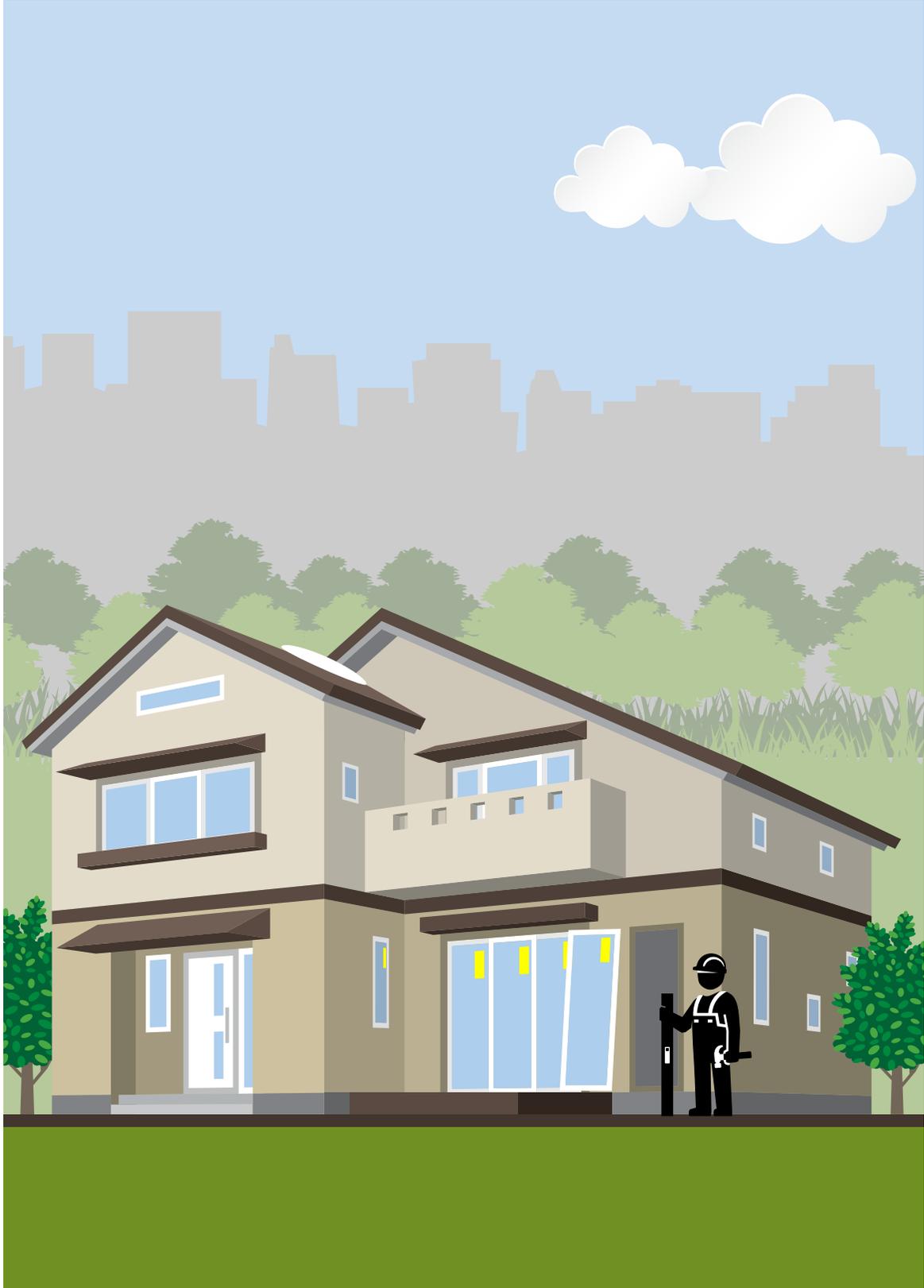
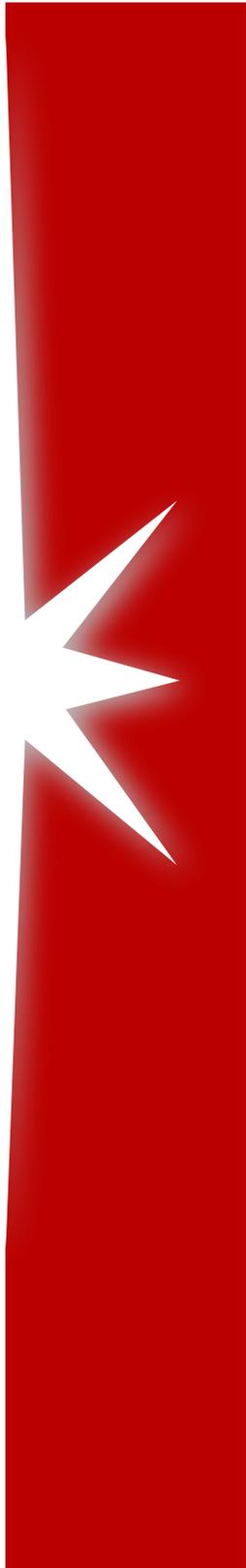


Residential
Fenestration in Building Alterations



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 transmittance (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 $\leq 0.5\%$ 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 $<60^\circ$ 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.

