Proposal Summary

Multifamily Domestic Hot Water Systems

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Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on February 17, 2023. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback. To provide your comments, email info@title24stakeholders.com by March 3rd, 2023.

Measure Description

The Multifamily Domestic Hot Water Systems topic covers measures related to hot water distribution, heat pumps systems, and electric readiness, as described below.

California Plumbing Code (CPC) Appendix M Pipe Sizing

This measure would add a prescriptive requirement for pipe sizing according to CPC Appendix M for both central and individual DHW systems in multifamily buildings pending final adoption in CPC. The California Building Standards Commission approved the Department of Housing and Community Development (HCD) proposal to adopt UPC Appendix M in March 2023. HCD has jurisdiction over multifamily buildings and final adoption of UPC Appendix M expected in August 2023 will allow builders to utilize the new pipe sizing procedure as a voluntary option in the California Plumbing Code.

Pipe Insulation Enhancement

This measure would add a mandatory requirement for field verification of pipe insulation quality. The measure would also focus on investigating the pipe insulation requirements of sections 160.4 for possible cleanup. These sections would require that all appurtenances (pumps, valves, strainers, etc.) in series in the DHW system heating plant and recirculation loop be insulated. It would add a requirement for insulating pipe supports or hangers. Continuous pipe insulation requirements at the heating plant and recirculation loop including hangers and appurtenances would reduce pipe heat losses by ensuring all exposed elements are insulated. It adds installation quality requirements

to seal seems, use extended stem isolation valves and specific insulation installation practices for tees and elbows. The clarifications to section 160.4 should simplify pipe insulation verification.

Require Balancing Valves

This measure would add a compliance option for thermostatic (thermal) balancing valves for each riser or zone (minimum of two) in combination with installation of variable speed pumps with differential pressure control on a centralized DHW system with recirculation. This compliance option would be available to distribution systems with smaller circulation systems as determined by calculating the total developed length of the circulation return piping. This measure is also applicable to additions and alterations of existing buildings, and is most likely to apply when the heating plant is being replaced at end of life.

Master Mixing Valves

This measure would add a prescriptive measure to install thermostatic master mixing valves (MMV) on the centralized heating plant hot water supply outlet header leading to the recirculation loop. MMVs are traditionally used to mitigate pathogen growth and scalding risk, but new research has shown that they offer energy saving benefits from lower recirculation loop heat losses and improved tank water temperature stratification versus mixing or tempering the hot water at each dwelling unit. MMVs precisely control the distribution supply temperature and redirect the warm return water back to the distribution system and away from the water heating plant. MMVs enhance load shifting capabilities with HP based heating plants and provide the ability to safely increase storage heating capacity of the heating plant without adding additional storage volume.

Demand Control Clean-up

The CASE team proposes to remove the prescriptive requirement for demand recirculation systems serving multiple dwelling units to align with technical considerations for multifamily applications (Prescriptive)

Individual HPWH Ventilation

This measure would establish ventilation criteria and requirements for consumer individual HPWHs. The CASE Team will evaluate ventilation approaches such as ducting and net free area for louvered doors, and venting sources (indoor vs. outdoor). Savings per dwelling unit are expected to be the same for both multifamily and single family. The measure would include mandatory requirements for minimum ventilation for all occupancies. This includes requirements for ventilation with three installation methods:

- Large unvented room, with minimum room volume of 100 ft3 / kBtu/h of compressor capacity or manufacturer provided requirements.
- Small vented room.
    - Minimum room volume of 20 ft3 / kBtu/h of compressor capacity or manufacturer provided requirements.
    - Larger of 125 in2 plus 25 in2 per kBtu of compressor capacity net free area or manufacturer provided requirements.
- Directly ducted in any size room, with some basic requirements like insulating the exhaust duct and sealing joints.
- Novel ventilation methods approved by the manufacturer and included in permit application.

Central HPWH Cleanup

For the 2022 code cycle, the Statewide CASE Team developed an alternate compliance pathway for central HPWH systems. The prescriptive requirements include basic equipment, plumbing, control, and design documentation requirements. It provides prescriptive compliance pathway for a wide range of central HPWH design options. This measure would improve the current prescriptive requirement by:

- Revise the existing prescriptive requirement to use single-pass HPWH as the primary HPWH equipment in DHW plant design. Additional revisions include removing primary storage tank plumbing configuration requirement to allow design flexibility, clean-up recirculation loop tank heater requirements.

- Add alternative prescriptive pathway leveraging the Northwest Energy Efficiency Alliance (NEEA)'s Advanced Water Heating Specification V8.0 for commercial HPWH system to allow design flexibility, ensure system efficiency and reliability using prescriptive pathway.

Central DHW Electric-Ready

The central DHW electric readiness mandatory measure would add electrical, space, ventilation, and condensate requirements at the time of construction to accommodate the future retrofit or replacement of fossil-fuel burning devices with electricity-powered devices. Specific requirements include:

- Physical space to accommodate electric water heating equipment and storage requirements in the future;
- Identification of ventilation access;
- Installation of condensate drain lines;
- Electrical system sizing and design to accommodate shifts to electric devices in the future; and

- Design documentations that the building design meets the requirements, to be approved by certified professionals.

Individual DHW Electric-Ready Cleanup

This mandatory measure would evaluate the current code language requirement for a "dedicated 125-volt, 20-amp electrical receptacle that is connected to the electric panel with a 120/240-volt 3 conductor, 10 AWG copper branch circuit", considering the distance between the main panel and water heater location. The CASE Team proposes revising the size to be rated at 30A to accommodate concerns about the likely voltage drop in multifamily applications. In addition, the CASE Team proposes new requirements including minimum space requirements and minimum ventilation requirements.

Data Needs/Stakeholder Information Requests

Data may be provided anonymously. To participate or provide information, please email Dove Feng, jfeng@trccompanies.com directly and cc info@title24stakeholders.com.

California Plumbing Code (CPC) Appendix M Pipe Sizing

- What standard or method do you use to size piping in MF buildings?
- Have you sized piping using Appendix M? If no, why not? If yes, do you have any concerns or feedback on the design, submittal or installation process?
- Would you size piping using Appendix M if it is adopted by the CPC as an alternative pipe sizing methodology?

