Residential Water Heaters

Handout No: 15
Revised: 1/1/20

A water heater is an appliance designed to supply hot water and is equipped with automatic controls limiting water temperature to a maximum of 210 degrees Fahrenheit.

Permit Requirements

A plumbing permit is required to install, remove, replace, or raise a water heater [2019 CA Plumbing Code (CPC) 502.0]. A permit must be obtained before beginning the work. Work performed without permit may be subject to investigation/penalty fees.

Smoke & Carbon Monoxide Alarms - Smoke and carbon monoxide alarms must be installed in accordance with Sections R314 and Section R315 of the 2019 California Residential Code.

Energy Requirements [2019 California Energy Code (CEEC) 150.0 (j) & (n)])

Replacement or additional water heaters must be either natural gas or propane fired unless no gas is connected to the building or the water heater otherwise complies with Section 150.2(b)(1)(H) of the California Energy Code (energy calculations and documentation required). The main intent of this requirement is to restrict the switch from gas to electric-resistance water heaters.

Mandatory energy requirements apply to the water heater itself, as well as any other components that are replaced or added. The water heater must be certified by the Energy Commission for minimum efficiency**. For replacement of existing water heaters, submit CF-1R-ALT-WATER HEATERS form at the end of this handout or other approved Certificate of Compliance form to document compliance with the mandatory energy requirements.**

Installation Requirements

- Fuel-burning water heaters installed in a garage area must be raised 18 inches (18") or more from the floor measured to the glow, spark or flame [CPC 507.13].
- A full-way valve shall be installed on the water heater discharge piping and on the cold-water supply pipe to each water heater at or near the water heater [CPC 606.2].
- Fuel-burning water heaters shall be vented to the building exterior. The vent must extend from the top of the heater to a point two feet (2') above the roof *(exception for direct vent water heaters)*. Type B or Type L vents shall extend in a vertical direction with offsets not exceeding 45 degrees, except that a vent system having not more than one 60-degree offset is permitted [CPC 509.6.2.2]. Vent connectors must slope upward towards the vent with a minimum of one-quarter inch per foot [CPC 509.10.6].
- Fuel-burning water heaters shall be assured a sufficient supply of air for proper fuel combustion and ventilation [CPC 506.0]. Installation in a garage typically provides enough air for proper combustion. Installation in an attic or closet requires combustion air calculations.
- Water heaters may be installed in a closet located in a bedroom or bathroom provided that required clearances and clear space is maintained within the space and provided that the closet is equipped with a listed, gasketed door assembly and a listed self-closing device. All combustion air for such installations shall be obtained from the outdoors [CPC 504.0 and 506.4]
- Flexible water line connections to a water heater are recommended. They provide protection against a water line breaking or leaking in the event of an earthquake. Flexible gas

connectors are not required, but are recommended for the same reason. A union is required on hot and cold water lines to facilitate removal of the appliance [CPC 609.5].

- Systems using gas or propane water heaters to serve newly constructed individual dwelling units shall include the following components [CEEC 150.0 (n)]:
    - A 120V accessible electrical receptacle is required within 3 feet of any new gas water heater (not applicable to replacements in the same location); and
    - A Category III or IV vent, or a B vent with straight pipe between the outside termination and the space where the water heater is installed; and
    - 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
    - A gas supply line with a capacity of at least 200,000 Btu/hr.
- An approved **dielectric** insulator is required on the water piping connections to the water heater. [CPC 507.1]

Sediment Trap.

Where a sediment trap is not incorporated as a part of a gas appliance, a sediment trap shall be installed downstream of the gas appliance shutoff valve as close to the gas inlet of the appliance as practical. The sediment trap shall be either a tee fitting with a capped nipple in the bottom outlet, as illustrated in Figure 1212.9, or other device recognized as an effective sediment trap. Illuminating appliances, ranges, clothes dryers, decorative appliances for installation in vented fireplaces, gas fireplaces, and outdoor grills shall not be required to be so equipped. [CPC 1212.9]

