Residential

Domestic Hot Water

What is Domesic Hot Water (DHW)?

Domestic hot water is potable hot water that is consumed for domestic purposes including food preparation, cleaning, and personal hygiene. The 2016 Building Energy Efficiency Standards (Energy Standards) regulate hot water appliances, insulation and systems for residential applications. Water heating energy use is based on the number of dwelling units, fuel type, distribution system, water heater type, and conditioned floor area. The water heating system is defined by the tank type, heater element type, distribution type, multifamily central water heating distribution, efficiency (either energy factor or recovery efficiency with the standby loss), tank volume, exterior insulation R-value (only for indirect) and rated input.

Why? Water heating energy use is an important end use in low-rise residential buildings. Roughly 90% of California households use natural gas-fueled water heaters, these are typically storage tank systems with volumes of 40 to 50 gallons. Roughly 6% of households use electricity to heat water and a few percent use propane (liquefied petroleum gas, or LPG). Standby loss associated with the center flue design represents about 25-35% of a typical gas storage water heater system's annual energy use.

Relevant Code Sections

2016 California Building Energy Efficiency Standards, Title 24, Part 6:

- Section 110.1 – Mandatory Requirements for Appliances
- Section 110.3 – Mandatory Requirements for Service Water-heating Systems and Equipment
- Section 150.0(j) – Water System Piping and Insulation for Piping, Tanks, and Cooling System Lines
- Section 150.0(n) – Water Heating System
- Section 150.1(b) – Performance Standards
- Section 150.1(c)8 – Prescriptive Standards/Component Package for Domestic Water-Heating Systems
- Section 150.2(a)1D – Additions Prescriptive Approach for Water Heaters
- Section 150.2(b)1G – Alterations Prescriptive Approach for Water-Heating System

Relevant Compliance Forms

- 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
- CF2R-ADD-02-E: Prescriptive Additions Non-HERS Installation Compliance Form
- CF2R-ALT-05-E: 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

Compliance Requirements

The requirements for residential domestic hot water appliances, systems and insulation include both Mandatory and Prescriptive requirements.

Mandatory Requirements

Mandatory requirements set forth in Sections 110.1 and 110.3 of the Energy Standards apply to all DHW appliances, whether the project is newly constructed, an addition or an alteration. These sections establish the requirements for the manufacture, construction, and installation of certain DHW systems, equipment, appliances and building components. Section 150.0 includes Mandatory requirements for residential DHW systems and insulation.

Minimum Water Heater Efficiency

Minimum efficiency requirements are based on the type and size of the water heater. Both small and large units are regulated by federal efficiency standards and California's Appliance Efficiency Regulations (Title 20). The California Energy Commission maintains an Appliance Efficiency Database that includes regulated equipment certified to comply with Title 20.

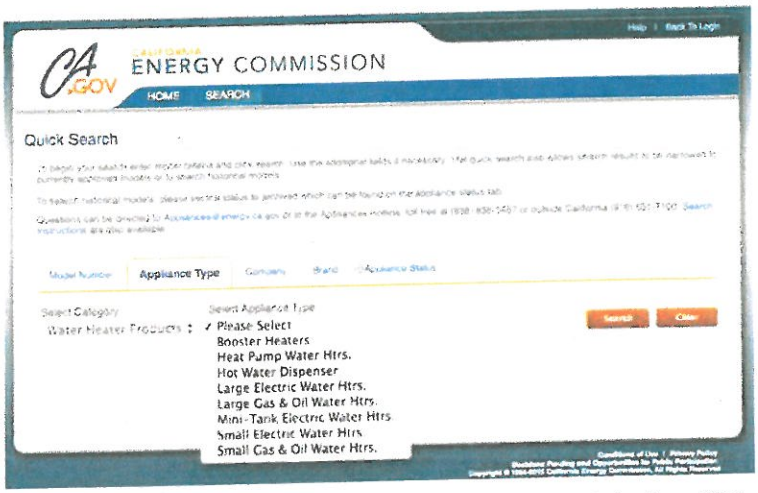


Figure 1: Example search for a water heater in the Energy Commission's Appliance Efficiency Database

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. Table 1 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.

Installation Requirements

Section 110.3 includes Mandatory installation requirements for outlet temperature controls, distribution system controls and storage tank insulation, and requirements related to multifamily and state buildings.

Tank and Pipe Insulation Requirements

Insulation for storage tanks must comply with 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

Pipe insulation shall comply with Section 150.0(j)2. The thickness of the pipe insulation corresponds to the temperature of the water as described in Table 120.3-A. For DHW systems with fluid temperatures 105°F -140°F, pipe insulation thickness ranges from 1-1.5 inches depending on the diameter of the pipe. Pipe insulation is a Mandatory requirement in the following cases:

- The first 5 feet of hot & cold water pipes from storage tank
- All hot 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 heating source to storage tank or between tanks
- Piping buried below grade
- All hot water pipes from heating source to kitchen fixtures

See Section 150.0(j)2 for exceptions to pipe insulation requirements.