Pipe Insulation Enhancement

- On a percentage basis, how often is pipe insulation not installed according to drawings and instructions?
- What standard pipe insulation requirements do you provide on drawings as a designer or apply from drawings as an installer?
- What are the typical field issues encountered with pipe insulation installs? Here is a list of example issues: gaps, insulation thickness doesn’t meet code minimum, damaged insulation, uninsulated fittings or valves, uninsulated pipe supports, and direct contact with metal pipe hangers to pipe.

Require Balancing Valves

- Can the installation of automatic balancing valves reduce installation costs as compared to the installation of manual balancing valves?
- What is common practice for balancing manual valves serving multi-riser distribution systems, and how does this impact installed performance?

- Are you aware of any independent field or lab studies that isolate the energy savings due to thermal balancing valves?

Master Mixing Valves

- What types of master mixing valves do you specify or install in MF central hot water systems with continuous recirculation? Here is a list of example types: 1) Single Mechanical Thermostatic Valve, 2) High/Low Set of Mechanical Valves, 3) Digital/Electronic Thermostatic Valve
- Do you install parallel MMVs for sizing purposes, redundancy purposes or to conduct routine maintenance?
- Do you see maintenance issues with thermostatic or digital MMVs?
- What performance, cost or reliability factors influences your MMV specification?

Demand Control Clean-up

- What is current practice in the industry, and are there performance concerns?
- Is it possible to capture the energy savings potential of demand control with another method of pump/distribution system control?

Individual HPWH Ventilation

- **Technical Feasibility**
    1. What is the typical DHW room size?
    2. How common is ducting in HPWH installs?
    3. What is the current practice to determine if a HPWH should be ducted or not?
- **Market Readiness**
    1. Are there unitary HPWH models available that do not provide a ducted option?
    2. What is currently used for ducting with HPWHs?
    3. For installers who have been called back to a site for HPWH issues, what have the issues been and how were they resolved?
        - Condensation in ducting?
        - Noise?
    4. What commissioning steps can be required of installers to ensure performance?
- **Costs**
    - What would be the incremental cost of ducting if the space in the DHW room was insufficient and could not otherwise be vented?

- What are the costs associated with marking the minimum clearances for the HPWH on the floor around its installed location if installed in a room with a volume less than 700 cu. Ft.?

Central HPWH Clean up

- What are the different design configurations that the code needs to address?
- How does each central HPWH design configuration compare to each other in terms of cost and energy efficiency?

Central DHW Electric-Ready

- During the new building design process, what planning needs to be done to make the central heat pump water heater electric ready?
- What other infrastructure needs to be installed during new-construction to make the central water heater electric-ready?

Individual DHW Electric-Ready Cleanup

- What is the minimum space required for a future heat pump water heater? Is there a standard closet size that we should know of when developing minimum space requirements?

Draft Code Language

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2022 documents are marked with red underlining (new language) and ~~strikethroughs~~ (deletions). Expected sections or tables of the proposed code (but not specific changes at this time) are highlighted in yellow.

Standards

SECTION 100.1 – DEFINITIONS AND RULES OF CONSTRUCTION

Section 100.1(b) – Definitions: Recommends new or revised definitions for the following terms:

AIR-TO-WATER HEAT PUMP (AWHP) is a factory-made packaged heat pump system containing one or more compressors, refrigerant-to-air and refrigerant-to-water heat exchangers, and other components for providing heated or cooled water for satisfying space conditioning loads, and in some cases domestic hot water requirements.

HEAT PUMP WATER HEATER (HPWH) is a water heater that transfers thermal energy from one temperature level to another ~~higher temperature level~~ for the purpose of

heating water, including all ancillary equipment such as fans, storage tanks, pumps, or controls necessary for the device to perform its function.

~~**SINGLE-PASS HEAT PUMP WATER HEATER** is a HPWH which the cold water passes through the heat pump(s) once and is heated to the intended storage temperature.~~

~~**MULTI-PASS HEAT PUMP WATER HEATER** is a HPWH which the cold water passes through the heat pump(s) multiple times, each time gaining a temperature increase, until the tank reaches the intended storage temperature.~~

INDIVIDUAL HEAT PUMP WATER HEATER is a HPWH which has all components, including fans, storage tanks, pumps, or controls necessary for the device to perform its function contained in a single factory-made assembly.

SPLIT-REFRIGERANT HEAT PUMP WATER HEATER is a HPWH which has a single outdoor section and one or more indoor sections connected to the outdoor section via a refrigerant circuit.

SPLIT-HYDRONIC HEAT PUMP WATER HEATER is a HPWH which has two distinct sections, one which has all refrigerant containing components and one or more storage sections, with all sections connected via a hydronic circuit.

SINGLE-PASS WATER HEATER is a water heater which the cold water passes through once and is heated to the intended use temperature.

MULTI-PASS WATER HEATER is a water heater which the cold water passes through multiple times, each time gaining a temperature increase, until the storage tank reaches the intended storage temperature.

NET FREE AREA is the total unobstructed area of the air gaps between louver and grille slats in a vent through which air can pass. The narrowest distance between two slats, perpendicular to the surface of both slats is the air gap height. The narrowest width of the gap is the air gap width. The NFA is the air gap height multiplied by the air gap width multiplied by the total number of air gaps between slats in the vent.

DOMESTIC HOT WATER SYSTEM APPURTENANCE are all elements that are in series in a domestic hot water distribution system, including fittings (elbows, tees, flanges, etc), pumps, valves (isolation, mixing, balancing, check, etc.), pipe supports and hangers, strainers, hose bibs, coil u-bends, meters, sensors, heat exchangers and air separators.

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

Section 110.3(c) – Installation: Recommends new subsection as follows:

7. **Heat pump water heaters.** Consumer integrated heat pump water heater (HPWH) installation shall meet the following requirements.

   A. **Outdoor Design Conditions.** Consumer integrated HPWHs with compressor cutout temperatures above the Winter Median of Extremes temperature for the closest location listed in Table 2-3 from Reference Joint Appendix JA2 may use unconditioned air as the inlet air source if equipped with a backup heat source that engages when the compressor is unable to provide sufficient heat for domestic hot water.

   B. **Ventilation Method.** Air for ventilation of consumer integrated heat pump water heaters (HPWHs) shall be obtained by application of one of methods in subsections 1 through 4. Spaces joined to the installation space via the applied ventilation method (the ventilation space) shall have a minimum volume (including the volume of the installation space) of 100 cu. ft. per kBtu of total compressor capacity for all HPWHs in the installation space. Only rooms or spaces directly communicating with the installation space or the ventilation space through openings that cannot be closed using doors or other movable barriers shall be considered part of the volume of the installation space or ventilation space.