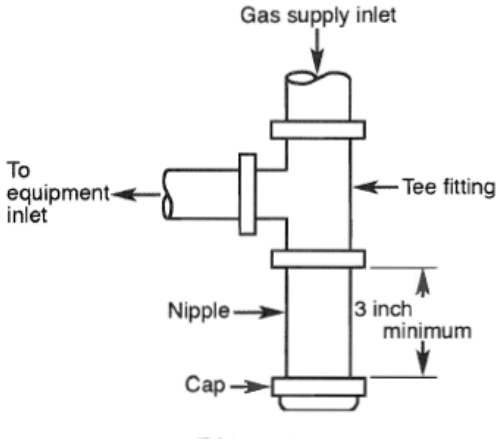


FIGURE 1212.8
METHOD OF INSTALLING A TEE FITTING SEDIMENT TRAP

Temperature/Pressure Relief Valve Requirement

- Storage-type water heaters shall be provided with an approved, listed and properly sized combination temperature/pressure relief valve and tankless water heaters shall be provided with an approved pressure relief valve installed on the appliance in accordance with the manufacturer's instructions. The relief valve shall be provided with a drain to the outside.
- The drain shall be the size of the valve outlet and be constructed of copper, iron or other approved piping rated for the operating temperature. The valve shall extend to the garage or exterior of the building and shall terminate between six and 24 inches (6" and 24") from the floor or ground. The pipe may not be trapped [CPC 608.4 & 608.5].
- Discharge from a relief valve into a water heater pan is prohibited [CPC 608.5]).

Protection against Physical Damage

- Water heaters shall be anchored or strapped in an approved manner to resist horizontal displacement due to earthquake motion. Strapping shall be at points within the upper and lower one-third (1/3) of its vertical dimensions. At the lower point, a minimum distance of four inches (4") shall be maintained above the controls [CPC 507.2].
