

What Are Fenestration Alterations?

The 2019 California Building Energy Efficiency Standards (Energy Code), 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 fact 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

2019 California Building Energy Efficiency Standards, Title 24, Part 6:

- [Section 10-111](#) – Certification and labeling of fenestration product U-factors, SHGC, VT, and Leakage
- [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

Relevant Compliance Forms

- [CF1R-ALT-01-E](#): Prescriptive Residential Alterations (when HERS is triggered)
- [CF1R-ENV-02-E](#): Area Weighted Average Calculation Worksheet (if necessary)
- [CF1R-ENV-03-E](#): Solar Heat Gain Coefficient (SHGC) Worksheet (if necessary)
- [CF2R-ENV-01-E](#): Fenestration Installation
- [CF2R-ALT-05-E](#): Certificate of Compliance – Prescriptive Alterations (Simple projects that do not trigger 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 flexibility but requires energy simulations to estimate 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 Energy Code
- Buildings with unrated products will not qualify for Prescriptive compliance and must use the Performance compliance approach

Exception:

Fenestration exempt from the maximum U-factor requirement includes:

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

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

Prescriptive vs Performance Approach

- 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 [Table 150.1-A](#) or [B](#)
- 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 6-15
 - 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.

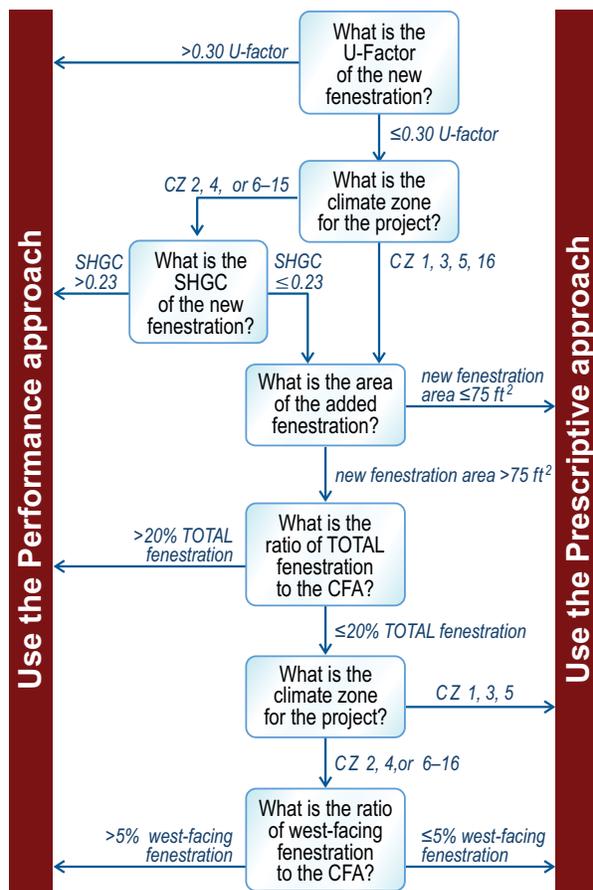


Figure 1: Prescriptive or Performance?*

* 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, 16	0.30 or lower	na	20% or less	na
2, 4, 6-15	0.30 or lower	0.23 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, 16	0.30 or lower	na
2, 4, 6-15	0.30 or lower	0.23 or lower

16 ft² or less additional skylight area or replacement skylights

1, 3, 5, 16	0.55 or lower	na
2, 4, 6-15	0.55 or lower	0.30 or lower

75ft² or less replacement fenestration

1, 3, 5, 16	0.40 or lower	na
2, 4, 6-15	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 Energy Code](#) 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 Requirement

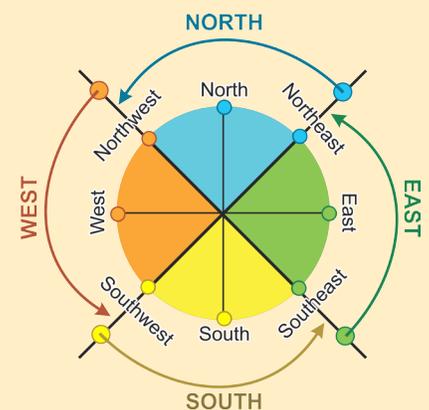
Orientation & West-facing Fenestration

“Orientation” refers to the direction that the fenestration faces.

West-facing fenestration – a consideration in Climate Zones 2, 4 and 6 -15 – 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



For More Information

Primary Documents

- Energy Code Residential Compliance Manual Section 3.5 – Fenestration (Window/Skylight/Glazed Door) and Opaque Doors:
energycodeace.com/site/custom/public/reference-ace-2019/Documents/35insulationproducts.htm
- Energy Code Section 10-111 – Certification and labeling of fenestration product U-factors, SHGC, VT, and Leakage:
energycodeace.com/site/custom/public/reference-ace-2019/Documents/10111certificationandlabelingoffenestrationproductandexteriordoo.htm
- Energy Code Section 110.6 – Mandatory Requirements for Fenestration Products and Exterior Doors:
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1106mandatoryrequirementsforfenestrationproductsandexteri.htm
- Energy Code Section 110.7 - Mandatory Requirements to Limit Air Leakage:
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1107mandatoryrequirements Tolimitairleakage.htm
- Energy Code Section 150.0(q) – Mandatory Features and Devices - Fenestration Products:
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1500mandatoryfeaturesanddevices.htm
- Energy Code Section 150.1(c) – Performance and Prescriptive Compliance Approaches for Low-Rise Residential Buildings - Fenestration & Shading:
energycodeace.com/site/custom/public/reference-ace-2019/Documents/section1501performanceandprescriptivecomplianceapproachesforlowr.htm
- Energy Code 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-2019/Documents/section1502energyefficiencystandardsforadditionsandalterationsto.htm
- Energy Code 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-2019/Documents/section1502energyefficiencystandardsforadditionsandalterationsto.htm

California Energy Commission Information & Services

- Energy Code Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov
- Online Resource Center:
www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/online-resource-center
 - The Energy Commission’s main web portal for Energy Code, including information, documents, and historical information

Additional Resources

- National Fenestration Rating Council (NFRC):
nfr.org
- 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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