      1. Installed without ducts in a space with a minimum volume equal to the larger of 100 cu. ft. per kBtu/hr of total compressor capacity for all individual HPWHs in the space or the minimum installation space volume provided by the manufacturer for this method.

      2. Installed without ducts in a space smaller than required by subsection 1 above, according to the following requirements:

         i. Minimum volume of the installation space shall be equal to the larger of 20 cu. ft. per kBtu/hr of compressor capacity for all individual HPWHs in the space or the minimum installation space volume provided by the manufacturer for this method; and

         ii. Installation space shall be vented to a communicating space in the same pressure boundary via permanent openings with the minimum total NFA equal to the larger of 125 sq. in. plus 25 sq. in. per kBtu/hr of compressor capacity for all individual HPWHs in the space or the minimum NFA provided by the manufacturer for this method, and that meet the following requirements:

a. Fully louvered doors with fixed louvers consisting of a single layer of fixed flat slats; or

b. Two permanent fixed openings, consisting of a single layer of fixed flat slat louvers or grilles, one commencing within 12 inches from the top of the enclosure and one commencing within 12 inches from the bottom of the enclosure.

3. Installed with ducts in any size space, according to manufacturer requirements and the following:

   i. All ducts shall be sealed at all joints using mastic.

   ii. All wall, floor, and ceiling penetrations are sealed using caulk or spray foam to join the exterior surface of the duct or duct insulation to the penetrated assembly; and

   iii. Exhaust air ducts and all ducts which cross pressure boundaries shall be insulated to a minimum insulation level of R-6.

   iv. If only makeup air is ducted, installation space shall include fixed flat slat louvers or grilles in the bottom half of the room, and/or a door undercut with a minimum total free area equal to the hydraulic diameter of the duct.

   v. If only exhaust air is ducted, installation space shall include a single layer of fixed flat slat louvers or grilles, and/or a door undercut with a minimum total NFA equal to the larger of 20 sq. in. or the minimum NFA provided by the manufacturer for this method.

   vi. If makeup and exhaust ducts both terminate within the same pressure boundary, airflow from termination points shall be diverted away from each other.

4. Installed using method for ventilation certified by the manufacturer. A letter from the manufacturer providing this certification shall be included with plans submitted to the enforcement agency for approval.

SECTION 160.4 – MANDATORY REQUIREMENTS FOR WATER HEATING SYSTEMS

(Note to reviewer: Section 160.4 (a) moved to 160.9 as part of the electric ready measure proposal)

~~(a)~~ Reserved. ~~Systems using gas or propane water heaters to serve individual dwelling units shall include the following components:~~

~~1. A dedicated 125 volt, 20 amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor, 10 AWG copper branch circuit, within 3 feet from the water heater and accessible to the water heater with no obstructions. In addition, all of the following:~~

~~A. Both ends of the unused conductor shall be labeled with the word "spare" and be electrically isolated; and~~

~~B. A reserved single pole circuit breaker space in the electrical panel adjacent to the circuit breaker for the branch circuit in A above and labeled with the words "Future 240V Use"; and~~

~~2. A Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed; and~~

~~3. 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, and~~

~~4. A gas supply line with a capacity of at least 200,000 Btu/hr.~~

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

(c) 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 by a listing agency that is approved by the Executive Director.

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

(e) 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).

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.
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(e)3: Boilers with steady state full-load combustion efficiency 90 percent or higher.

(f) Pipe Insulation ~~for piping and tanks~~

1. All piping for multifamily domestic hot water systems shall be insulated to meet the requirements of Table 160.4-A. Multifamily buildings shall comply with the applicable requirements of Sections 160.4(f)1A through 160.4(f)1E.

   A. **Insulation Requirements.**

      i. 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.

      ii. Insulation on the piping and appurtenances shall be continuous.

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

      iv. All pipe insulation seams shall be sealed.

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

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

      vii. Extended stem isolation valves shall be installed.

      viii. 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:

         a. 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.

b. 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".

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

d. The insulation shall not impede the functionality of the valve (e.g., opening and closing an isolation valve).

B. 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. Hot water piping includes the pipe or tube and the fittings (elbows, tees, couplings, etc.). Plumbing appurtenances include all elements that are in series with the hot water piping, such as flanges, pumps, valves (isolation, mixing, balancing, check, etc.), strainers, hose bibs, meters, sensors, heat exchangers and air separators.

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

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

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

D. **Insulation thickness.**

i. For insulation with a 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.

ii. For insulation with a conductivity outside the range shown in Table 160.4-A for the applicable fluid temperature range, the insulation shall have a minimum R-value shown in Table 160.4-A or thickness as calculated with Equation 160.4-A:

$$T = PR\left[\left(1 + \frac{t}{PR}\right)^{\frac{K}{k}} - 1\right]$$ (Equation 160.4-A)

WHERE:

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

PR = 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.

E. Insulation verification.

i. For hot water piping serving individual and multiple dwelling units, heating plant and recirculation system piping insulation quality shall be field verified to meet the pipe insulation mandatory requirements. The HERS rater shall inspect the heating plant and horizontal supply header and return piping. The rater shall use a sampling approach for vertical supply risers and branches to ensure pipe insulation has been installed.

Exception 1 to Section 160.4(f)1: 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(f)1: 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(f)1: 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

Fluid Operating Temperature Range (°F)	Insulation Conductivity			Nominal Pipe Diameter (in inches)				
	Conductivity (in Btu·in/h·ft²· °F)	Mean Rating Temperature (°F)		< 1	1 to <1.5	1.5 to < 4	4 to < 8	8 and larger
Multifamily Domestic Hot Water Systems				Minimum Pipe Insulation Required (Thickness in inches or R-value)				
105-140[1]	0.22-0.28	100	Inches	1.0	1.5	2.0	2.0	2.0
			R-value	R 7.7	R 12.5	R 16	R 12.5	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.

SECTION 160.9 – MANDATORY REQUIREMENTS FOR ELECTRIC READY BUILDINGS

For the electric ready equipment in 160.9 a - e, any intervening subpanels, panelboards, switchboards, and busbars shall be sized to meet the future electric power requirements, ~~at the service voltage~~ from the specified electric ready components to the point at which the conductors serving the building connect to the utility distribution system. The building service conduit shall also be sized to meet the future electric power requirements. The capacity requirements may be adjusted for demand factors in accordance with the California Electric Code.