Section 150.0(j)3 contains requirements for insulation protection, including requirements around pipes exposed to weather and vapor retarders for chilled water or refrigerant suction piping.

Water Heater System Requirements

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

- A 120V electrical receptacle that is within 3 feet from the water heater and accessible to the water heater with no obstructions **and**
- 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**
- 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

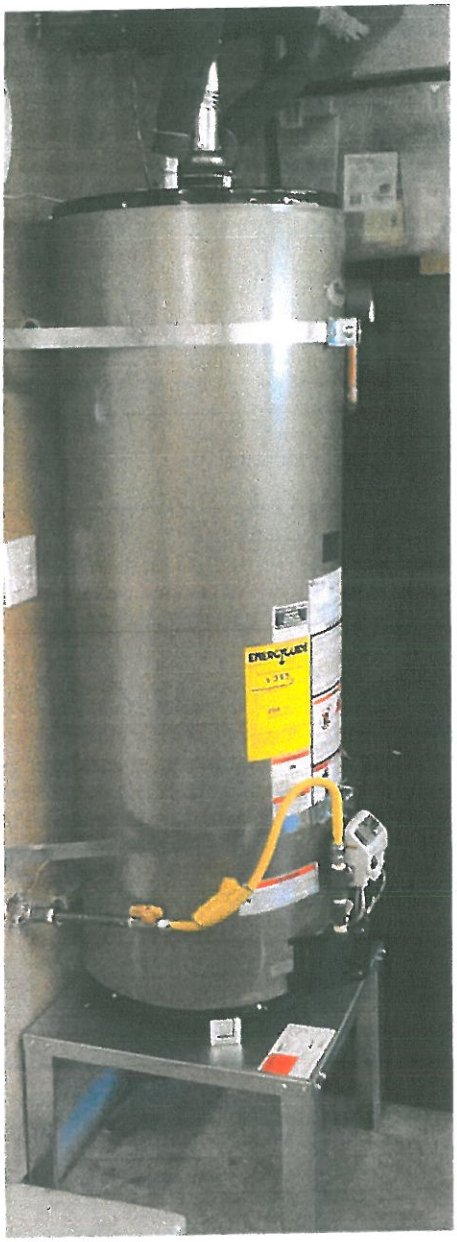
See Section 150.0(n) for more information.

Prescriptive Requirements

Domestic Water Heating Systems (Individual Dwelling Units)

If using the Prescriptive compliance path, DHW equipment serving individual dwelling units (detached single-family homes, low-rise multifamily buildings) must comply with one of the following options, per Section 150.1(c)8:

- **Storage Type Water Heaters:** A gas or propane fired unit 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
- **Storage Type Water Heaters:** A gas or propane fired unit with an input of more than 105,000 Btu/hr, 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 Installation



- **Instantaneous Type Water Heaters:** A gas or propane fired unit with an input of 200,000 Btu/hr or less. For instantaneous water heaters with an input rating greater than 6.8 kBTU/hr (2 kW) the following Mandatory requirements can be found in Section 110.3(c)7 of the Energy Standards:
  - Isolation valves must be installed on both the cold water supply and the hot water pipe leaving the water heater
  - Hose bibbs or other fittings must be installed on each valve for flushing the water heater when the valves are closed

For recirculation distribution systems, only Demand Recirculation Systems with manual control pumps shall be used. Additional detail can be found in Section 150.1(c)8 and Appendix RA4.4.

Domestic Water Heating Systems (Multifamily Buildings/Multiple Dwelling Units)

DHW systems that serve multiple dwelling units (those in low-rise or high-rise multifamily buildings) may be installed and must contain the following components:

- Gas or propane water heating equipment meeting the minimum energy efficiency requirements set forth in Section 110.1 and Section 110.3, summarized in Table F-2 in the 2016 Residential Compliance Manual, and in this document
- At least two recirculation loops, each serving roughly the same number of units
  - Exception: For systems serving less than eight dwelling units a single recirculation loop is required
- A solar water-heating system meeting the installation criteria specified in Reference Residential Appendix RA4 and 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

For more information regarding DHW systems in multifamily buildings the the Multifamily Fact Sheet.