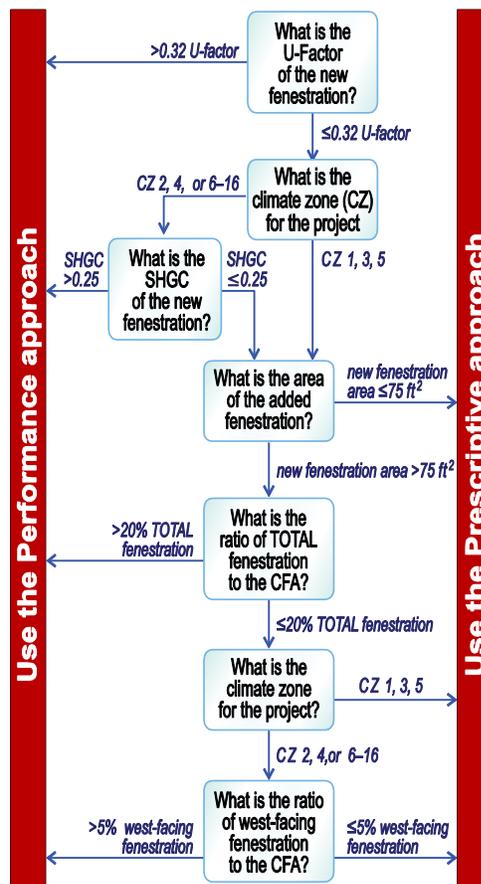


Figure 1: Prescriptive or Performance?*

* 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 or more than 75 ft² replacement fenestration^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 or replacement skylights

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

75ft² or less replacement fenestration

1,3,5	0.40 or lower	na
2,4,6-16	0.40 or lower	0.35 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

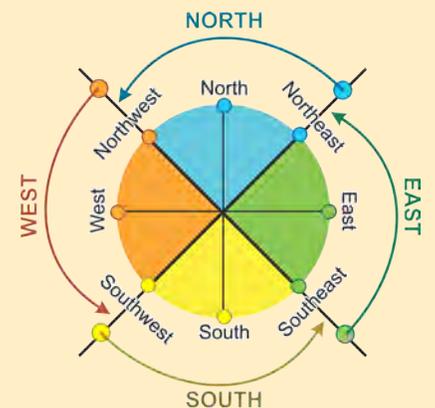
Orientation & West-facing Fenestration

“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 $\leq 45^\circ$ north of true west to $< 45^\circ$ south of true west.
- Skylights tilted:
 - To the west (from $\leq 45^\circ$ north of true west to $< 45^\circ$ 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

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

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

A. General Information

01 Project Name	02 Date Prepared
03 Project Location	04 Building Area Orientation (East or West)
05 CA Code	06 Number of Above-Ground Units
07 Zip Code	08 Fuel Type
09 Climate Zone	10 Total Conditioned Floor Area (Sq. Ft.)
11 Building Type	12 Site Area (Sq. Ft.)
13 Project Scope	14 Compliance to Minimum R-Value Requirements and Minimum Thermal Emittance or SHGC

B. Building Insulation Details (Section 150.20(b))

Tag/ID	Assembly Type	Frame Type	Frame Depth (Inches)	Frame Spacing (Inches)	Cavity R-value	Proposed				Required							
						Insulation R-value	U-factor	SHGC	Emittance	Insulation R-value	U-factor	SHGC	Emittance				

C. Roof Replacement (Section 150.20(a))

Tag/ID	Method of Attachment	Roof Slope (Inch/12)	Roof Exposure	CRRC Product ID Number	Product Type	R-value (Inches)	Initial Solar Reflectance	Aged Solar Reflectance	Thermal Emittance (Max)	SHGC (Optional)	Minimum Required	
											Thermal Emittance	SHGC (Optional)

FENESTRATION INSTALLATION
 CERTIFICATE OF INSTALLATION
 Fenestration Installation
 Project Name: _____ Minimum Area: _____ Maximum Area: _____
 Manufacturer: _____
 Installation Date: _____

A. Fenestration Glazing

Includes all Windows, Sliding, Greenhouse/Flex Windows, and Glassed Doors.
 Note: If meeting Exception 1 to 150.10.3A, installing a 3/8" glass in door, it is assumed to meet the minimum required U-factor 0.31 & SHGC 0.25.
 Note: If meeting Exception 1 to 150.10.3A, installing a 3/8" window in door, it is assumed to meet the minimum required U-factor 0.30 & SHGC 0.25.

Tag/ID	Manufacturer Brand	Fenestration Area (Sq. Ft.)	Orientation	Chromogenic	U-factor	SHGC	SHGC Source	Fenestration Type	Exterior Shading Device (Describe)	Comments/Special Features

B. Fenestration Installation

01 For new construction, installed window U-factor and SHGC values should be equal to or less than that listed on the CFM.
 02 For existing buildings the U-factor and SHGC values should be the same or better than the required Energy Commission prescriptive requirements.
 03 Temporary labels should not be removed until verified by the building inspector.
 04 The fenestration product manufacturer's installation specifications shall be followed when installing these products. The space between the fenestration product and rough opening shall be completely filled with insulation, at least insulation R-10, 8 if cut to size and placed properly around the fenestration product.
 The responsible person's signature on this compliance document affirms that all applicable requirements in this table have been met.

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/10111certificationandlabelingoffenestrationproductufactorsolarh.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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