(a) Heat Pump Space Heater Ready. Systems using gas or propane furnaces to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the furnace and accessible to the furnace with no obstructions. The branch circuit conductors shall be rated at 30 amps minimum. The blank cover shall be identified as “240V ready”. All electrical components shall be installed in accordance with the *California Electrical Code*.
2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future heat pump space heater installation. The reserved space shall be permanently marked as “For Future 240V use”.

(b) Electric Cooktop Ready. Systems using gas or propane cooktops to serve individual dwelling units shall include the following:

1. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the cooktop and accessible to the cooktop with no obstructions. The branch circuit conductors shall be rated at 50 amps minimum. The blank cover shall be identified as “240V ready”. All electrical components shall be installed in accordance with the *California Electrical Code*.

2. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric cooktop installation. The reserved space shall be permanently marked as “For Future 240V use”.

(c) Electric Clothes Dryer Ready. Clothes dryer locations with gas or propane plumbing shall include the following:

1. Systems serving individual dwelling units shall include:

A. A dedicated 240 volt branch circuit wiring shall be installed within 3 feet from the clothes dryer location and accessible to the clothes dryer location with no obstructions. The branch circuit conductors shall be rated at 30 amps minimum. The blank cover shall be identified as “240V ready”. All electrical components shall be installed in accordance with the *California Electrical Code*.

B. The main electrical service panel shall have a reserved space to allow for the installation of a double pole circuit breaker for a future electric clothes dryer installation. The reserved space shall be permanently marked as “For Future 240V use”.

2. Systems in common use areas shall include:

A. Conductors or raceway shall be installed with termination points at the main electrical panel, via subpanels panels if applicable, to a location no more than 3 feet from each gas outlet or a designated location of future electric replacement equipment. Both ends of the conductors or raceway shall be labelled “Future 240V Use.” ~~The conductors or raceway and any intervening subpanels, panelboards, switchboards, and busbars shall be sized to meet the future electric power requirements, at the service voltage to the point at which the conductors serving the building connect to the utility distribution system, as specified below. The capacity requirements may be adjusted for demand factors in accordance with the California Electric Code.~~ Gas flow rates shall be determined in accordance with the California Plumbing Code. Capacity shall be one of the following:

i. 24 amps at 208/240 volts per clothes dryer;

ii. 2.6 kVA for each 10,000 Btu per hour of rated gas input or gas capacity; or

30. iii. The electrical power required to provide equivalent functionality of the gas-powered equipment as calculated and documented by the responsible person associated with the project.

(d) Systems using gas or propane water heaters to serve individual dwelling units shall include the following components:

1. A dedicated 125 volt, 20 amp electrical receptacle that is connected to the electric panel with a 120/240 volt 3 conductor, copper branch circuit rated to 30 amps, within 3 feet from the water heater and accessible to the water heater with no obstructions. In addition, all of the following:

    A. Both ends of the unused conductor shall be labeled with the word "spare" and be electrically isolated; and

    - B. A reserved single pole circuit breaker space in the electrical panel adjacent to the circuit breaker for the branch circuit in A above and labeled with the words "Future 240V Use"; and

2. A Category III or IV vent, or a Type B vent with straight pipe between the outside termination and the space where the water heater is installed; and
3. 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, and
4. A gas supply line with a capacity of at least 200,000 Btu/hr.
5. The construction drawings shall indicate the location of the future heat pump water heater. The reserved location shall have minimum interior dimensions of 39"x39"x96"
6. A ventilation method meeting one of the following:
    A. Installed in space with minimum volume of 450 cu. ft., or
    B. Installed in a smaller space vented to a communicating space in the same pressure boundary via permanent openings with a minimum total net free area of 250 sq. in., so that the total combined space connected via permanent openings is 450 cu. ft. or larger. The permanent openings shall be:
        1. Fully louvered doors with fixed louvers consisting of a single layer of fixed flat slats; or
        2. Two permanent fixed openings, consisting of a single layer of fixed flat slat louvers or grilles, one commencing within 12 inches from the top of the enclosure and one commencing within 12 inches from the bottom of the enclosure.
    C. Installed with two 8" capped ducts, venting to exterior

1. All ducts shall be sealed at all joints using mastic.
2. All wall, floor, and ceiling penetrations are sealed using caulk or spray foam to join the exterior surface of the duct or duct insulation to the penetrated assembly; and
3. Exhaust air ducts and all ducts which cross pressure boundaries shall be insulated to a minimum insulation level of R-6.
4. If makeup and exhaust ducts both terminate within the same pressure boundary, airflow from termination points shall be diverted away from each other.

(e) **Central Heat Pump Water Heater Electric Ready.** Water heating systems using gas or propane to serve multiple dwelling units shall meet the requirements of 160.9(f) and include the following for the future heat pump:

1. The system input capacity of the gas or propane water heating system shall be determined as the sum of the input gas or propane capacity of all water heating devices associated with each gas or propane water heating system.
2. Space shall be reserved and shall include service and air flow clearances as applicable. The space reserved shall be:
    A. Heat Pump. The minimum space reserved shall include space for service clearances, air clearances, and keep outs, and shall meet one of the following:
        i. If the input capacity of the gas water heating system is less than 200,000 BTU/HR, the minimum space reserved for the heat pump shall be 2.0 square feet per input 10,000 Btu/ HR of the gas or propane water heating system, and the minimum linear dimension of the space reserved shall be 48 linear inches.
        ii. If the input capacity of the gas water heating system is greater than or equal to 200,000 BTU/HR, the minimum space reserved for the heat pump shall be 3.6 square feet per input 10,000 Btu/ HR of the gas or propane water heating system, and the minimum linear dimension of the space reserved shall be 84 linear inches.
        iii. The space reserved shall be the space required for a heat pump water heater system that provides equivalent functionality of the gas-powered equipment as calculated and documented by the responsible person associated with the project.