HERS-Verified Recirculation Strategies

Several recirculation strategies require verification by a HERS rater and center around demand recirculation. Demand recirculation systems require that the pump operation is initiated just before the hot water draw and is operated by either a manual or sensor control which shuts off the pump due to a rise in pipe temperature. The following are requirements for these systems:

- **Demand Recirculation: Manual Control (RA4.4.9)** – shall be located in the kitchen and any point of use at least 20 feet away from the water heater. The manual control may be operated by wired or wireless mechanisms but must have a standby power of 1 watt or less
- **Demand Recirculation: Sensor Control (RA4.4.10)** – shall be located in the kitchen and any point of use at least 20 feet away from the water heater. The sensor mechanism may include motion sensors, door switches, and flow switches, and must have a standby power of 1 watt or less

With either strategy, the control shall shut off the pump in accordance with the following methods:

- After the pump has been activated, the controls shall allow the pump to operate until the water temperature at the thermo-sensor rises no more than 10°F above the initial temperature of the water in the pipes, or
- The controls shall not allow the pump to operate when the temperature exceeds 102°F

The controls shall limit pump operation to a maximum of five minutes following ANY activation.

See Residential Appendix 3.6.6 (RA3.6.6) and Residential Appendix 4.4.7 (RA4.4.7) for more information.

Addition and Alteration Projects

Mandatory Requirements

All of the Mandatory requirements discussed above apply to addition and alteration projects except that:

- Existing inaccessible piping does not require pipe insulation, and
- System requirements from Section 150.0(n) do not apply unless an addition project is adding a water heater

Prescriptive Requirements

Many addition and alteration projects will use the Prescriptive compliance path. For more details on requirements, see:

- For Additions - Section 150.2(a)1D
- For Alterations - Section 150.2(b)1G

These sections offer compliance through meeting the requirements of Section 150.1(c)8 or alternative compliance paths if these requirements can't be met under existing conditions.

The Energy Commission has published a Minimum Water Heater Energy Factor Reference Guide. See page 2 for guidance on replacement heat pump water heaters.

Compliance Credit for Performance Path

Compliance credit for DHW distribution is available for several different strategies, including one non-HERS credit for pipe insulation (PIA) and four HERS distribution credits:

- Pipe Insulation (PIA)
- Pipe Insulation (PIC-H)
- Parallel Piping with 5' maximum length (PP-H)
- Compact Design (CHWDS-H)
- Point of Use (POU-H)

Solar Water Heating

The Water Heating Calculation Method allows water heating credits for solar water heaters. Solar systems save energy by using renewable resources to offset the use of conventional energy sources.

Solar water heating is Prescriptively required for water heating systems serving multiple dwelling units, whether they are multifamily, hotel/motels or high-rise nonresidential buildings.

Collector Requirements

Collectors for solar water heating systems used to meet the requirements of the Energy Standards (such as those for DHW systems serving multiple dwelling units) must be certified by the Solar Rating and Certification Corporation (SRCC). Additionally the installed collector or system must be either OG-100 or OG-300 certified:

- **OG-100** certification applies only to the collector, the part of the solar energy system exposed to the sun collecting heat
  - For a listings of compliant products please refer to the SRCC Collector Ratings
- **OG-300** certification integrates the performance of the collector with a performance model of the entire system and must be installed with the following guidelines:
  - Face within 35 degrees of due south
  - Have a tilt slope of at least 3:12
  - Be unshaded by buildings or trees

For more specific installation guidelines, see Residential Appendix 4.4.20.

Forms – Which & When

During Design:

- 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
  - All forms completed and signed by permit applicant (designer, installing contractor or building owner)
  - All forms submitted to the building department during permit application

Notes:

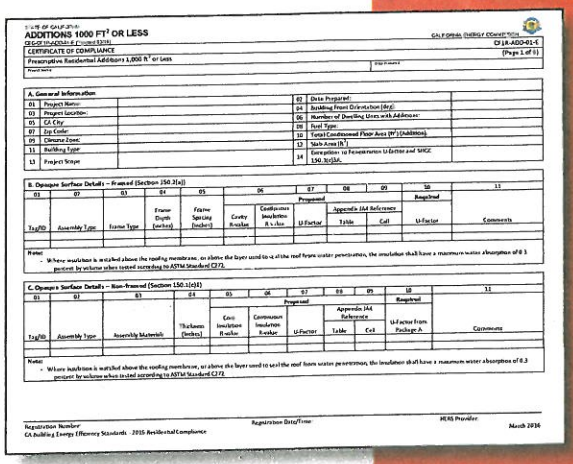
- The required CF1R forms are based on project specifics and will vary.