- Water heaters located where they may be physically damaged from a vehicle must be provided with protection [CPC 507.13.1]. A three-inch (3") diameter concrete-filled pipe embedded 24” in the concrete slab is recommended.

Additional Installation Requirements for All Water Heaters Installed in an Attic

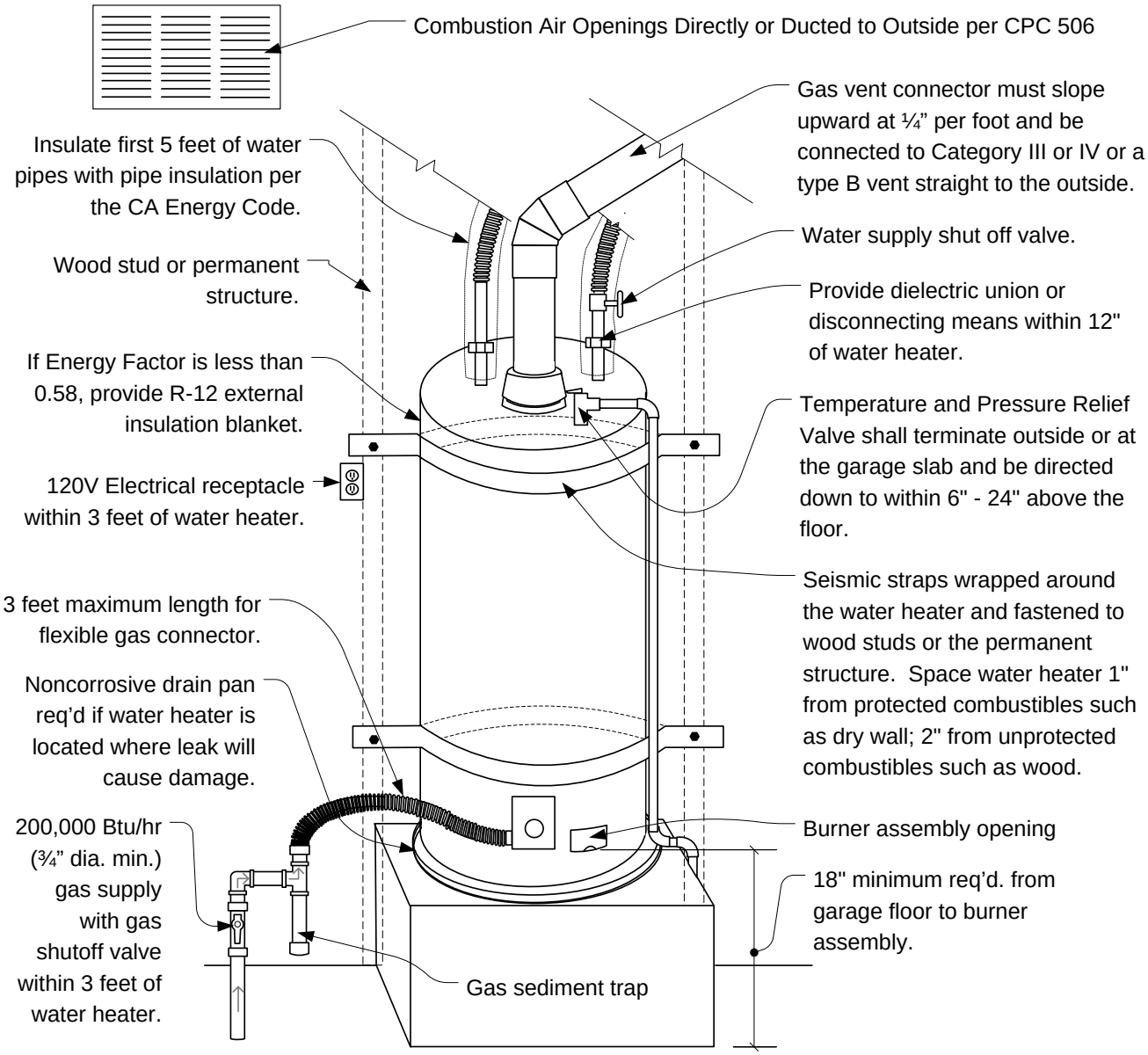
- An opening and passageway not less than the largest component of the appliance and not less than 22 inches by 30 inches shall be provided.
- Where the height of the passageway is less than 6 feet, the distance from the passageway access to the appliance shall not exceed 20 feet measured along the centerline of the passageway.
- The passageway from the entrance opening to the appliance shall be unobstructed and shall have solid flooring not less than 24 inches wide.
- A level working platform not less than 30 inches by 30 inches shall be provided in front of the service side of the appliance.
- A permanent 120-volt receptacle outlet and a lighting fixture shall be installed near the appliance. The light fixture shall be high efficacy. The switch controlling the light fixture must be located at the entrance to the passageway and be a manual-on switch with a vacancy sensor. [CPC 508.4.4 and CEEC 150.0(k).2.I.]
- Drainage Pan. A watertight pan of corrosion-resistant materials shall be installed beneath the water heater with not less than ¾" of an inch diameter drain to an approved location. [CPC 507.5]