B. Tanks. The minimum space reserved shall include space for service clearances and keep outs and shall meet one of the following:

i. If the input capacity of the gas water heating system is less than 200,000 BTU/HR, the minimum space reserved for the storage and temperature maintenance tanks shall be 4.4 square feet per input 10,000 Btu/HR. of the gas or propane water heating system.

ii. If the input capacity of the gas water heating system is greater than or equal to 200,000 BTU/HR, the minimum physical space reserved for the storage and temperature maintenance tanks shall be 3.6 square feet per input 10,000 Btu/HR. of the gas or propane water heating system.

iii. The space reserved shall be the space required for a heat pump water heater system that provides equivalent functionality of the gas-powered equipment as calculated and documented by the responsible person associated with the project.

3. Ventilation shall be provided by meeting one of the following:

A. Physical space reserved for the heat pump shall be located outside, or

B. A pathway shall be reserved for future routing of supply and exhaust air via ductwork or louvers from the reserved heat pump location to an appropriate outdoor location. Penetrations through the building envelope for louvers and ducts shall be installed and capped for future use. Ductwork and louvers shall be sized to meet one of the following:

i. If the input capacity of the gas water heating system is less than 200,000 BTU/HR, the minimum air flow rate shall be 70 CFM per input 10,000 Btu/HR of the gas or propane water heating system and the total external static pressure drop of ductwork and louvers shall not exceed 0.17” when the future heat pump water heater is installed.

ii. If the input capacity of the gas water heating system is greater than or equal to 200,000 BTU/HR, the minimum air flow rate shall be 420 CFM per input 10,000 Btu/HR of the gas or propane water heating system and the total external static pressure drop of ductwork and louvers shall not exceed 0.17” when the future heat pump water heater is installed.

iii. Ductwork and louvers shall be sized to serve a heat pump water heater system that provides equivalent functionality of the gas-

powered equipment as calculated and documented by the responsible person associated with the project.

4. Condensate drainage piping. An approved receptacle that is sized in accordance with the California Plumbing Code to receive the condensate drainage shall be installed within 3 feet of the reserved heat pump location, or piping shall be installed from within 3 feet of the reserved heat pump location to an approved discharge location that is adequately sized in accordance with the California Plumbing Code, and meets one of the following:

    A. If the input capacity of the gas water heating system is less than 200,000 BTU/HR,, condensate drainage shall be sized for 0.2 tons of refrigeration capacity per input 10,000 Btu/HR

    B. If the input capacity of the gas water heating system is greater than or equal to 200,000 BTU/HR,, condensate drainage shall be sized for 0.7 tons of refrigeration capacity per input 10,000 Btu/HR

    c. Condensate drainage shall be sized to serve a heat pump water heater system that provides equivalent functionality of the gas-powered equipment as calculated and documented by the responsible person associated with the project.

5. Electrical

    A. Physical space shall be reserved on the bus system of the main switchboard or on the bus system of a distribution board to serve the future heat pump water heater system including the heat pump and temperature maintenance tanks. In addition, the physical space reserved shall be capable of providing adequate power to the future heat pump water heater in accordance with one of the following:

        i. Heat Pump

            A. If the input capacity of the gas water heating system is less than 200,000 BTU/HR,, provide 0.1 kVA per input 10,000 Btu/HR

            B. If the input capacity of the gas water heating system is greater than or equal to 200,000 BTU/HR,, provide 1.1 kVA per input 10,000 Btu/HR

            C. The electrical power required to power a heat pump water heater system that provides equivalent functionality of the gas-powered equipment as

calculated and documented by the responsible person associated with the project.

ii. Temperature Maintenance Tank

A. If the input capacity of the gas water heating system is less than 200,000 BTU/HR,, provide 1.0 kVA per input 10,000 Btu/HR

B. If the input capacity of the gas water heating system is greater than or equal to 200,000 BTU/HR,, provide 0.6 kVA per input 10,000 Btu/HR

C. The electrical power required to power a heat pump water heater system that provides equivalent functionality of the gas-powered equipment as calculated and documented by the responsible person associated with the project.

(f) For the electric ready equipment in 160.9 a - e, the building electrical system shall be sized to meet the future electric requirements of appliances. The building main service conduit, the electrical system to the point specified in each subsection, and any on-site distribution transformers shall have sufficient capacity to supply full rated amperage at each electric ready appliance. The capacity requirements may be adjusted for demand factors in accordance with the California Electric Code.

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 budget calculated for the Proposed Design Building under Subsection (b) is no greater than the energy budget calculated for the Standard Design Building under Subsection (a).

(a) Energy Budget for the Standard Design Building.

The energy budget for the Standard Design Building is expressed in terms of source energy and time-dependent valuation (TDV) energy, and they are determined by applying the mandatory and prescriptive requirements to the Proposed Design Building. The source energy budget and the TDV energy budget is the sum of the TDV energy for space-conditioning, indoor lighting, mechanical ventilation, photovoltaic (PV) and battery storage system, service water heating, and covered process loads.

(b) Energy Budget for the Proposed Design Building.

The energy budget for a Proposed Design Building is expressed in terms of source energy and time-

dependent valuation (TDV) energy, and they are determined by calculating the source energy and TDV energy for the Proposed Design Building. The source energy budget and the TDV energy budget is the sum of the energy for space-conditioning, indoor lighting, mechanical ventilation, photovoltaic (PV) and battery storage system, and service water heating and covered process loads. The Proposed Building shall separately comply with the source energy budget and the TDV energy budget.

EXCEPTION to Section 170.1(b). A community shared solar electric generation system, or other renewable electric generation system, and/or community shared battery storage system, that provides dedicated power, utility energy reduction credits, or payments for energy bill reductions, to the permitted building and is approved by the Energy Commission as specified in Title 24, Part 1, Section 10-115, may offset part or all of the solar electric generation system or battery storage system TDV energy required to comply with the Standards, as calculated according to methods established by the Commission in the Nonresidential ACM Reference Manual.

(c) Calculation of Energy Budget.

The TDV energy for both the Standard Design Building and the Proposed Design Building shall be computed by Compliance Software certified for this use by the Commission. The processes for Compliance Software approval by the Commission are documented in the ACM Approval Manual.

(d) 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)1and 10-103(a)2 that demonstrates, using an approved calculation method, that the building has been designed so that its source energy budget and TDV energy budget do not exceed the Standard Design 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.

   A. EER/EER2/SEER/SEER2/CEER/HSPF/HSPF2 Rating. When performance compliance requires installation of a space conditioning system with a rating that is greater than the minimum rating required by TABLE 170.2-K or specified for the standard design, the installed system shall be field verified in accordance with the procedures specified in the applicable sections of Reference Residential Appendix RA3.