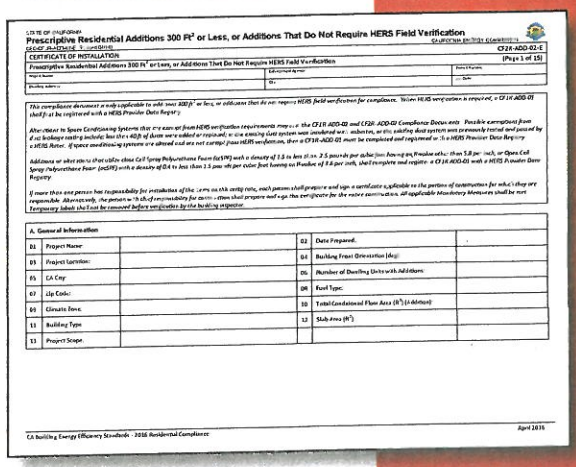
During Construction

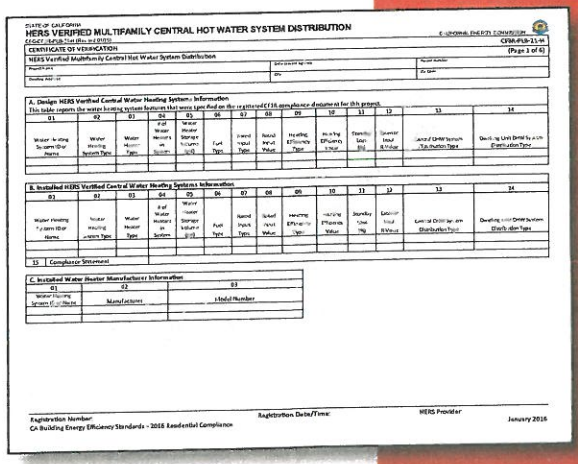
- CF2R-ADD-02-E: Prescriptive Additions Non-HERS Installation Compliance Form
- CF2R-ALT-05: Prescriptive Alterations Non-HERS Installation Compliance Form
- CF2R-PLB-01: Non-HERS Multifamily Central Hot Water System Distribution Installation Compliance Form
- CF2R-PLB-02: Non-HERS Single Dwelling Unit 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 completed and signed by installing contractor
  - All forms should be made available for the inspector when onsite

Notes:

- The required CF2R and CF3R forms are based on project specifics and will vary.


ADDITIONS 1000 FT² OR LESS
CERTIFICATE OF COMPLIANCE
Prescriptive Residential Additions 1,000 ft² or Less
CF1R-ADD-01-E
(Page 1 of 1)


Prescriptive Residential Additions 300 ft² or Less, or Additions That Do Not Require HERS Field Verification
CERTIFICATE OF INSTALLATION
CF2R-ADD-02-E
(Page 1 of 15)


HERS VERIFIED MULTIFAMILY CENTRAL HOT WATER SYSTEM DISTRIBUTION
CERTIFICATE OF VERIFICATION
CF2R-PLB-21-H
(Page 1 of 6)

For More Information

Primary Documents

- Energy Standards Section 110.1 – Minimum Water Heater Efficiency
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1101mandatoryrequirementsforappliances.htm
- Energy Standards Section 110.3 – Installation Requirements
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1103mandatoryrequirementsforservicewaterheatingsystemsand.htm
- Energy Standards Section 150.0(n) – Water Heating System
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1500mandatoryfeaturesanddevices.htm
- Energy Standards Section 150.0(j) - Water System Piping and Insulation for Piping, Tanks, and Cooling System Lines
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1500mandatoryfeaturesanddevices.htm
- Energy Standards Section 150.1(c)8 - Prescriptive Standards/ Component Package, Domestic Water-Heating Systems
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1501performanceandprescriptivecomplianceapproachesforlowr.htm
- Energy Standards Section 150.2(a)1D - Additions, Prescriptive Approach, Water Heater
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1502energyefficiencystandardsforadditionsandalterationsto.htm
- Energy Standards Section 150.2(b)1G – Alterations, Prescriptive Approach, Water-Heating System
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1502energyefficiencystandardsforadditionsandalterationsto.htm
- Energy Standards Residential ACM Reference Manual Chapter 2.10, Domestic Hot Water:
  energy.ca.gov/2015publications/CEC-400-2015-024/CEC-400-2015-024-CMF-REV2.pdf
- Energy Standards Residential Compliance Manual Chapter 5, Water Heating Requirements:
  energy.ca.gov/2015publications/CEC-400-2015-032/chapters/chapter_5-Water_Heating_Requirements.pdf
- Energy Standards Residential Appendix (RA) 4.4.21, Solar Water Heating Systems
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/ra44waterheatingmeasures.htm
- 2015 Title 20 Appliance Efficiency Regulations
  energy.ca.gov/2015publications/CEC-400-2015-021/CEC-400-2015-021.pdf
  - Updated standards adopted since the publication of the 2015 Appliance Efficiency Regulations are available at WestlawNext

California Energy Commission Information & Services

Title 24, Part 6

- Energy Standards Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov
- Online Resource Center:
  energy.ca.gov/title24/orc/
  - The Energy Commission's main web portal for Energy Standards, including information, documents, and historical information

Title 20

- Appliances Hotline: (888) 838-1467 or outside California (916) 651-7100
- Questions may also be emailed to Appliances@energy.ca.gov
- California Appliance Efficiency Standards Site:
  energy.ca.gov/appliances
- Modernized Appliance Efficiency Database (MAEDBS):
  https://cacertappliances.energy.ca.gov/Login.aspx

Additional Resources

- Solar Rating & Certification Corporation (SRCC):
  solar-rating.org
- Energy Code Ace:
  EnergyCodeAce.com
  - An online "one-stop-shop" providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California's investor-owned utilities.
    Of special interest: Fact Sheets
    energycodeace.com/content/resources-fact-sheets/
    - High-rise and Low-rise Multifamily
    - Quick Reference Sheet: Residential Equipment Minimum Heating and Cooling Efficiencies

    Please register with the site and select an industry role for your profile in order to receive messages about all our free offerings!