Additional Requirements for Tankless Water Heaters

- Outdoor Installations: Tankless water heaters installed outdoors must be listed for outdoor use.
- Gas Supply and Gas Meter Size: For water heater replacements. the larger BTU input of a tankless water heater will likely necessitate the installation of a larger gas line and/or gas meter. The gas piping serving the tankless water heater must be calculated sized in accordance with the requirements of Chapter 12 of the California Plumbing Code. Check with PG&E to determine if the gas meter is large enough for you gas system.
- Gas Valve: High quality full port gas shutoff valve must be installed unless the valve is oversized. Some ball valves significantly reduce the diameter of the pipe and should therefore be avoided.
- Exhaust Vent: Tankless gas water heaters must be vented in accordance with the manufacturer's installation instructions and the California Plumbing Code. Required clearances from exhaust vents to openings in the building must be maintained. Typically, tankless gas water heaters must be vented separately from all other appliances. Do not upsize (oversize) the vent pipe. For best results, try to keep the vent system as short and straight as possible.
- Clearance Requirements: Tankless water heaters typically have different clearance to combustibles requirements depending on the unit being installed. Refer to the manufacturer's installation manual for all clearance requirements.

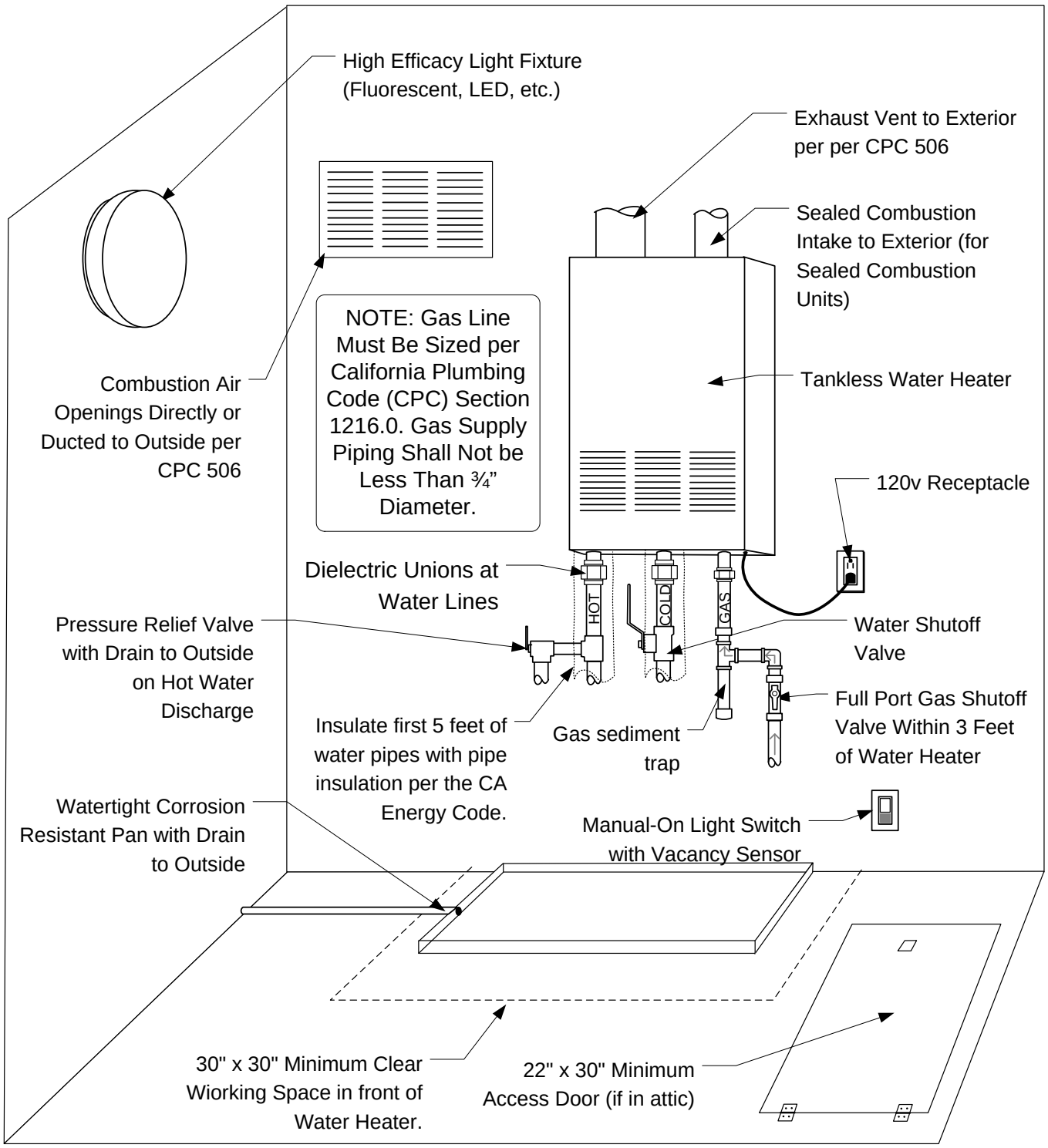
Inspection Requirements

The water heater shall have a final inspection after all work authorized by the permit has been completed. No piping, equipment or part thereof should be covered or concealed until it has been inspected and approved by the City Building Inspector. In dwelling units, carbon monoxide and smoke alarms are required in accordance with California Residential Code (CRC) Sections R314 and R315. More information can be found on the City's web site at http://www.sonomacity.org/Government/Departmental-Offices/Building.aspx .



Typical Storage Type Gas Water Heater Installation Detail

Revised 12/11/19



Typical Tankless Type Gas Water Heater Installation Detail

Revised 11/6/18

SIZING GAS PIPE

You can size your gas piping system by using the information in this handout. The following demand gas input ratings are approximate. Actual British thermal units per hour (Btu/h) input ratings for your appliances should always be used whenever possible. Refer to the appliance nameplate or product literature for specific Btu/h ratings.