   B. Variable Capacity Heat Pump (VCHP) Compliance Option. When performance compliance requires installation of a heat pump system that meets all the requirements of the VCHP compliance option specified in the ACM Reference Manual, the system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.4.4.3.

C. Low Leakage Air Handler. When performance compliance requires installation of a low leakage air-handling unit, the installed air handling unit shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.1.4.3.9.

D. RESERVED

E. Heat Pump - Rated Heating Capacity. When performance compliance requires installation of a heat pump system, the heating capacity values at 47 degrees F and 17 degrees F shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.4.4.2.

F. Whole House Fan. When performance compliance requires installation of a whole-house fan, the whole house fan ventilation airflow rate and fan efficacy shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.9.

G. Central Fan Ventilation Cooling System. When performance compliance requires installation of a central fan ventilation cooling system, the installed system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.3.4.

H. Dwelling Unit Enclosure Air Leakage. When performance compliance requires a building enclosure leakage rate that is lower than the standard design, the building enclosure shall be field verified in accordance with the procedures specified in Reference Residential Appendix RA3.8.

I. Quality Insulation Installation (QII). When performance compliance requires field verification of QII, the building insulation system shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.5.

J. PreCooling. When performance compliance requires field verification of the installation and programming of a PreCooling Thermostat, it shall be field verified in accordance with the procedures in Reference Residential Appendix RA3.4.5.

3. Thermal Balancing Valve compliance option. When performance compliance requires installation of thermal balancing valves with variable speed circulation pump(s), the installation shall meet the procedures in Reference Residential Appendix RA4.4

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 170.2 PRESCRIPTIVE APPROACH

Section 170.2(d)~~Water Heating Systems Water-heating systems shall meet the requirements of either 1, 2, 3 or 4.~~ Domestic Hot Water System.

Domestic hot water systems serving individual dwelling units shall meet the requirements of either 1 and 2. Domestic hot water systems serving multiple dwelling units shall meet the requirements of either 3, 4 or 5, and 6, 7 and 8.

1. For systems serving individual dwelling units, the water heating system shall meet the requirement of either A, B, C, or shall meet the performance compliance requirements of Section 170.1:
   A. A single 240 volt heat pump water heater. In addition, meet the following:
      i. A compact hot water distribution system as specified in the Reference Appendix RA4.4.6. in climate 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~~.~~; and
      iii. Installation shall meet requirements specified in Section 110.3 (c).
   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 Zones 16, a drain water heat recovery system that is field verified as specified in the Reference Appendix RA3.6.9.
   C. A gas or propane instantaneous water heater with an input of 200,000 Btu per hour or less and no storage tank.
2. Recirculation distribution systems serving individual dwelling units, shall use Demand Recirculation Systems with manual on/off control as specified in the Reference Appendix RA4.4.9.
3. For heat pump water-heating systems serving multiple dwelling units, the water heating system shall be installed according to the manufacturer design and installation guidelines and meet A or B, or shall meet the performance compliance requirements of Section 170.1: ~~the following requirements:~~
   A. A system meeting the following requirements:
      i. Use single-pass primary heat pump water heater. 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.
      ii. The primary storage tank temperature setpoint shall be at least 135°F.
      iii. The fuel source for the recirculation loop tank shall be electricity. ~~if auxiliary heating is needed. The recirculation loop heater shall be capable of multi-pass water heating operation.~~

iv. ~~For systems with single pass primary heat pump water heater, the primary thermal storage tanks shall be piped in series if multiple tanks are used. For systems with multi-pass primary heat pump water heater, the primary thermal storage tanks shall be piped in parallel if multiple tanks are used.~~

v. The recirculation loop tank temperature setpoint shall be at least 10°F lower than the primary thermal storage tank temperature setpoint ~~such that hot water from the recirculation loop tank is used for the temperature maintenance load before engaging the recirculation loop tank heater~~.

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

vii. A recirculation system

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

Exception to Section 170.2(d)~~2G~~3A.vii.: Buildings with eight or fewer dwelling units.

B. A system that meets requirement of NEEA Advanced Water Heating Specification for commercial HPWH system Tier 2 or higher.

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

A. 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)~~3~~4A: 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)~~3~~4A: If 25 percent of the annual water-heating requirement is provided by site-solar energy or site-recovered energy.

B. A recirculation system.

Exception to Section 170.2(d)~~3~~4B: Buildings with eight or fewer dwelling units.

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

i. 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

ii. 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.

5. A water-heating system serving multiple dwelling units determined by the Executive Director to use no more energy than the one specified in Subsection 1,~~2, or 3~~3, or 4 above.

6. For hot water distribution piping serving multiple dwelling units, verify pipe sizing is in accordance with CPC Appendix M.

7. Recirculation distribution systems serving multiple dwelling units shall meet the requirements in Section110.3(c)2 and 110.3(c)~~5~~ 4, ~~and shall be capable of automatically controlling the recirculation pump operation based on measurement of hot water demand and hot water return temperature.~~

8. Domestic hot water distribution systems with recirculation loop(s) serving multiple dwelling units shall install a mechanical or digital thermostatic master mixing valve on each distribution supply and return loop that:

   A. Conforms to the American Society of Sanitation Engineers (ASSE) 1017-2009 standard, *Performance Requirements for Temperature Actuated Mixing Valves for Hot Water Distribution Systems*

   B. Shall be installed on the central heating plant hot water supply outlet header leading to the recirculation loop; and

   C. Shall be installed and commissioned in accordance with manufacturer's instructions and meet requirements in Nonresidential and Multifamily Reference Appendix section RA3.6.11.

   D. Shall indicate water mixing parameters as defined in RA3.6.11 on the plumbing plans, if this exceeds the mixing capability of the specified master mixing valve, then the designer shall provide instructions to commission a balancing valve to prevent temperature.

Reference Appendices

RA2.2 Measures that Require Field Verification and Diagnostic Testing

Table RA2-1 describes the measures that require installer certification and HERS Rater field verification and diagnostic testing, and identifies the protocol or test procedure in the Reference Residential Appendices that shall be used for completing installer and HERS Rater field verification and diagnostic testing.