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Residential

Fenestration in Building Alterations

Alterations:

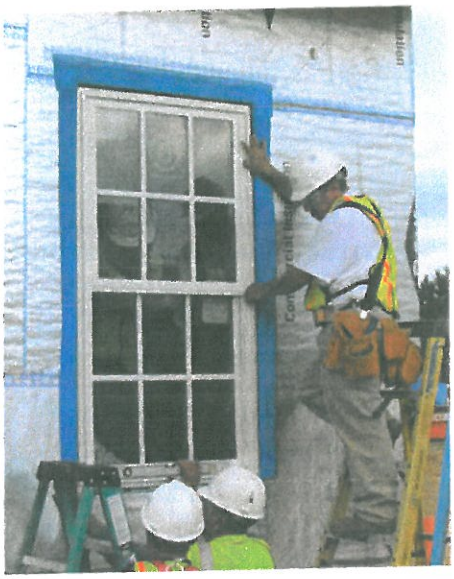
- 2016 Energy Standards include requirements for alterations and additions affecting fenestration, including windows, skylights, and doors with more than 3 ft^2 of glass.
- When the construction type is classified as an alteration, fenestration may be replaced (altered) or increased (added).
- Prescriptive requirements are triggered when fenestration products are replaced or added. Requirements vary depending on the area of replaced or added fenestration.

Product Labeling

Typically, manufactured windows come with labels indicating that the National Fenestration Rating Council (NFRC) has certified the performance ratings of the window. **Leave the labels on the windows until the field inspection is done.**

What Are Fenestration Alterations?

The 2016 Building Energy Efficiency Standards (Energy Standards) Title 24, Part 6 include requirements for alterations and additions affecting fenestration, including windows, skylights, and doors with more than 3 ft² of glass. When the construction type is classified as an alteration fenestration may be replaced (altered) or increased (added). Fenestration products installed in construction projects classified as additions trigger the new construction requirements for fenestration performance and U-factor requirements. This trigger sheet focuses on fenestration that is replaced or increased.



Why?

Windows, glazed doors, dynamic glazing, window films, and skylights have a significant impact on energy use in a home. Energy efficient fenestration can greatly reduce heating and cooling loads. The size, orientation, and types of fenestration products can dramatically affect the overall energy performance of a house. Glazing type, orientation and shading play a major role in a home's energy use by affecting how much HVAC systems have to heat and cool the house.

Relevant Code Sections

2016 California Building Energy Efficiency Standards, Title 24, Part 6:

- Section 110.6 – Mandatory Requirements for Fenestration Products and Exterior Doors
- Section 110.7 – Mandatory Requirements to Limit Air Leakage
- Section 150.0(q) – Mandatory Features and Devices - Fenestration Products
- Section 150.1(c) – Performance and Prescriptive Compliance Approaches for Low-Rise Residential Buildings - Fenestration & Shading
- Section 150.2(b)1A – Additions and Alterations to Existing Low-Rise Residential Buildings - Alterations Prescriptive Approach - Fenestration
- Section 150.2(b)1B – Additions and Alterations to Existing Low-Rise Residential Buildings - Alterations Prescriptive Approach - Replacement Fenestration
- Section 10-111 – Certification and labeling of fenestration product U-factors, SHGC, VT, and Leakage

Relevant Compliance Forms

- CF1R-ALT-01-E: Prescriptive Residential Alterations
- CF1R-ENV-02-E: (if necessary) Area Weighted Average Calculation Worksheet
- CF1R-ENV-03-E: (if necessary) Solar Heat Gain Coefficient (SHGC) Worksheet
- CF2R-ENV-01-E: Fenestration Installation
- CF2R-ALT-05-E: Prescriptive Alterations Simple Non HERS
- CF3R-EXC-20-H: Verification of Existing Conditions for Alterations

Compliance Requirements: Prescriptive (vs) Performance

There are both Prescriptive and Performance compliance approaches for altering or adding residential fenestration to an existing building. A Prescriptive approach follows code requirements that clearly state what applies, while a Performance-based one provides more design freedom but involves more complex energy simulations and tradeoffs between systems. Requirements vary by the type and area of fenestration added or replaced in the project, as well as climate zone. This Fact Sheet provides information on how to assess whether your project should use the Prescriptive or Performance approach – and the code requirements for each.