APPROXIMATE GAS INPUT FOR TYPICAL APPLIANCES
From CPC TABLE 1208.4.1

Appliance	Btu/h	Cfh
Warm Air Furnace	100,000	100
Storage Type Water heater 30 to 40 gal.	35,000	35
Storage Type Water heater 50 gal.	50,000	50
Tankless (Instantaneous) Water Heater - 2 gal./minute	142,800	143
Tankless (Instantaneous) Water Heater - 4 gal./minute	285,000	285
Tankless (Instantaneous) Water Heater - 6 gal./minute	428,400	429
Range, freestanding	65,000	65
Built-in oven or broiler unit	25,000	25
Built-in cook top	40,000	40
Clothes dryer	35,000	35
Gas fireplace direct vent	40,000	40
Gas log	80,000	80

The tables used to size gas piping are based on cubic feet per hour (Cf/h). To convert Btu/h to Cf/h, divide Btu/h by 1,000. *(Per PG&E)* For gas pipe sizing assistance from the building department, a drawing showing piping layout, lengths, type of appliance and gas Btu/h demand ratings is required for us to help you.

Pipe sizing for Schedule 40 Metallic Pipe (Black or galvanized iron pipe)
Maximum Capacity of Gas Pipe in Cubic Feet Per Hour (Cf/h)
Values From CPC Table 1215.2(1)

Pipe Sizes	Distance from Meter to Most Remote Appliance in Feet on Each Branch												
	10’	20’	30’	40’	50’	60’	70’	80’	90’	100’	125’	150’	200’
1/2"	172	118	95	81	72	65	60	56	52	50	44	40	34
3/4"	360	247	199	170	151	137	126	117	110	104	92	83	71
1"	678	466	374	320	284	257	237	220	207	195	173	157	134
1-1/4"	1,390	957	768	657	583	528	486	452	424	400	355	322	275
1-1/2"	2,090	1,430	1,150	985	873	791	728	677	635	600	532	482	412

SAMPLE GAS LINE CALCULATION

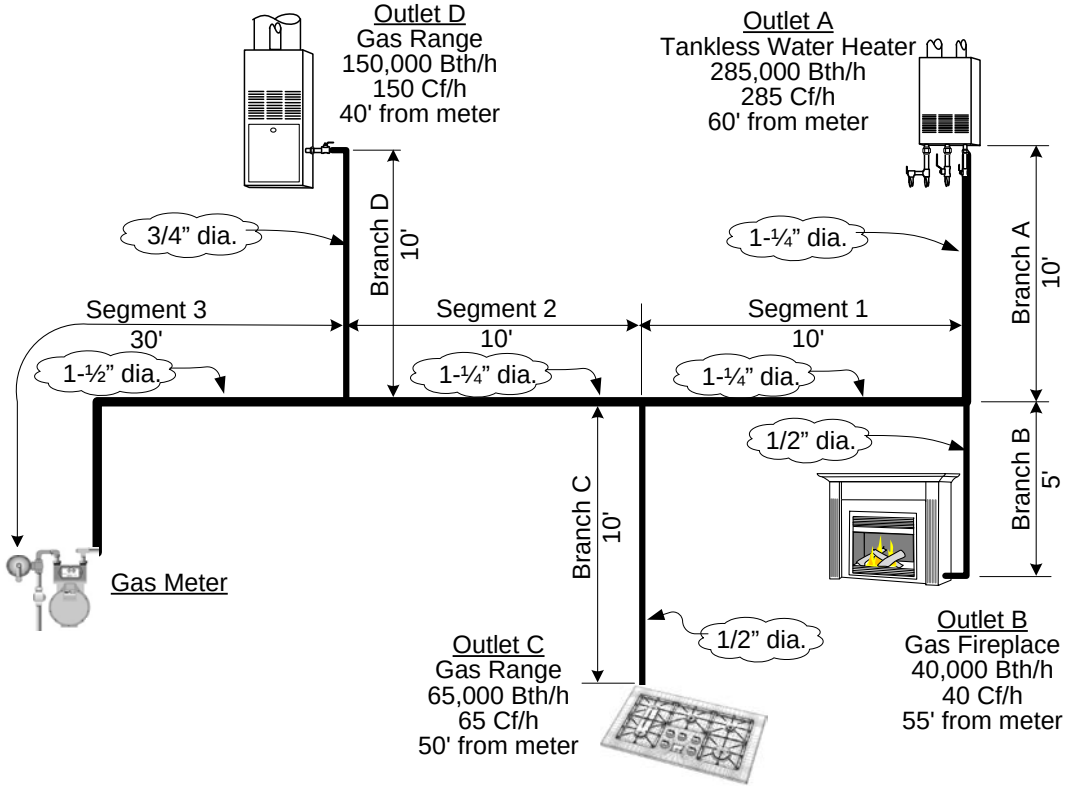
1. To determine the Btu/h gas input for each appliance check the nameplate on the appliance or check the product specifications or use the approximate values in CPC TABLE 1208.4.1.
2. Determine the length of pipe from the gas meter to each outlet, if length falls between lengths shown go to next higher column.
3. Figure the lateral pipe sizes for each individual appliance and each main segment of piping based on the combined Btu/h gas input demand and total length for each pipe segment.