RA2-1 – Summary of Measures Requiring Field Verification and Diagnostic Testing

Measure Title	Description	Procedure(s)
Duct Measures		
Duct Sealing	Component Packages require that space conditioning ducts be sealed. If sealed and tested ducts are claimed for compliance, field verification and diagnostic testing is required to verify that approved duct system materials are utilized, and that duct leakage meets the specified criteria.	RA3.1.4.3
Duct Location, Surface Area and R-value	Compliance credit can be taken for improved duct location, surface area and R-value. Field verification is required to verify that the duct system was installed according to the design, including location, size and length of ducts, duct insulation R-value and installation of buried ducts.[1] For buried ducts measures, Duct Sealing and High QII is required.	RA3.1.4.1
Verification of low leakage ducts located entirely in conditioned space	Duct system location shall be verified by visual inspection and diagnostic testing. Compliance credit can be taken for verified duct systems with low air leakage to the outside when measured in accordance with Reference Residential Appendix Section RA3.1.4.3.8. Field Verification for ducts in conditioned space is required. Duct sealing is required.	RA3.1.4.3.8
Low Leakage Air-handling Units	Compliance credit can be taken for installation of a factory sealed air handling unit tested by the manufacturer and certified to the Commission to have met the requirements for a Low Leakage Air-Handling Unit. Field verification of the air handler's model number is required. Duct Sealing is required.	RA3.1.4.3.9
Verification of Return Duct Design	Verification to confirm that the return duct design conform to the applicable criteria given in TABLE 150.0-B, TABLE 150.0-C, TABLE 160.3-A, or TABLE 160.3-B.	RA3.1.4.4
Verification of Air Filter Device Design	Verification to confirm that the air filter devices conform to the requirements given in applicable Standards Sections 150.0(m)12 or 160.2(b)1.	RA3.1.4.5
Verification of Prescriptive Bypass Duct Requirements	Verification to confirm zonally controlled systems comply with the	RA3.1.4.6

Measure Title	Description	Procedure(s)
	bypass duct requirements in Section 150.1(c)13 or 170.2(c)3C.	
Air Conditioning Measures		
Improved Refrigerant Charge	Component Packages require in some climate zones that air-cooled air conditioners and air-source heat pumps be diagnostically tested in the field to verify that the system has the correct refrigerant charge. For the performance method, the Proposed Design is modeled with less efficiency if diagnostic testing and field verification is not performed. The system must also meet the prerequisite minimum System Airflow requirement.	RA3.3 RA3.2 RA1.2
Installation of Fault Indicator Display	Component Packages specify that a Fault Indicator Display can be installed as an alternative to refrigerant charge testing. The existence of a Fault Indicator Display has the same calculated benefit as refrigerant charge testing. Field verification is required.	RA3.4.2
Verified System Airflow	When compliance requires verified system airflow greater than or equal to a specified criterion, field verification and diagnostic testing is required.	RA3.3
Air-handling Unit Fan Efficacy	When compliance requires verified fan efficacy (Watt/cfm) less than or equal to a specified criterion, field verification and diagnostic testing is required.	RA3.3
Verified Energy Efficiency Ratio (EER/EER2)	Compliance credit can be taken for increased EER/EER2 by installation of specific air conditioner or heat pump models. Field verification is required.[2]	RA3.4.3 RA3.4.4.1
Verified Seasonal Energy Efficiency Ratio (SEER/SEER2)	HERS Rater field verification of the SEER/SEER2 rating is required for some systems.	RA3.4.3 RA3.4.4.1
Rated Heat Pump Capacity Verification	When performance compliance uses a heat pump, the rated capacity of the installed system shall be verified to be greater than or equal to the specified value.	RA3.4.4.2
Evaporatively Cooled Condensers	Compliance credit can be taken for installation of evaporatively cooled condensers. Field verification of duct leakage is required. Field verification of refrigerant charge is required. Field verification of EER/EER2 is required.	RA3.1.4.3, RA3.2 RA3.4.3. RA3.4.4.1
Variable Capacity Heat Pump (VCHP) Compliance Option	When performance compliance uses the VCHP compliance option, the system shall be field verified to confirm it meets the eligibility requirements.	RA3.4.4.3
Ventilation Cooling Measures		
Whole House Fan	When performance compliance uses a whole house fan, the installed whole house fan airflow rate (cfm) and fan efficacy (W/cfm) shall be verified to be	RA3.9

Measure Title	Description	Procedure(s)
	equal to or better than the specified values.	
Central Fan Ventilation Cooling System	When performance compliance uses a central fan ventilation cooling system (CFVCS), the installed CFVCS ventilation airflow rate (cfm) and fan efficacy (W/cfm) shall be verified to be equal to or better than the specified values.	RA3.3.4
Mechanical Ventilation Measures for Improved Indoor Air Quality		
Continuous Whole-Building Mechanical Ventilation Airflow	Measurement of whole-building mechanical ventilation is mandatory for newly constructed buildings.	RA3.7.4.1
Intermittent Whole-Building Mechanical Ventilation Airflow	Measurement of whole-building mechanical ventilation is mandatory for newly constructed buildings.	RA3.7.4.2
Kitchen Local Mechanical Exhaust Verification	Verification of kitchen local mechanical exhaust is mandatory for newly constructed buildings.	RA3.7.4.3
Heat Recovery Ventilation (HRV) or Energy Recovery Ventilation (ERV) Rated Performance Verification	When performance compliance requires verification of the HRV/ERV fan efficacy (W/cfm) or heat recovery efficiency, then the installed ventilation system shall be verified.	RA3.7.4.4
Building Envelope Measures		
Building Envelope Air Leakage	Compliance credit can be taken for reduced building envelope air leakage. Field verification and diagnostic testing is required. Multifamily dwelling units are required to have enclosure leakage verified when supply or exhaust ventilation systems are installed.	RA3.8
Quality Insulation Installation (QII)	Compliance Software recognizes standard and improved envelope construction. Quality Insulation Installation is a prescriptive measure in all climate zones for newly constructed buildings and additions greater than 700 square feet, except low-rise multifamily buildings in Climate Zone 7. Field verification is required.	RA3.5
Quality Insulation Installation for Spray Polyurethane Foam (SPF) Insulation	A HERS Rater shall verify the installation of SPF insulation whenever R-values other than the default R-value per inch are used for compliance.	RA3.5.6
Single Family DHW Measures		
Verified Pipe Insulation Credit (PIC-H)	Inspection to verify that all hot water piping in non-recirculating systems is insulated and that corners and tees are fully insulated. No piping should be visible due to insulation voids with the exception of the last segment of piping that penetrate walls and delivers hot water to the sink, appliance, etc.	RA3.6.3.
Verified Parallel Piping (PP-H)	Inspection that requires that the measured length of piping between the water heater and single central manifold does not exceed five feet	RA3.6.4