Mandatory Requirements

Whether you use the Prescriptive or Performance approach to demonstrate compliance, new or replacement fenestration must meet the following mandatory requirements:

- Air infiltration rates for manufactured fenestration and pet doors must be ≤0.3 cfm/ft² of window area at a pressure differential of 75 pascals
- All new fenestration that separates conditioned space from unconditioned space or outdoors must have a maximum or weighted-average U-factor of 0.58 or lower
- All fenestration products must either have their performance rated by the National Fenestration Rating Council (NFRC), or use default performance values for U-factor, Solar Heat Gain Coefficient (SHGC) and visible trasmittance (VT) from Tables 110.6-A and 110.6-B of the Standards. Buildings with unrated products will not qualify for prescriptive compliance and must use the performance compliance approach.

Exception:

Your project does not need to meet the maximum U-factor requirement if it involves:

- ≤10 ft2 of fenestration OR
- the fenestration area is ≤ 0.5% of the total CFA (whichever is greater) OR
- the fenestration areas is ≤ 30 ft2 of dual-glazed greenhouse or garden windows

Repairs

No fenestration energy efficiency requirements apply if you:

- Replace a broken pane of glass, but not the entire window
- Uninstall fenestration components for maintenance or repair and re-install in the same location without increasing the pre-existing energy consumption

Assessing Your Project

- If you add more than 75 ft² to the building's fenestration area, the new fenestration must meet requirements for TOTAL fenestration area and WEST-facing fenestration area, as well as the U-factor and SHGC for the climate zone
- If you add fenestration area up to 75 ft² – or if you add up to 16 ft² of new skylight area with U-factor ≤0.55 and SHGC ≤0.30 – the total/west-facing fenestration area requirements do not apply (A skylight is fenestration installed on a roof <60° from the horizontal)
- If you replace existing fenestration, the replaced fenestration must meet the area-weighted U-factor and SHGC requirements of Package A (See Table 1)
- Exceptions are:
  - Replacements of vertical fenestration up to 75 ft² will comply with a maximum U-factor of 0.40 in climate zones 1 - 16, and a maximum SHGC of 0.35 in climate zones 2, 4, and 6 - 16
  - Replaced skylights are allowed a maximum U-factor of 0.55, and a maximum SHGC of 0.30
- If the project does not meet the prescriptive requirements:
  - Adjust your project – For example, purchase more energy efficient windows or add less fenestration area

  OR
  - Use the Performance approach – This requires using approved energy modeling software.
- Check with an energy consultant before removing any existing windows or other feature
- You may be able to use the energy efficiency values from your existing features to demonstrate compliance with the performance approach. This would require verification by a HERS Rater of the existing features before they are changed.

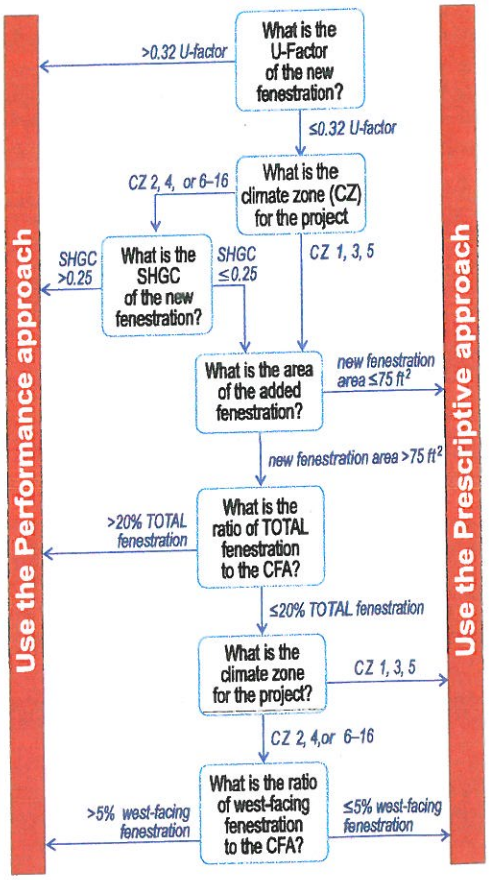


*Figure 1: Prescriptive or Performance?**

* This flowchart depicts the most common decisions regarding fenestration alteration projects. Exceptions may apply to projects that have small glazing areas and use efficient fenestration products. For example, if the fenestration area is ≤10 ft² or 0.5% of the Conditioned Floor Area (CFA), whichever is larger, it is exempt from the maximum U-factor requirement. As another example, ≤3 ft² of new glazing area installed in doors need to meet neither the U-factor nor the SHGC maximums.