Solution:

Appliance Outlet	Determine Piping Length from Meter to Appliance	Find Cf/h from CPC Table 1208.4.1	Pipe Size Required
Outlet A	60’	285	1-¼” dia.
Outlet B	60’ (55’ rounded up per table)	40	1/2” dia.
Outlet C	50’	65	1/2” dia.
Outlet D	40’	150 (from appliance nameplate)	3/4” dia.

Determine the size of the main pipe feeding more than one appliance. Using the length of piping from the most remote outlet (Outlet A = 60’) use that length (60’) in Table 1216.2(1) to determine the pipe size needed based on demand load for each segment.

Main Pipe Section	Appliances (Outlets) Served	Total Combined Cf/h Demand for Segment	Pipe Size Required
Section 1	Outlets A and B	325 Cf/h (285 + 40)	1-¼” dia.
Section 2	Outlets A, B and C	390 Cf/h (285 + 40 + 65)	1-¼” dia.
Section 3	All Outlets	540 Cf/h (285 + 40 + 65 =150)	1-½” dia.



Sample Gas Piping Sizing

Revised 10/15/14

Mandatory Energy Requirements for Water Heating Systems:

Prior to issuance of a building permit – the CA Energy Code requires that all new or replacement water heater installations be accompanied by a CF1R energy form submitted to the building department. The type of CF1R energy form will vary depending on the project specifics as follows:

- CF1R-ALT-WATER HEATERS: Replacement of existing water heater (*see the last page of this handout*)
- CF1R-ADD-01-E: Prescriptive Additions Compliance Form
- CF1R-ADD-02-E: Prescriptive Additions Non-HERS Compliance Form
- CF1R-ALT-01-E: Prescriptive Alterations Compliance Form
- CF1R-ALT-05-E: Prescriptive Alterations Non-HERS Compliance Form
- CF1R-NCB-01-E: Prescriptive Newly Constructed Building Compliance Form
- CF1R-PLB-01-E: Hydronic Heating System Worksheet
- CF1R-STH-01-E-OG300: Solar Water Heating Systems Worksheet
- CF1R-STH-02-E-OG100: Solar Water Heating Systems Worksheet application

All forms must be completed and signed by permit applicant (designer, installing contractor or building owner).
Required forms must be submitted to the building department with the permit application.

Prior to final approval of the work covered by a building permit - a CF2R energy form must be completed following the water heater installation and CF3R forms must be completed when HERS water heater verification is required.

- CF2R-ADD-02-E: Prescriptive Additions Non-HERS Installation Compliance Form
- CF2R-ALT-05: Prescriptive Alterations Non-HERS Installation Compliance Form
- CF2R-PLB-01: Non-HERS Multifamily Central Hot Water System Distribution Installation Compliance Form
- CF2R-PLB-02: Non-HERS Single Dwelling Unit Hot Water System Distribution Installation Compliance Form
- CF2R-PLB-21: HERS Multifamily Central Hot Water System Distribution Installation Compliance Form
- CF2R-PLB-22: HERS Single Dwelling Unit Hot Water System Distribution Installation Compliance Form
- CF2R-STH-01: Solar Water Heating System Installation Compliance Form
- CF3R-EXC-20-H: HERS Verification of Existing Conditions for Alterations
- CF3R-PLB-21: HERS Verification of Multifamily Central Hot Water System Distribution
- CF3R-PLB-22: HERS Verification of Single Dwelling Unit Hot Water System Distribution

All forms must be completed and signed by installing contractor.
Required forms must should be made available for the inspector when onsite.