Measure Title	Description	Procedure(s)
Verified Compact Hot Water Distribution System Expanded Credit (CHWDS-H-EX)	Field verification to insure that the eligibility criteria specified in RA 3.6.5 are met.	RA3.6.5
Demand Recirculation: Manual Control (RDRmc-H)	Inspection to verify that all recirculating hot water piping is insulated and that corners and tees are fully insulated. No piping should be visible due to insulation voids	RA3.6.6
Demand Recirculation: Sensor Control(RDRsc-H)	Inspection to verify that all recirculating hot water piping is insulated and that corners and tees are fully insulated. No piping should be visible due to insulation voids.	RA3.6.7
Verified Drain Water Heat Recovery System (DWHR-H)	Inspection to verify that the DWHR unit(s) and installation configuration match the compliance document and the DWHR(s) is certified to the Commission to have met the requirements.	RA3.6,9
Multifamily DHW Heating Measures		
Multiple Recirculation Loop Design for DHW Systems Serving Multiple Dwelling Units	Inspection that a central DHW system serving a building with more than eight dwelling units has at least two recirculation loops, each serving roughly the same number of dwelling units. These recirculation loops may the same water heating equipment or be connected to independent water heating equipment.	RA3.6.8
Verified Drain Water Heat Recovery System (DWHR-H)	Inspection to verify that the DWHR unit(s) and installation configuration match the compliance document and the DWHR(s) is certified to the Commission to have met the requirements.	RA3.6.9
Hot Water Pipe Insulation Verification	Inspection to verify that the hot water piping, fittings and appurtenances are insulated per Title 24, Part 6, Section 160.4 requirements at the heating plant, recirculation system, and branches. Metallic piping shall be thermally isolated from pipe hangers using non-crushable pipe insulation. All seams in the insulation shall be sealed. No piping should be visible due to insulation voids except piping specifically exempted in the California Plumbing Code or Title 24, Part 6.	RA3.6.10
MMV Default Installation and Commissioning Instructions	Example MMV schematic and instructions for installation and commissioning to meet code when manufacturer's instructions are not available or are limited.	RA3.6.11

1. Note: Compliance credit for increased duct insulation R-value (not buried ducts) may be taken without field verification if the R-value is the same throughout the building, and for ducts located in crawlspaces and garages where all registers are either in the floor or within 2 feet of the floor. These two credits may be taken subject only to enforcement agency inspection.

2. Note: The requirement for verification of a high EER/EER2 does not apply to equipment rated only with an EER/EER2.

Individual HPWH Ventilation

No changes to the Reference Appendices are required for this measure as currently written.

Pipe Insulation Enhancement

RA3.6.10 Hot Water Pipe Insulation Verification

The HERS rater shall inspect the heating plant and horizontal supply header and return piping. The rater shall use a sampling approach for vertical supply risers and branches to ensure pipe insulation has been installed. The HERS rater will inspect the pipe insulation installed to verify if it meets the mandatory requirements in Title 24 Part 6 section 160.4, which includes exceptions 1 through 3 of 160.4(f)1.

Automatic Balancing Valves

RA4.4 Water Heating Measures

RA4.4.3 ~~Reserved for future use~~ Proper Thermal Balancing Valve installation

To receive the thermal balancing valve credit, plan calculations shall be completed that demonstrate that the total developed length of the return piping portion of the domestic hot water return pipe loop meets the criteria to receive credit. The plans shall also indicate the use of a variable speed pump.

The circulation pump design flow rate should be calculated to meet the design hot water return temperature based on the calculated distribution system heat losses and the design hot water supply temperature. The circulation pump specified should be the smallest pump required to meet the design flow rate plus an acceptable safety factor.

Each thermal balancing valve shall be installed after the last fixture on the hot water supply riser it serves. As part of the contractor's start-up procedure, the contractor shall perform the following:

1. Close all fixtures in the domestic water system
2. Start the circulation pump at a constant speed, targeting the circulation pump design flow, and allow the system 60 minutes to warm-up
3. Verify that the temperature at the last riser does not exceed 120 °F
4. If the temperature at the last riser exceeds 120 °F, adjust the pump speed down and repeat the procedure, allowing 30 minutes for warm-up
5. Once the temperature at the last riser is acceptable, record the pump differential pressure and set the pump into differential pressure control mode using the recorded differential pressure as the set point.

Master Mixing Valves

RA3.6.11 MMV Minimum Installation and Commissioning Requirements

Manufacturer's instructions for installation and commissioning of the master mixing valve (MMV), when available, shall always be followed. The MMV specifier shall ensure that the manufacturer's installation and commissioning instructions meet the minimum requirements.

Minimum installation requirements are:

- Balancing valve installed on the recirculation system return piping leading to only the water heater for mechanical MMV only.
- Check valves and isolation valves installed near all MMV.
- Manufacturer's MMV installation instructions are provided in the plumbing drawings.

Minimum commissioning requirements are:

- Commission MMV for mixed outlet temperature during recirculation only.
- Commission MMV for mixed outlet temperature for a combination of recirculation and hot water draws.
- Commission balancing valve when applicable depending on the water mixing parameters, calculated inlet water flow, and MMV mixing ratio.
- Manufacturer's MMV commissioning instructions are provided in the plumbing drawings.

The water mixing parameters that require to be shown on the plumbing plans are:

- Recirculation pump flow rate,
- Mixing valve outlet temperature,
- Recirculation return water temperature, and
- Mixing valve hot water inlet temp.

These inputs are used to calculate percentage of water flow on cold side and hot side of MV during recirculation water flow only condition to see if it exceeds mixing capability of the specified master mixing valve. The percentage of water flow to the cold and hot inlet of the MMV and water mixing ratio of MMV are required to be shown on the plumbing plans. If the calculated water flow ratio to the inlet of the MMV exceeds manufacturer's recommendations for that valve, then the balancing valve shall be commissioned to eliminate temperature creep to mitigate scalding risk after periods of no water draw.