Prescriptive Requirements

The Prescriptive requirements for fenestration vary by climate zone and the type and area of the fenestration:

More than 75 ft² additional fenestration area or more than 16 ft² of skylight area[A]

Climate Zones	U-Factor[E]	SHGC[B,E]	TOTAL Fenestration[C] Area % of CFA[D]	WEST-facing[C] Area % of CFA[D]
1, 3, 5	0.32 or lower	na	20% or less	na
2, 4, 6-16	0.32 or lower	0.25 or lower	20% or less	5% or less

75 ft² or less additional fenestration area[A]

Climate Zones	U-Factor[E]	SHGC[B,E]
1, 3, 5	0.32 or lower	na
2, 4, 6-16	0.32 or lower	0.25 or lower

16 ft² or less additional skylight area

1, 3, 5	0.55 or lower	na
2, 4, 6-16	0.55 or lower	0.30 or lower

A Fenestration area is the glass plus the frame. For doors with glass area less than 50% of total door area, consider the "frame" to be two inches on all sides of the glass. For doors with glass area 50% or more of the total door area, count the entire door area as glazing.

B If the fenestration has qualifying exterior shading (e.g., a permanent awning) the SHGC may be calculated taking that shading into consideration. If you use exterior shading to meet the SHGC requirement, you must submit a CF1R-ENV-03-E: "Solar Heat Gain Coefficient (SHGC) Worksheet."

C "TOTAL fenestration" is all new fenestration plus existing fenestration that remains after the alteration. See "Orientation and West-facing Fenestration" (below) for a definition of west-facing fenestration.

D "CFA" is conditioned floor area; see Section 100.1 "Definitions and Rules of Construction" in the Standards for details.

E Maximum area-weighted average values.
See Exception 3 to Section 150.1(c)3A for fenestration containing chromogenic glazing. (Chromogenic glazing is high performance glazing that is able to vary its transmittance appropriately in response to automatic controls based on the solar intensity. This means it has the potential to improve building energy efficiency compared to standard low-e glazing.)

Table 1: Prescriptive Requirements

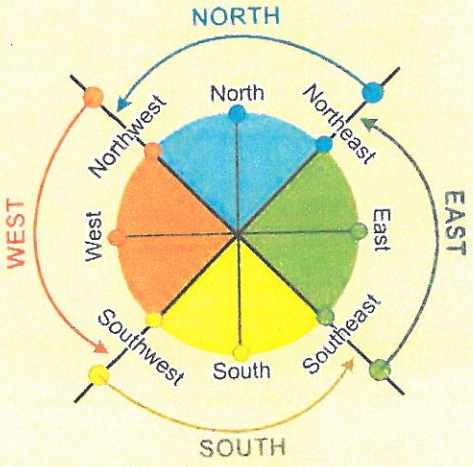
Orientation & West-facing Fenestration

"Orientation" refers to the direction that the fenestration faces.

West-facing fenestration – a consideration in climate zones 2, 4 & 6 - 16 – includes:

- A window (or a door with glass) that faces from ≤45° north of true west to <45° south of true west.
- Skylights tilted:
  - To the west (from ≤45° north of true west to <45° south of true west)
  - In any direction when the pitch is less than 1:12

Actual Orientation…	…Is Considered
45° east of north to 44° west of north	North-facing
45° north of west to 44° south of west	West-facing
45° west of south to 44° east of south	South-facing
45° south of east to 44° north of east	East-facing



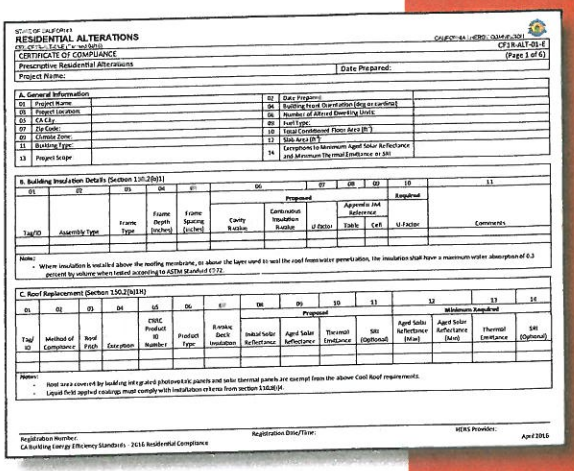
Forms – Which & When

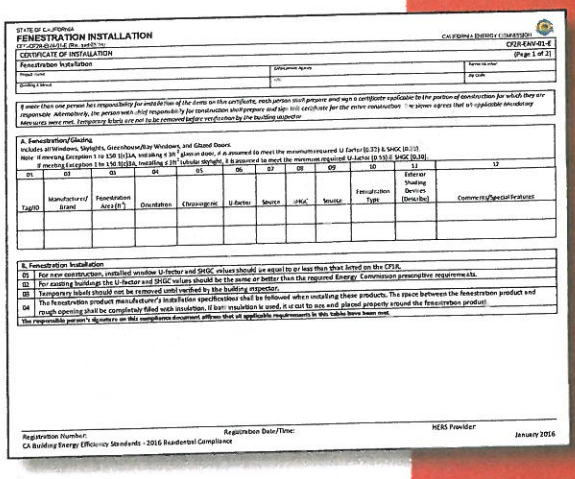
In addition to a Permit, you will need the following forms applicable to your project.