The delineation between small and large units is determined by the energy input for the type of unit. Small gas-fired units have a maximum input of 75,000 Btu/hr for storage type units and 200,000 Btu/hr for instantaneous units. The table below outlines the minimum efficiencies for common gas water heater types.

Water Heater Size and Type	Energy Factor (EF)/Thermal Efficiency
Small Gas Storage (≤55 gallons, ≤75 kBtu/hr input)	EF = 0.675 – (0.0015*Volume)
Small Gas Storage (>55 gallons, ≤75 kBtu/hr input)	EF = 0.8012 – (0.00078*Volume)
Small Gas Instantaneous (≤200 kBtu/hr input)	EF = 0.82 – (0.0019*Volume)
Large Gas Storage (any size volume but with an input-to-volume ratio of <4,000 Btu/hr/gal)	Thermal Efficiency = 0.80
Large Gas Instantaneous (≥4,000 Btu/hr/gal)	Thermal Efficiency = 0.80
Additionally, large gas storage units and large gas instantaneous units with a volume of 10 or more gallons must have a maximum standby loss determined by: $\frac{Q}{800} + 110(Vr)^{\frac{1}{2}}$ where Q is the nameplate input in Btu/hr and Vr is the rated capacity in gallons.	

Table 1: Minimum Efficiencies for Common Water Heater Types Manufactured After April 14, 2015

For minimum efficiencies of electric and oil water heaters, see Tables 5.1 and 5.2 in Chapter 5 of the Residential Compliance Manual.

- Insulation for storage tanks must comply with CA Energy Code Section 150.0(j)1:
  - Unfired tanks (such as storage tanks for solar hot water systems or boilers) shall have either a minimum R-12 external wrap or a minimum internal insulation of R-16. Internal insulated tanks must include a label on the exterior of the tank showing the R-value.
- Water piping must be insulated as follows:
  - The first 5 feet of hot and cold water pipes from the storage tank.
  - All water piping with a nominal diameter of 3/4 inch or larger.
  - All piping associated with a domestic hot water recirculation system regardless of the pipe diameter.
  - Piping from the heating source to storage tank or between tanks.
  - Piping buried below grade.
  - All hot water pipes from the heating source to the kitchen fixtures.
  - Pipe insulation thickness is typically required to be 1" or 1-1/2" as determined by CEEC Table 120.3-A. Pipe insulation exposed to the weather must be rated for outdoor use or shall be covered with an approved material.

For new or added residential water heaters (detached single-family homes, low-rise multifamily buildings), the water heater design must utilize a Prescriptive or Performance approach. If using the Prescriptive compliance path, domestic hot water heaters must comply with one of the following options, per CA Energy Code Section 150.1(c)8:

- Small Instantaneous Type Water Heaters: A single gas or propane water heater with an input of 200,000 Btu/hr or less with no storage tank may be installed. For instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2 kW) see Section 110.3(c)6 of the Energy Standards
- Small Storage Type Water Heaters: A single gas or propane storage type water heater with an input of 105,000 Btu/hr or less and a volume of 55 gallons or less, that meets the requirements for Quality Insulation Installation, and has either a field verified compact hot water distribution system or all DHW piping is insulated and field verified.
- Large Storage Type Water Heaters: A single gas or propane storage type water heater with an input of 105,000 Btu/hr or less and a volume of more than 55 gallons, and has either a field verified compact hot water distribution system or all DHW piping is insulated and field verified. These larger systems do not have to meet the requirements for Quality Insulation.

Dwelling Unit distribution systems are limited to standard trunk and branch or demand recirculation for gas or propane water heater. Demand recirculation is not allowed for an electric water heater. If there is no natural gas connected to the building, an electric water heater may be replaced with another electric water heater. However, changing from gas to electric is not allowed. Multi-family central systems must use certified equipment as defined under Section 110.1 and 110.3.

