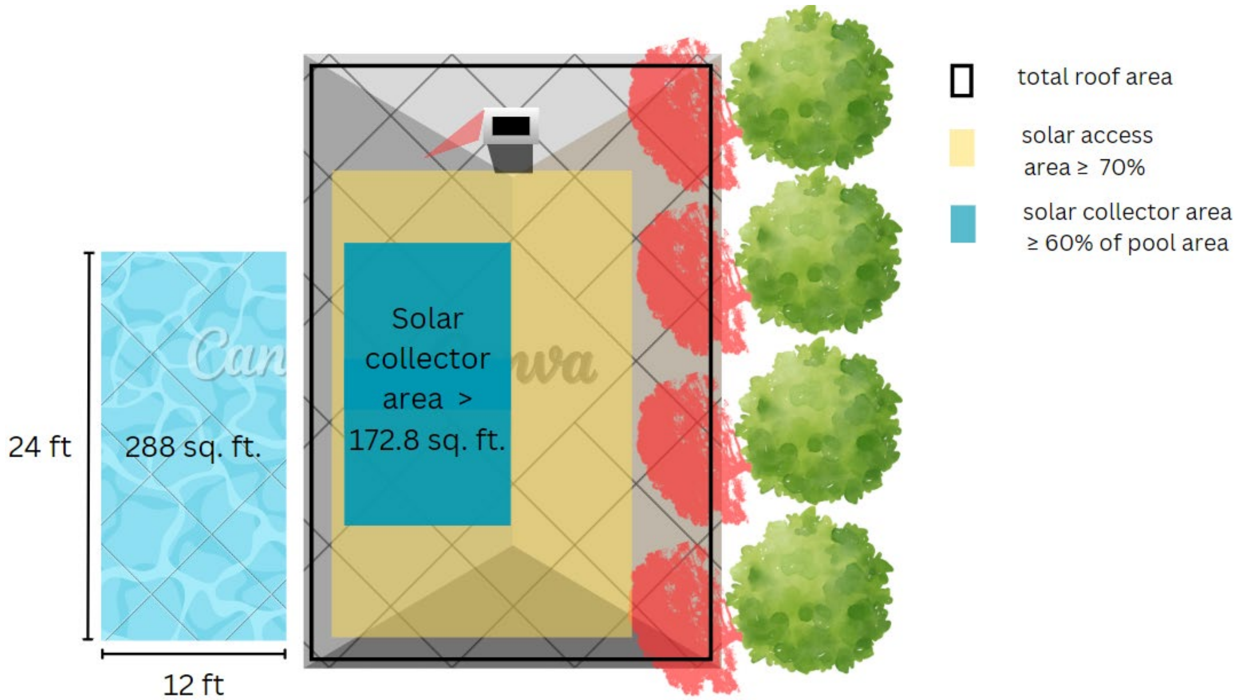
I am designing a residential swimming pool with a surface area of 288 square feet for a single family home. If I want to use a gas heater as a backup to solar, what would be the sizing requirements of my solar pool heating system?

Answer:

If you plan to use a gas heater as a backup, the solar pool heating system must have a solar collector surface area that is at least 60% of the pool's surface area. For a pool with a surface area of 288 square feet, the calculation is as follows: $288\ ft^2 \times 0.60 = 172.8\ ft^2$

You need to install a solar pool heating system with a collector surface area of at least 172.8 square feet.

Figure 5-8: Example Home for Solar Pool Heating



Source:

Additionally, you will need to determine the SARA for your building to ensure you have sufficient space for the solar collectors. This includes:

- Assessing Planned Obstructions: Identify any trees, structures, or other potential obstructions that could shade the solar collectors and reduce their efficiency. This assessment should cover the current situation as well as future landscaping plans. For steep slope roofs, only shading from permanent obstructions outside the dwelling (such as trees, hills, and adjacent structures) is considered. For low slope roofs, all obstructions, including those part of the building design, are considered.
- Determining Annual Solar Roof Access: Calculate the annual solar access for the roof area where the solar collectors will be installed. This involves considering shading patterns throughout the year to ensure that the collectors receive adequate sunlight.

If the roof area has less than 70% annual solar access due to shading or other obstructions, it may not be suitable for a solar pool heating system as per the regulations.

Example 5-15

Question:

I am installing a portable electric spa, the type that is factory built and delivered on a truck. Do I need to comply with the heating source sizing requirements outlined in Title 24?

Answer:

Your portable electric spa is excepted from the T24 pool heating sizing requirements. The portable electric spa must meet the minimum efficiency and cover requirements in Title 20 (20 CCR Section 1605.3(g)(7)).

Pool Pump Requirements

Reference: Section 150.0(p)1

For maximum energy efficiency, pool filtration should be operated at the lowest possible flow rate for a period that provides sufficient water turnover for clarity and sanitation. Auxiliary pool loads that require high flow rates, such as spas, pool cleaners, and water features, should be operated separately from the filtration to allow the filtration flow rate to be kept to a minimum.

All dedicated-purpose pool pumps and replacement motors must be listed in the Energy Commission's directory of certified equipment.

Dedicated-purpose pool pumps must comply with the standards in 20 CCR Section 1605.1(g)(7) of the Appliance Efficiency Regulations.

Replacement dedicated-purpose pool pump motors must comply with the standards in 20 CCR Section 1605.3 of the Appliance Efficiency Regulations.

The pool filtration flow rate may not be greater than the rate needed to turn over the pool water volume in 6 hours or 36 gallon per minute (gpm), whichever is greater. This means that for pools of less than 13,000 gallons, the pump must be sized to have a flow rate of less than 36 gpm, and for pools of greater than 13,000 gallons, the pump must be sized using the following equation:

$$Max\ Flow\ Rate\ (gpm) = \frac{Pool\ Volume\ (gallons)}{360\ minutes}$$

These are maximum flow rates. Lower flow rates and longer filtration times are encouraged and will result in added energy savings. All pool pumps sold in California must be tested and listed with the CEC according to the *Appliance Efficiency Regulations*. The pool pump must be chosen such that the flow rate calculated by the system curve is less than the 6-hour turnover rate. The following equation is used to calculate the system curve. The coefficient included in the equation is dependent on the capacity of the pool.

$$H = C \times F^2$$

Where,

- H = The total system head in feet of water
- F = The flow rate in gallons per minute (gpm)
- C =0.0167 for pools less than or equal to 17,000 gallons, or 0.0082 for pools greater than 17,000 gallons

Pool Pump Controls

Pool controls are a critical element of energy efficient pool design. Modern pool controls allow for auxiliary loads such as cleaning systems, solar heating, and temporary water features without compromising energy savings.

Pool Pipe, Filter, and Valve Requirements

Please refer to Chapter 5.10.2.3 of the *2022 Single-family Residential Compliance Manual*.

Compliance and Enforcement

Please refer to Chapter 5.11 of the *2022 Single-family Residential Compliance Manual*.

Design Review

Please refer to Chapter 5.11.1 of the *2022 Single-family Residential Compliance Manual*.

Field Inspection

Please refer to Chapter 5.11.2 of the *2022 Single-family Residential Compliance Manual*.

ECC Field Verification and/or Diagnostic Testing

Single Family

ECC-verification is required for all hot water distribution types that include options for field verification. The first type is alternative designs to conventional distribution systems that include parallel piping, demand recirculation, and automatic and manual on-demand recirculation. The second type is for compact distribution systems earning the expanded credit, which can be used only when verified by field verification. For all of the cases where ECC-verification is required, the ECC-Rater must verify that the eligibility requirements in RA3.6 for the specific system are met.

In addition, ECC-verified drain water heat recovery is an option for prescriptive compliance and as a compliance credit for the performance approach.

Glossary/Reference

General Glossary/Reference for Water Heating

Please refer to Chapter 5.12.1 of the *2022 Single-family Residential Compliance Manual2022 Single-family Residential Compliance Manual*.

General Glossary/Reference for Swimming Pool and Spa

Relevant terms are defined in Reference Joint Appendix JA1. The following are terms that are either not defined in JA1 or expansions to the Appendix I definitions.

- Flow rate is the volume of water flowing through the filtration system in a given time, usually measured in gallons per minute.
- Nameplate power is the motor horsepower (hp) listed on the nameplate and the horsepower by which a pump is typically sold.
- Pool pumps usually come with a leaf strainer before the impeller. The pumps contain an impeller to accelerate the water through the housing. The motors for residential pumps are included in the pump purchase but can be replaced separately. The pumps increase the "head" and "flow" of the water. Head is necessary to move fluid through pipes, drains, and inlets, push water through filters and heaters, and project it through fountains and jets. Flow is the movement of the water used to maintain efficient filtering, heating, and sanitation for the pool.
- Return refers to the water in the filtration system returning to the pool. The return lines or return side, relative to the pump, can also be defined as the pressure lines or the pressure side of the pump. Water in the returns is delivered back to the pool at the pool inlets.
- Service factor indicates the percentage above nameplate horsepower at which a pump motor may operate continuously when full-rated voltage is applied and ambient

temperature does not exceed the motor rating. Full-rated pool motor service factors can be as high as 1.65. A 1.5 hp pump with a 1.65 service factor produces 2.475 hp (total hp) at the maximum service factor point.

- Suction created by the pump is how the pool water gets from the skimmers and drains to the filtration system. The suction side and suction lines refer to the vacuum side of the pump. It is at negative atmospheric pressure relative to the pool surface.
- Total dynamic head (TDH) refers to the sum of all the friction losses and pressure drops in the filtration system from the pools drains and skimmers to the returns. It is a measure of the system's total pressure drop and is given in units of either psi or feet of water column (sometimes referred to as "feet" or "feet of head").
- Total motor power or T-hp refers to the product of the nameplate power and the service factor of a motor used on a pool pump.
- Turnover is the act of filtering one volume of the pool.
- Turnover time (also called turnover rate) is the time required to circulate the entire volume of water in the pool or spa through the filter. For example, a turnover time of 6 hours means an entire volume of water equal to that of the pool will be passed through a filter system in six hours.

$$Turnover\ Time = \frac{Volume\ of\ the\ pool}{Flow\ Rate}$$