During Design:

- CF1R-ALT-01-E: Certificate of Compliance for Residential Alterations
  - Completed and signed by the designer, installing contractor or homeowner
  - Submitted to the building department during permit application
- CF1R-ENV-02-E: (if necessary) – Area Weighted Average Calculation Worksheet
  - Completed and signed by the designer, installing contractor or homeowner
  - Submitted with the CF1R-ALT-01-E when there is more than one type of window and one or more does not meet prescriptive compliance requirements
- CF1R-ENV-03-E: (if necessary) – Solar Heat Gain Coefficient (SHGC) Worksheet
  - Completed and signed by the designer, installing contractor or homeowner
  - Submitted with the CF1R-ALT-01-E only if exterior shading devices are used to meet the SHGC requirement

Why?: To show compliance with energy code for fenestration alterations


RESIDENTIAL ALTERATIONS
CERTIFICATE OF COMPLIANCE
Prescriptive Residential Alterations
Project Name:
Date Prepared:


FENESTRATION INSTALLATION
CERTIFICATE OF INSTALLATION
Fenestration Installation

During Construction:

- CF2R-ENV-01-E: Fenestration Installation
  - Completed by the installing contractor
  - Made available for the Inspector when onsite
- CF2R-ALT-05-E: Prescriptive Alterations Simple Non HERS
  - Completed by the installing contractor
  - Made available for the Inspector when onsite
- CF3R-EXC-20-H: HERS Verification of Existing Conditions for Alterations
  - Completed and signed by HERS Rater

Why?: To verify the field installation meets or exceeds energy code

Product Labeling

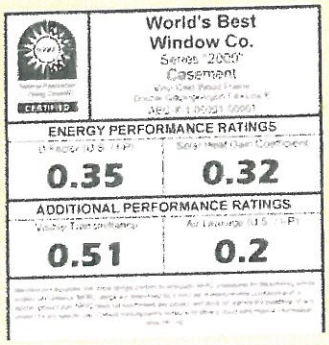
Typically, manufactured windows come with labels indicating that the NFRC has certified the performance ratings of the window. **Leave the labels on the windows until the field inspection is done.**

Manufactured fenestration not certified by NFRC must:

- Use the CEC Default values found in Table 110.6-A and Table 110.6-B in the Energy Standards

OR

- Use the equations in Reference Appendix NA6



For More Information

Primary Documents

- Energy Standards Residential Compliance Manual Section 3.5
  energy.ca.gov/2015publications/CEC-400-2015-032/chapters/chapter_3-Building_Envelope_Requirements.pdf
- Energy Standards Section 110.6 – Mandatory Requirements for Fenestration Products and Exterior Doors
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1106mandatoryrequirementsforfenestrationproductsandexteri.htm
- Section 110.7 - Mandatory Requirements to Limit Air Leakage
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1107mandatoryrequirementstolimitairleakage.htm
- Energy Standards Section 150.0(q) – Mandatory Features and Devices - Fenestration Products
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1500mandatoryfeaturesanddevices.htm
- Energy Standards Section 150.1(c) – Performance and Prescriptive Compliance Approaches for Low-Rise Residential Buildings - Fenestration & Shading
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1501performanceandprescriptivecomplianceapproachesforlowr.htm
- Energy Standards Sections 150.2(b)1A – Additions and Alterations to Existing Low-Rise Residential Buildings - Alterations Prescriptive Approach - Fenestration
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1502energyefficiencystandardsforadditionsandalterationsto.htm
- Energy Standards Sections 150.2(b)1B – Additions and Alterations to Existing Low-Rise Residential Buildings - Alterations Prescriptive Approach - Replacement Fenestration
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/section1502energyefficiencystandardsforadditionsandalterationsto.htm
- Energy Standards Section 10-111 – Certification and labeling of fenestration product U-factors, SHGC, VT, and Leakage
  energycodeace.com/site/custom/public/reference-ace-2016/index.html#!Documents/10111certificationandlabelingoffenestrationproductufactorssolarh.htm

California Energy Commission Information & Services

- Energy Standards Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov
- Online Resource Center:
  energy.ca.gov/title24/orc/
  – The Energy Commission's main web portal for Energy Standards, including information, documents, and historical information

Additional Resources

- EnergyCodeAce.com
  – An online "one-stop-shop" providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California's investor-owned utilities.
  Please register with the site and select an industry role for your profile in order to receive messages about all our free offerings!

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