Description of Terms for the following **CF1R-ALT-WATER HEATERS** form:

1. **Dwelling Unit Name:** Enter a Dwelling Unit Name
2. **Water Heating System Identification**: Enter a unique name for the Water Heating System.
3. **Water Heating System Location or Area Served:** Enter the zone or area served by the system.
4. **Water heating system type:** Domestic Hot Water (DHW), Hydronic, Combined Hydronic, or Central. DHW is for domestic hot water, hydronic is a water heating system used for space heating only; combined hydronic are when the water heater will provide both space conditioning and domestic hot water.
5. **Water heater type:** For non-central systems, only Small Storage or Small Instantaneous are allowed. For central systems specify Large Storage, Small Storage, Heat Pump, Boiler, Large Instantaneous, Small Instantaneous or Indirect.
6. **Number of water heaters in system:** In single-family and multi-family with water heaters in each dwelling units the value is 1. For multi-family central systems serving multiple dwelling units enter the total number of water heaters.
7. **Water heater volume (gal):** tank capacity in gallons. For individual water heaters for a dwelling unit this will be 80 gallons or less. If instantaneous, enter n/a. For multi-family central systems enter the total storage volume.
8. **Fuel Type:** Gas, Propane, Electric (Only if natural gas is not connected, or if the conditions of Section 150.2(b)1.H.ii.c. or 150.2(b)1.H.ii.d. are met)
9. **Rated Input Type:** Enter the equipment input rating type. Enter Btu/h for gas fired systems; kW for electric fired systems.
10. **Rated Input Value:** Enter the numeric value of rated input.
11. **Heating Efficiency Type:** Energy Factor, AFUE, or Thermal Efficiency. From product literature or a California Energy Commission directory.
12. **Heating Efficiency Value:** Enter the value from product literature or a California Energy Commission directory.
13. **Standby Loss (percent):** Applies only to large storage water heaters. *[This item is not typical - Enter N/A for small storage or instantaneous water heaters.]*
14. **Exterior Insulation R-Value:** Enter the R-value if exterior insulation on the storage tank is installed
15. **Back-up solar savings fraction:** If compliance requires a back-up solar system, indicate the solar contribution (e.g., 0.30). External calculations are required. *[This item is not typical]*

Certificate of Compliance: Residential WH Replacements (2019 CA Energy Code)	**CF1R-ALT-WATER HEATERS**
This form is to be used for <u>Residential Water Heater Replacements Only</u> and shall <u>not</u> to be used for New Buildings or for Adding a Second Water Heater. Use Form CF1R-ADD-01-E, CF1R-ADD-02-E or other appropriate form for New Buildings or for Adding a Second W.H.	
Residential Alterations Climate Zone: 2	**Page 1**
Site Address:	Date:
Building Type: ❑ Single Family ❑ Multi Family	Enforcement Agency: **City of Sonoma**

WATER HEATING SYSTEMS (Section 150.2(b)1.G)

01	02	03	04	05	06	07	08
Dwelling Unit Name	Water Heating System Identification	Water Heating System Location or Area Served	Water Heating System Type	Water Heater Type	# of Water Heaters in system	Water Heater Storage Volume (gal)	Fuel Type
	System #1						
	System #2						

	09	10	11	12	13	14	15
	Rated Input Type	Rated Input Value	Heating Efficiency Type	Heating Efficiency Value	Standby Loss (%)	Exterior Insulation R-Value	Back-Up Solar Savings Fraction
System #1							
System #2							

DOCUMENTATION AUTHOR'S DECLARATION STATEMENT

I certify that this Certificate of Compliance documentation is accurate and complete.

Documentation Author Name:	Documentation Author Signature:
Company:	Date:
Address:	CEA/ HERS Certification Identification (if applicable):
City/State/Zip:	Phone:

RESPONSIBLE DESIGNER'S DECLARATION STATEMENT

I certify the following under penalty of perjury, under the laws of the State of California:

1. The information provided on this Certificate of Compliance is true and correct.
2. I am eligible under Division 3 of the California Business and Professions Code to accept responsibility for the building design identified on this Certificate of Compliance.
3. I certify that the energy features and performance specifications for the building design identified oil this Certificate of Compliance conform to the requirements of Title 24, Parts 1 and 6 of the California Code of Regulations.
4. The building design features identified on this Certificate of Compliance are consistent with the information provided to document this building design on the other applicable compliance forms, worksheets, calculations, plans and specifications submitted to the enforcement agency for approval with tins building permit application.
5. I will ensure that a registered copy of this Certificate of Compliance shall be made available with the building permit(s) issued for the building, and made available to the enforcement agency for all applicable inspections. I understand that a registered copy of this Certificate of Compliance is required to be included with the documentation the builder provides to the building owner at occupancy.

Responsible Designer Name:	Responsible Designer Name:
Company:	Date:
Address:	License:
City/State/Zip:	Phone: