

## What Are the Envelope Requirements for Single-family Buildings?

This fact sheet explains the Title 24, Part 6 Building Energy Efficiency Standards (Energy Code or Title 24, Part 6) envelope requirements for single-family building projects that are classified as New Construction, Additions or Alterations. The envelope features covered include roofs, walls, air barrier, floors, soffits and fenestration.

All applicable single-family envelope requirements must be met when:

- ✦ A single-family building is newly constructed and conditioned
- ✦ An existing single-family building is newly conditioned
- ✦ An existing unconditioned building of another occupancy type is converted to a conditioned single-family building

However, when a project is an Alteration, envelope requirements apply only for the altered envelope features.

For building envelope, Energy Code requirements apply to:

- ✦ Roofing product efficiency and installation, attic ventilation and radiant barrier
- ✦ Exterior or demising roof, wall, and/or floor insulation
- ✦ Vapor retarder and infiltration control
- ✦ Solid door efficiency
- ✦ Fenestration efficiency, rating, and area allowance
- ✦ Envelope HERS measures

### Ace Tip

Not all requirements in this fact sheet apply to every project.

To print the section of the fact sheet that applies to your project or to a specific building feature, refer to the Table of Contents and enter the applicable page range.

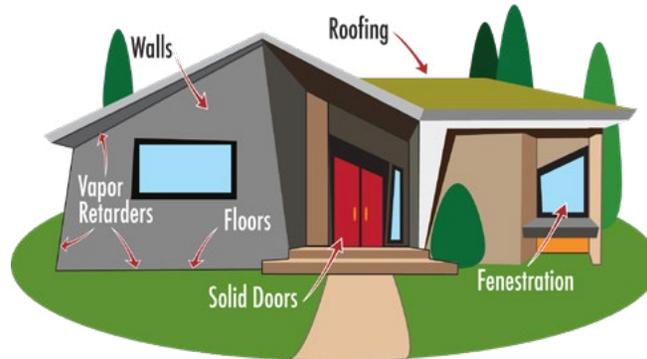


Figure 1. Envelope Features in Single-family Buildings

Single-family Building Types with Envelope Requirements		
Occupancy Group and Building Type California Building Code §§310 and 312	Building and Space Type Energy Code §100.1	
<b>R-3</b>	<b>Residential Group R-3:</b> Buildings with 2 or fewer dwelling units for permanent residents	<b>Single-family:</b> Occupancy Group R-3 buildings with 2 or fewer dwelling units Examples: Houses, duplexes, townhomes, accessory dwelling units (ADUs) <i>Hotels, motels and multifamily buildings are excluded.</i>
<b>R-3.1</b>	<b>Residential Group R-3.1:</b> Residential care facilities for 6 or fewer clients	<b>Occupancy Group R-3.1 residential care facilities</b> are considered single-family Examples: Adult residential facilities, foster family homes, group homes
<b>U</b>	<b>Miscellaneous:</b> Accessory and miscellaneous buildings and structures on single-family residential sites	<b>Occupancy Group U buildings on single-family residential sites</b> are considered single-family Examples: Barns, greenhouses, carports

Table 1. Single-family Building Types with Envelope Requirements

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## Key Terms

**Addition** is any change to a building that increases conditioned floor area and conditioned volume. See also “newly conditioned space.” Addition is also any change that increases the floor area and volume of an unconditioned building of an occupancy group or type regulated by Title 24, Part 6. Addition is also any change that increases the illuminated area of an outdoor lighting application regulated by Title 24, Part 6.

**Demising Partition** is a wall, fenestration, floor or ceiling that separates conditioned space from enclosed unconditioned space or a controlled environment horticulture space.

**Exterior Partition** is an opaque, translucent or transparent solid barrier that separates conditioned space from ambient air or space. For low-rise residential occupancies, exterior partitions also include barriers that separate conditioned space from unconditioned space, or the ground.

**Newly Conditioned Space** is any space being converted from unconditioned to directly conditioned or indirectly conditioned space. Newly conditioned space must comply with the requirements for an addition. See [§150.2](#) for residential Additions.

**Newly Constructed Building** is a building that has never been used or occupied for any purpose.

**Single-family Buildings** are any of the following:

- ✦ A residential building of Occupancy Group R-3 with two or less dwelling units
- ✦ A building of Occupancy Group R-3, other than a multifamily building or hotel/motel building
- ✦ A townhouse
- ✦ A building of Occupancy Group R-3.1
- ✦ A building of Occupancy Group U when located on a residential site

Seasonally occupied agricultural housing limited by state or federal agency contract to occupancy not more than 180 days in any calendar year is not subject to the Energy Code requirements.

## How Does this Fact Sheet Apply to Your Project?

Use this fact sheet to determine Energy Code envelope requirements for New Construction, Additions and Alterations of single-family buildings.

There are two basic steps to comply with the Energy Code:

1. Meet all Mandatory requirements by installing required systems, equipment and devices and ensuring that they perform all functions required by the Energy Code.
2. Select your method of compliance by choosing either the Performance Approach or the Prescriptive Approach.



### Mandatory Requirements

All conditioned single-family buildings must meet a set of Mandatory requirements for minimum envelope efficiencies and construction of assemblies. Examples of building envelope components addressed by Mandatory Measures include minimum insulation levels and infiltration.



### Prescriptive Approach

The Prescriptive Approach is considered the most direct path to compliance. It is a set of prescribed performance levels for various building components, where each component must meet the required minimum efficiency. There are different Prescriptive requirements for different Climate Zones and New Construction or Additions versus Alterations. The Performance Approach can be used to gain more flexibility than the Prescriptive requirements.



### Performance Approach

The Performance Approach builds on the Prescriptive Approach by allowing energy allotments to be traded between building systems for single-family buildings. There can be proposed energy use trade-offs between features of the building envelope, domestic water-heating, space-heating and cooling equipment. This compliance approach requires using energy analysis software that has been approved by the California Energy Commission (CEC).



## Product Certification and Rating

### Department of Consumer Affairs

For the following products to be installed in California, manufacturers must certify to the Department of Consumer Affairs, Bureau of Household Goods and Services (BHGS) <https://bhgs.dca.ca.gov> that the products meet the standards for insulating materials detailed in Title 24, Part 12, Chapter 12-13, Article 3:

- ✦ Insulation must be certified to meet the applicable conductive thermal performance for the product type ([§110.8\(a\)](#)).
- ✦ Radiant barriers must be certified to have an emittance of 0.05 or less ([§110.8\(j\)](#)).

### National Fenestration Rating Council

The National Fenestration Rating Council (NFRC) rates the performance of manufactured and site-built windows, glass doors, opaque doors and skylights and publishes the directory of NFRC-rated products on its website.

- ✦ Manufactured products: <https://search.nfrc.org/search/searchdefault.aspx>
- ✦ Site-Built products: <https://cmast.nfrc.org/>

### Cool Roof Rating Council

The Cool Roof Rating Council (CRRCC) rates the solar reflectance, thermal emittance and solar reflectance index of roofing materials and publishes the directory of CRRCC-rated products on its website <https://coolroofs.org/directory/roof/>.



## Does Your Project Trigger the Energy Code?

New Construction, Addition and Alteration projects are subject to the Energy Code. Repairs are not subject to the Energy Code if the repair does not increase energy use. See Table 2 for a list of typical project scopes, how they are classified and whether they must comply with the Energy Code.

Is Your Project New Construction, Addition, Alteration or a Repair?		
Project Scope	Project Type	Is the Energy Code triggered?
Newly constructed single-family buildings	New Construction	YES
New detached accessory dwelling unit (ADU)	New Construction	YES
Adding onto a building with new conditioned floor area and volume	Addition	YES
Converting an existing enclosed unconditioned space to conditioned space	Addition	YES
Replacing existing building features associated with conditioned space	Alteration	YES
Recovering or replacing roofing but NOT repairing a roof	Alteration	YES
Repairing, but NOT recovering or replacing roofing	Repair	No
Replacing glass or sashes within an existing frame of a conditioned space	Repair	No

**Accessory Dwelling Unit (ADU)** is an attached or detached residential dwelling unit which provides complete independent living facilities for one or more persons. An ADU shall include permanent provisions for living, sleeping, eating, cooking, and sanitation on the same parcel as the primary residence. An ADU is considered a single-family project when associated with a single-family occupancy.

**Addition** is any change to a [building](#) that increases conditioned floor area and [conditioned volume](#). See also "[newly conditioned space](#)." **Addition** is also any change that increases the floor area and volume of an unconditioned building of an occupancy group or type regulated by Title 24, Part 6. Addition is also any change that increases the illuminated area of an [outdoor lighting](#) application regulated by Title 24, Part 6.

**Conditioned Space** is an enclosed space within a building that is directly conditioned or indirectly conditioned.

**Conditioned Space, Directly** is an enclosed space that is provided with wood heating, mechanical heating that has a capacity exceeding 10 Btu/hr-ft<sup>2</sup>, or mechanical cooling that has a capacity exceeding 5 Btu/hr-ft<sup>2</sup>. Directly conditioned space does not include [process space](#).

**Conditioned Space, Indirectly** is enclosed space that (1) is not directly conditioned space; and (2) either (a) has a thermal transmittance area product (UA) to directly conditioned space exceeding that to the outdoors or to unconditioned space and does not have [fixed](#) vents or openings to the outdoors or to unconditioned space, or (b) is a space through which air from directly conditioned spaces is transferred at a rate exceeding three air changes per hour.

**Repairs** must not increase the preexisting energy consumption of the repaired component, system or equipment.

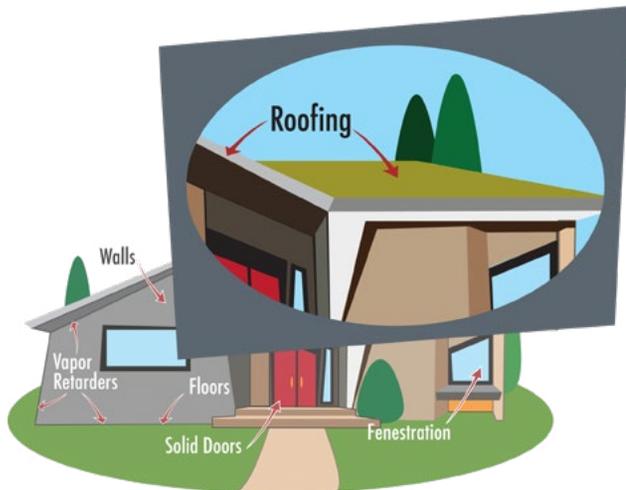
**Newly Conditioned Space** is any space being converted from unconditioned to directly conditioned or indirectly conditioned space. Newly conditioned space must comply with the requirements for an addition. See [§150.2](#) for single-family occupancies.

**Table 2.** Is Your Project New Construction, Addition, Alteration or a Repair?



# Roofs

**Why Is Compliance Required for Roofs?** Roofs have a high potential for solar gains and losses, so increasing insulation levels in these areas can provide significant reductions in heating and cooling loads in buildings. Adding continuous rigid insulation above the roof deck can reduce conductive heat transfer through framing members. Adding rated “cool roof” roofing material can reduce the conductive heat flow through the roof, increasing the efficiency of the roof assembly.



**Figure 2.** Roofing Material on a Single-family Building

## Key Terms

**Attic Roof** is an enclosed space directly below the roof deck and above the ceiling beams.

**Rafter Roof** can be either flat or in a sloped application with insulation typically installed between the rafters. With this construction, the insulation is in contact with the ceiling and there is typically a one-inch air gap above the insulation so that moisture can be vented. Whether there is an air space above the insulation depends on local climate conditions and may not be required in some building permit jurisdictions. Filling the entire cavity of framed rafter assemblies with loose-fill mineral fiber, wool, cellulose, or low-density open cell spray polyurethane foam (ocSPF) requires prior approval by the local building official.

**Rated Cool Roof Material** is a roofing product with high solar reflectance and thermal emittance properties, which help reduce cooling loads by lowering interstitial space (attic) temperatures on hot, sunny days. Solar reflectance and thermal emittance are properties of the roofing material.

- ✦ **Aged Solar Reflectance** is the solar reflectance of the surface after three years, which typically is lower than the initial reflectance value. The higher the solar reflectance, the better (i.e., the more heat is reflected from the roofing material).
- ✦ **Thermal Emittance** provides a means of quantifying how much of the absorbed heat is rejected for a given material. The higher the thermal emittance value, the better (i.e., the more heat the roofing material emits back to the atmosphere).
- ✦ **Solar Reflectance Index (SRI)** is a measure of the roof's ability to reject solar heat which includes both reflectance and emittance.

**Roof** is the outside cover of a building or structure including the structural supports, decking and top layer that is exposed to the outside with a slope less than 60° from the horizontal.

**Roof, Low Sloped** is a roof that has a ratio of rise to run of less than 2:12 (9.5° from the horizontal).

**Roof, Steep Sloped** is a roof that has a ratio of rise to run greater than or equal to 2:12 (9.5° from the horizontal).

**R-value** is the measure of the thermal resistance of insulation or any material or building component expressed in  $\text{ft}^2\text{-hr-}^\circ\text{F/Btu}$ . All insulation must be certified by the Department of Consumer Affairs, Bureau of Household Goods and Services that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12-13, Article 3, “Standards for Insulating Material.”

**U-factor** is the overall coefficient of thermal transmittance of a fenestration, wall, floor or roof/ceiling component, in  $\text{Btu}/(\text{hr} \times \text{ft}^2 \times ^\circ\text{F})$ , including air film resistance at both surfaces.

**Wet Insulation Requirements:** There are Mandatory requirements in [§110.8\(h\)](#) that dictate how to determine designed U-factor performance when using the Prescriptive Method to show compliance when wet insulation is used above the roofing membrane or layer to seal the roof from water penetration. Water can penetrate this insulation material and affect the energy performance of the roofing assembly in wet and cool climates. In Climate Zones 1 and 16, the insulating R-value of continuous insulation materials installed above the waterproof membrane of the roof must be multiplied by 0.8, and installers must use the result value in choosing the table column in [Joint Reference Appendix JA4](#) for determining assembly U-factor (when using the JA4 table to comply). See the footnotes for [Tables 4.2.1 through 4.2.7](#) in the Joint Reference Appendix JA4.



## New Construction and Additions

When associated with conditioned spaces, New Construction and Additions must meet Energy Code requirements for roofing materials. See Figure 3 and Table 5 for the corresponding Mandatory and Prescriptive Energy Code sections.

Prescriptive Single-family New Construction and Addition Roofing Requirements Associated with Conditioned Spaces			
New Construction and Additions Project Scope Examples	Roof Type	Climate Zone	Rated "Cool Roof" Roofing Material <i>When associated with conditioned spaces</i> §§110.8(i), 150.1(c)11, 150.2(a)
New Building	Low-sloped	13, 15	Yes
		1-12, 14, 16	No
	Steep-sloped	10-15	Yes
		1-9, 16	No
Addition > 300 ft <sup>2</sup> with Roof	Low-sloped	13, 15	Yes
		1-12, 14, 16	No
	Steep-sloped	10-15	Yes
		1-9, 16	No
Addition ≤ 300 ft <sup>2</sup> with Roof	Low- or Steep-sloped	1-16	No

**Table 3.** Prescriptive Single-family New Construction and Addition Roofing Requirements Associated with Conditioned Spaces

## Rated Cool Roof Material

To qualify as a "cool roof" under the Energy Code, roofing material must have a Cool Roof Rating Council (CRRC) rating and meet the specified value for reflectance and emittance, or SRI value, specified in Certificate of Compliance (CF1R).

Refer to Table 4 for the roof material requirements and exceptions for Single-family New Construction and Additions.

Prescriptive Cool Roof Requirements for Single-family Buildings by Roof Slope and Climate Zone				
Roof Style	Climate Zone	Either		Or
		3-year Aged Solar Reflectance	Thermal Emittance	SRI
Low-sloped	13, 15	≥ 0.63	≥ 0.75	≥ 75
	All others	NR	NR	NR
Steep-sloped	10-15	≥ 0.20	≥ 0.75	≥ 16
	All others	NR	NR	NR

**Low-sloped** = rise-to-run ratio of < 2:12 (lower than 9.5 degrees); **steep-sloped** = rise-to-run ratio ≥ 2:12 (9.5 degrees or more); **SRI** = solar reflectance index.

**\*Exceptions for single-family low-sloped roofs:**  
 Roof constructions with a weight of at least 25 lb/ft<sup>2</sup> over the roof membrane  
 Any roof area covered by building integrated photovoltaic panels or integrated solar thermal panels

**Table 4.** Prescriptive Cool Roof Requirements for Single-family Buildings by Roof Slope and Climate Zone



### WHAT'S NEW

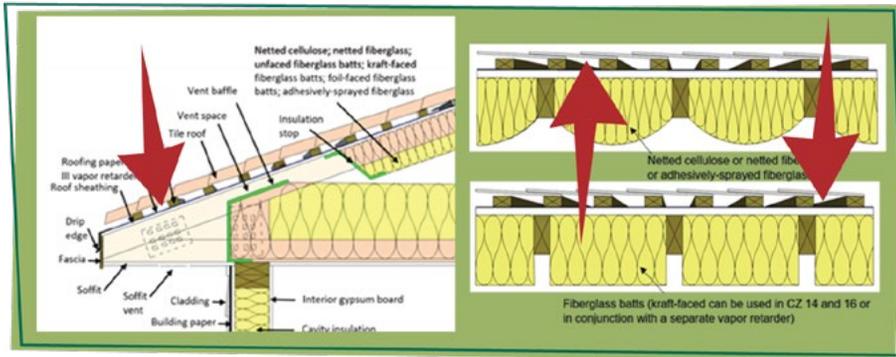
For New Construction projects with vented roofs in Climate Zone 4 or 8-16, when the air handler and ductwork are in the attic, there is new Mandatory maximum U-factor 0.184.

Additions ≤ 700 ft<sup>2</sup> have revised insulation requirements.



## Prescriptive Option B Air Space Below Roofing Material

For Prescriptive Option B compliance of a vented attic, a one-inch air space is required between the roof deck and the roofing material (see Figure 3 and Table 5 on this page). This air space is typical with a tile roof application. If an air space is not provided, the Performance Approach must be used to determine if compliance can be achieved.



**Figure 3.** Prescriptive Option B Air Space Below Roofing Material for Single-family Buildings

## Prescriptive Requirements for Roof and Ceiling Insulation

The Prescriptive insulation requirements for ceilings and roofs depend not only upon Climate Zone, HVAC ducting location and scope of work but also upon the roof assembly type specific to attic roofs (§§150.1(c)1A, 150.2(a)1).

When a project does not have a vented attic or is unable to meet the insulation, roofing air space or duct location requirements in Table 5, the Performance Approach must be used to determine if compliance can be achieved.

## Prescriptive Radiant Barrier Requirements for New Construction and Additions

A radiant barrier is a highly reflective, low emitting material installed at the underside surface of the roof deck and the inside surface of gable ends or other exterior vertical surfaces in attics to reduce solar heat gain. For Prescriptive compliance, radiant barriers must be installed in vented attics that do not require insulation below the roof deck, except for buildings in Climate Zones 1 and 16 (§150.1(c)2). Radiant barriers must meet the Mandatory requirements of §110.8(j). If a residence does not meet the Prescriptive radiant barrier requirements, the Performance Approach must be used.

## Prescriptive Roof and Ceiling Insulation Requirements for Single-family New Construction and Additions

Project Scope	Roof Type	HVAC Duct and Air Handler Location	Climate Zone	Insulation		
				Ceiling Insulation Between Attic and Conditioned Space	Below-Roof Deck Insulation	Air Space Between Roofing and Roof Deck
<b>§§150.0(a), 150.1(c)1A, 150.2(a)1</b>						
New Building	Vented Attic	Option B: In Attic	1-2	R-38	None	Yes
			3, 5-7	R-30	None	Yes
			4, 8-16	R-38	R-19*	Yes
		Option C: Conditioned Space	1, 11-16	R-38	None	No
2-10	R-30		None	No		
	Unvented or Rafter	Performance Approach Required				
Addition > 700 ft²	Vented Attic	Option B: In Attic	1-2	R-38	None	Yes
			3, 5-7	R-30	None	Yes
			4, 8-16	R-38	R-19	Yes
		Option C: Conditioned Space	1, 11-16	R-38	None	No
			2-10	R-30	None	No
	Unvented or Rafter	Performance Approach Required				
Addition ≤ 700 ft²	Vented Attic	N/A	1-2, 4, 8-16	R-38 (or U-factor ≤ 0.025)	None	No
			3, 5-7	R-30 (or U-factor ≤ 0.031)	None	No
		Unvented or Rafter	Performance Approach Required			

\* Note that for New Construction, Option B roof decks in Climate Zones 4 and 8-16 have a Mandatory U-factor ≤ 0.184. Some below-roof deck insulation will be required to meet U-factor ≤ 0.184 even when using the Performance Approach. This does not apply to Additions or Alterations.

**Table 5.** Prescriptive Roof and Ceiling Insulation Requirements for Single-family New Construction and Additions



## Alterations

### Key Terms

**Roof Recover** is the process of installing an additional roof covering over a prepared existing roof covering without removing the existing roof covering.

**Roof Recover Board** is a rigid type board, installed directly below a low-sloped roof membrane, with or without above deck thermal insulation, to: (a) improve a roof system's compressive strength, (b) physically separate the roof membrane from the thermal insulation, or (c) physically separate a new roof covering from an underlying roof membrane as part of a roof overlay project.

**Roof Replacement** is the process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

### WHAT'S NEW

Additional Climate Zones are subject to the rated Cool Roof roofing material requirements and the revisions to the exceptions associated with these requirements.

Altered vented attic roofs have new insulation and air sealing requirements.

## Mandatory and Prescriptive Roofing Material and Insulation Requirements for Single-family Building Alterations Associated with Conditioned Spaces

Altered Roof Project Scope Examples		Rated Cool Roof Material Requirements Applicable to Any Roof Type	Insulation Requirements			Air Sealing
			Roof	Ceiling	Above Recessed Downlight Luminaire	
<i>When associated with conditioned spaces</i>						
		<a href="#">§§110.8(i); 150.2(b)1l</a>	<a href="#">§§110.8(a)-(c); 150.0(a); 150.2(b)1l</a> and <a href="#">J</a>			<a href="#">§150.2(b)1Jii</a>
<b>Steep-sloped Roof Alteration</b>	Replacing or recovering > 50% in CZ 4, 8-15	Yes	No	No	No	No
	Replacing or recovering ≤ 50% in CZ 4, 8-15	No	No	No	No	No
	Replacing or recovering in CZ 1-3, 5-7, 16	No	No	No	No	No
<b>Low-sloped Roof Alteration</b>	Replacing or recovering > 50% in CZ 4, 8-15	Yes	Yes	No	No	No
	Replacing or recovering > 50% in CZ 6-7	Yes	No	No	No	No
	Replacing or recovering > 50% in CZ 1-2, 16	No	Yes	No	No	No
	Replacing or recovering ≤ 50% in CZ 1-2, 4, 6-16	No	No	No	No	No
	Replacing or recovering in CZ 3, 5	No	No	No	No	No
<b>Vented Attic Alterations</b>	Altering ceiling in CZ 2, 4, 8-16	No	No	Yes per <a href="#">§150.2(b)1J</a>	Yes	Yes
	Altering ceiling in CZ 1, 3	No	No	Yes per <a href="#">§150.2(b)1J</a>	Yes	No
	Altering ceiling in CZ 6	No	No	Yes per <a href="#">§150.2(b)1J</a>	No	No
	Altering ceiling in CZ 5, 7	No	No	Yes per <a href="#">§150.0(a)</a>	No	No
<b>Other</b>	Altering non attic or non-vented attic roof (e.g., rafter roof)	No	No	Yes per <a href="#">§150.0(a)</a>	No	No

**Low-sloped** = rise-to-run ratio of < 2:12 (lower than 9.5 degrees); **steep-sloped** = rise-to-run ratio ≥ 2:12 (9.5 degrees or more).

**Table 6.** Roofing Material and Insulation Requirements for Single-family Building Alterations Associated with Conditioned Spaces

## Altered Roof Rated “Cool Roof” Material

See New Construction and Additions for criteria for rated Cool Roof materials.

Refer to Table 7 to determine the roofing material requirements for your project based on roof slope, building type and Climate Zone.

Prescriptive Roofing Material Requirements for Single-family Building Alterations				
Roof Style	Climate Zone	Either		Or
		3-year Aged Solar Reflectance	Thermal Emittance	SRI
Low-sloped	4, 6-15	≥ 0.63*	≥ 0.75	≥ 75
	All others	NR	NR	NR
Steep-sloped	4, 8-15	≥ 0.20**	≥ 0.75	≥ 16
	All others	NR	NR	NR

**Low-sloped** = rise-to-run ratio of < 2:12 (lower than 9.5 degrees); **steep-sloped** = rise-to-run ratio ≥ 2:12 (9.5 degrees or more); **SRI** = solar reflectance index.

### \*Exceptions for low-sloped roofs:

- ✦ Roof constructions with a weight of at least 25 lb/ft<sup>2</sup> over the roof membrane
- ✦ Any roof area covered by building integrated photovoltaic panels or integrated solar thermal panels
- ✦ Altered roof/ceiling tradeoff for aged solar reflectance (See options in Table 8.)

### \*\*Exceptions for steep-sloped roofs:

- ✦ Roof constructions with a weight of at least 25 lb/ft<sup>2</sup> over the roof membrane
- ✦ Any roof area covered by building integrated photovoltaic panels or integrated solar thermal panels
- ✦ When ceiling assembly U-factor is ≤ 0.025 (or ≥ R-38 ceiling insulation)
- ✦ When radiant barrier is installed (not including when installed above spaced sheathing) meeting install requirements of §150.1(c)2
- ✦ When in CZs 2, 4, 9, 10, 12 and 14 and no ducts are in the attic
- ✦ When there is ≥ R-2 continuous insulation above or below the roof deck

**Table 7.** Prescriptive Roofing Material Requirements for Single-family Building Alterations

## Tradeoffs Allowed in Alterations to Low-sloped Roofs

In an exception to the roofing material requirements, Alterations to low-sloped roofs may lower the required minimum aged solar reflectance by increasing the roof deck insulation R-value. See Table 8 for the tradeoff options by Climate Zone.

Prescriptive Tradeoffs Allowed in Alterations to Low-sloped Roofs of Single-family Buildings		
Minimum Aged Solar Reflectance	Roof Deck Continuous Insulation Tradeoff R-Value	
	Climate Zone 6 - 7	Climate Zone 2, 4, 8-15
0.60	R-2	R-16
0.55	R-4	R-18
0.50	R-6	R-20
0.45	R-8	R-22
No Requirement	R-10	R-24

**Table 8.** Prescriptive Tradeoffs Allowed in Alterations to Low-sloped Roofs of Single-family Buildings (adapted from Table 150.2-B)

## Rated Cool Roof Material

For key terms related to roofing, see page 4.

To qualify as a Cool Roof under the Energy Code, roofing material must have a Cool Roof Rating Council (CRRC) rating and meet the specified value for reflectance and emittance, or solar reflectance index (SRI) value, specified in the Certificate of Compliance (CF1R) form. For the CRRC list of Rated Roof Products, see <https://coolroofs.org/directory/roof>.



## Prescriptive Insulation Requirements for Altered Roofs

Insulation requirements apply when altering existing roofs and ceilings and when an altered low-sloped roof is recovered or replaced in some Climate Zones. Luminaires not rated for insulation contact must be replaced or retrofitted with a fire-proof cover that allows insulation to be installed directly over the cover. Attic ventilation requirements of California Building Code also apply. See Table 9 for new insulation requirements and exceptions to those requirements based on existing roof or ceiling insulation.

Altered Roof Type	Climate Zone	Prescriptive and Mandatory Insulation Requirements for Altered Roofs		
		New Insulation Requirement		Compliance Exceptions Based on Existing Insulation
Low-sloped*	1, 2, 4, 8-16	Continuous $\geq$ R-14 insulation (or U-factor $\leq$ 0.039)		Existing $\geq$ R-10 continuous insulation above or below roof deck   In CZ 1, 2, 4, 8-10, existing U-factor $\leq$ 0.056 or with $\geq$ R-19 between rafters and in contact with roof deck
	3, 5-7	No		No
Ceiling to Vented Attic**	11-16	$\geq$ R-49 (or U-factor $\leq$ 0.020)	Maintain Insulation depth above recessed downlight luminaires***	Existing $\geq$ R-38 insulation installed at ceiling level
	2, 4, 8-10	$\geq$ R-49 (or U-factor $\leq$ 0.020)		Existing $\geq$ R-38 insulation installed at ceiling level
	1, 3, 6	$\geq$ R-49 (or U-factor $\leq$ 0.020)		Existing $\geq$ R-19 insulation installed at ceiling level
	5, 7	$\geq$ R-22 between wood framing (or U-factor $\leq$ 0.043)		No
All Other Roof Types	Any	Non-rafter: $\geq$ R-22 between wood framing (or U-factor $\leq$ 0.043) Rafter: $\geq$ R-19 between wood framing (or U-factor $\leq$ 0.054)		No

### \*Insulation installation exceptions for low-sloped roofs:

- ✦ The continuous insulation may be reduced to R-4 when continuous  $\geq$  R-14 insulation would reduce the height from the roof surface to the top of the base flashing to less than that set forth in the manufacturer's installation instructions as per the California Residential Code §R900 when:
  - ◇ Mechanical equipment is located on the roof and **will not** be temporarily disconnected and lifted as part of the roof replacement; and/or
  - ◇ Existing sidewall or parapet walls are finished with an exterior cladding material other than the roof covering membrane material; and the exterior cladding material must be removed to install the new roof covering membrane to maintain the minimum base flashing height; and the ratio of the replaced roof area to the linear dimension of affected sidewall or parapet walls is  $<$  25 ft<sup>2</sup> per linear foot.
- ✦ The continuous insulation requirements may be reduced where increasing the thickness of above deck insulation would reduce the flashing around an existing exterior wall opening below what is permitted by the fenestration or door manufacturer's installation instructions or a registered design professional's approved flashing design, as per the California Residential Code §R703.4 or by California Residential Code §R905.2.8.3.
- ✦ Tapered insulation with thermal resistance less than prescribed at the drains and other low points may be used provided that the thickness of insulation is increased at the high points of the roof so that the average thermal resistance equals or exceeds the required value.

### \*\*Insulation installation exceptions for vented attics:

- ✦ The Alteration would directly cause the disturbance of asbestos.
- ✦ Knob and tube wiring is located in the vented attic.
- ✦ When the accessible space in the attic is not large enough to accommodate the required R-value, the entire accessible space must be filled with insulation provided such installation does not violate §806.3 of Title 24, Part 2.5.
- ✦ If an altered dwelling unit shares attic space with unaltered dwelling units, the unaltered dwelling units do not require ceiling insulation.

\*\*\* Insulation above recessed downlights is required in CZ 1-4 and 8-16, but with an exception for homes in CZ 1-4 and 8-10 with  $\geq$  R-19 existing ceiling insulation.

**Table 9.** Prescriptive and Mandatory Insulation Requirements for Altered Roofs of Single-family Buildings



## Altered Vented Attic Air Sealing Requirements

Air sealing is required in Climate Zones 2, 4 and 8-16 when altering the ceiling to a vented attic. All accessible areas of the ceiling plane between the altered attic and the conditioned space must meet the air leakage limitation requirements of §110.7. All joints, penetrations and other openings in the building envelope that are potential sources of air leakage must be caulked, gasketed, weather stripped or otherwise sealed to limit infiltration and exfiltration. This is not a requirement verified by a HERS Rater.

Prescriptive Air Sealing Requirements for Altered Vented Attic Ceiling by Climate Zone	
Climate Zone	Air Sealing Requirements §150.2(b)1Jii
2, 4, 8-16	Yes*
1, 3, 5-7	No

**\*Exceptions to air sealing requirements:**

- ✦ *There is existing  $\geq R-19$  insulation at the ceiling level.*
- ✦ *When atmospherically vented space-heating or water-heating combustion appliances are located inside the pressure boundary of the dwelling unit.*

**Table 10.** Prescriptive Air Sealing Requirements for Altered Vented Attic Ceiling by Climate Zone



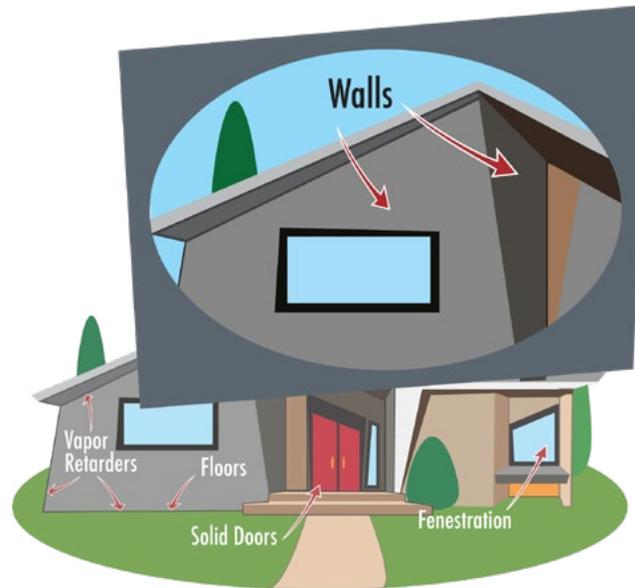
# Walls

**Why is compliance required for walls?** Walls are important because heat travels through a building's envelope (roofs, walls, floors, windows) and tends to travel from higher temperatures to lower temperatures by conduction, convection or radiation. The greater the temperature difference, the greater the rate of heat transfer. Therefore, heat gain in a building occurs when the outdoor temperature is greater than the indoor temperature. Heat gain in buildings also can come from people, lights and appliances. Similarly, heat loss occurs when the indoor temperature is greater than the outdoor temperature.

Insulation is one of the most important components for reducing heat gain and loss through opaque construction assemblies. Insulation comes in many different types, forms and applications. Its effectiveness is measured in R-value, which is the measure of resistance to heat flow. The higher the R-value, the greater the insulation provided.

When choosing insulation, it is important to consider where the material will be installed in the building envelope assembly and how much insulation is necessary to meet or exceed the Energy Code. Opaque construction assemblies often consist of one or more types of insulation in different locations for cavity insulation and continuous insulation. In many cases, determining the best strategy for insulating depends on the building design and overall project budget.

Another consideration for selecting insulation is its environmental impact. Many of the newer insulation materials are far more "green" than previously available products, including formaldehyde-free and recycled-content insulation.



**Figure 4.** Exterior Walls of a Single-family Building

## Key Terms

**R-value** is the measure of the thermal resistance of insulation or any material or building component expressed in  $\text{ft}^2\text{-hr-}^\circ\text{F}/\text{Btu}$ . All insulation must be certified by the Department of Consumer Affairs, Bureau of Household Goods and Services (BHGS) that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12-13, Article 3, "Standards for Insulating Material."

**U-factor** is the overall coefficient of thermal transmittance of a fenestration, wall, floor or roof/ceiling component, in  $\text{Btu}/(\text{hr} \times \text{ft}^2 \times ^\circ\text{F})$ , including air film resistance at both surfaces.



## New Construction and Additions

When associated with conditioned spaces, New Construction and Additions must meet Energy Code insulation requirements for exterior walls and demising walls. They must always meet applicable Mandatory Measures, while also complying with either the Prescriptive or Performance Approach. See Table 11 for the applicable Mandatory and Prescriptive Energy Code sections.

Mandatory and Prescriptive Single-family New Construction and Addition Wall Requirements Associated with Conditioned Spaces			
Project Scope	Exterior Wall Insulation Requirements	Demising Wall Insulation Requirements	Interior Wall Requirements*
	<i>When associated with conditioned spaces</i>		
	<a href="#">§§110.8(a)-(c), 150.1(c)1B, 150.2(a)1A-B</a>	<a href="#">§§110.8(a)-(c), 150.0(c)</a>	N/A
<b>New Construction: new building</b>	<b>Yes</b>	<b>Yes</b>	N/A
<b>Addition</b>	<b>Yes</b>	<b>Yes</b>	N/A
<b>Conditioning an existing building for the first time</b>	<b>Yes</b>	<b>Yes</b>	N/A

\* Interior walls are the walls that separate conditioned spaces from other enclosed conditioned spaces.



### WHAT'S NEW

There are no changes in the 2022 Energy Code for walls in New Construction or Additions to single-family buildings.

**Table 11.** Mandatory and Prescriptive Single-family New Construction and Addition Wall Requirements Associated with Conditioned Spaces



## Wall Insulation Requirements

U-factors for common construction assemblies can be determined based on framing type, spacing, cavity insulation and various thicknesses of continuous insulation.

Determining proposed assembly U-factor can be done by either using the tables under [Joint Reference Appendix JA4.3 Walls](#) or the layers method in [CEC-certified software](#).

Compliance for New Construction can use an area-weighted average calculation, although metal-framed walls may not be combined with any other wall type. Wood-framed walls can be combined with structurally insulated wall panels (SIPs), spandrel or curtain, metal panel or straw bale wall types. Mass walls can be combined with concrete sandwich panel, log and insulated concrete form walls. Area-weighted average calculations are not allowed for Alterations.

For Prescriptive compliance, exterior framed walls must have an overall assembly U-factor no greater than the applicable value in [Table 150.1-A](#) (Prescriptive Component Package for Single-family Standard Building Design). Above or below grade mass walls can comply Prescriptively by either installing continuous insulation that meets the R-values from Table 150.1-A or by having an overall assembly U-factor no greater than the value from Table 150.1-A. Buildings with exterior walls that do not meet the Prescriptive requirements must show compliance using the Performance Approach. Demising walls must meet the [§150.0\(c\)](#) Mandatory maximum U-factor requirements of  $\leq 0.102$  for framed 2 x 4 walls and  $\leq 0.071$  for framed 2 x 6 walls. This is equivalent to installing R-13 in 2 x 4 wood framing or R-20 in 2 x 6 wood framing. Metal-framed walls would need additional insulation to comply with the Mandatory maximum U-factors. Other demising wall types are supported in §150.0(c). Because the demising wall requirements are Mandatory, the Performance Approach does not allow for a greater U-factor allowance.

## Prescriptive Requirements for Wall Insulation in Single-family Building New Construction and Additions

Wall Type	Insulation	Climate Zone	New Construction and Addition Requirements	
			Minimum R-value****	Maximum U-factor
Framed Walls*	N/A	1-5, 8-16	See U-factor	$\leq 0.048$
		6-7	See U-factor	$\leq 0.065$
Above Grade Mass Walls**	Interior Insulation	1-15	R-13	$\leq 0.077$
		16	R-17	$\leq 0.059$
	Exterior Insulation	1-15	R-8	$\leq 0.125$
		16	R-13	$\leq 0.077$
Below Grade Mass Walls***	Interior Insulation	1-15	R-13	$\leq 0.077$
		16	R-15	$\leq 0.067$
	Exterior Insulation	1-13	R-5	$\leq 0.200$
		14-15	R-10	$\leq 0.100$
		16	R-19	$\leq 0.053$

\* Assembly U-factors for exterior framed walls can be met with cavity insulation alone or with continuous insulation alone, or with both cavity and continuous insulation that results in an assembly U-factor equal to or less than the U-factor shown. Use [Joint Reference Appendix JA4 Table 4.3.1, 4.3.1\(a\)](#), or [Table 4.3.4](#) to determine whether framed wall assemblies with alternative insulation products are less than or equal to the required maximum U-factor.

\*\* Mass wall has a heat capacity  $\geq 7.0 \text{ Btu/h-ft}^2$ . "Interior" denotes insulation installed on the inside surface of the wall. "Exterior" denotes insulation installed on the exterior surface of the wall.

\*\*\* Below grade "interior" denotes insulation installed on the inside surface of the wall, and below grade "exterior" denotes insulation installed on the outside surface of the wall.

\*\*\*\* Prescriptive minimum R-values for mass walls are for continuous insulation, not for insulation installed between framing attached to mass walls. Mass walls with insulation penetrated by framing could comply by meeting the Prescriptive maximum U-factor.

**Table 12.** Prescriptive Requirements for Wall Insulation in Single-family Building New Construction and Additions



## Metal-framed Walls

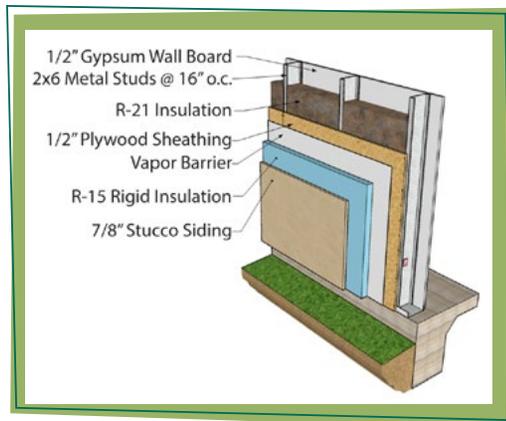
In New Construction and Additions with metal-framed walls, refer to Table 13 and Figure 5 for an example of how to achieve the required U-factor in a wall assembly.

### Example: How to Achieve a Wall Assembly U-factor in a Metal-framed Single-family Building - New Construction or Addition

Material Layers (exterior layer listed first)	 Prescriptive	 Performance
	<a href="#">Joint Reference Appendix 4.3.4-J8</a>	<a href="#">Layer Manager</a>
7/8" Stucco	U-factor = 0.045*	U-factor = 0.039
R-15 Rigid Insulation		
Vapor Barrier		
1/2" Plywood Sheathing		
2x6 Metal Studs at 16" oc with R-21 Cavity Insulation		
1/2" Gypsum Board		

\*Joint Reference Appendix JA4 assembly assumes an exterior air film, a 7/8 inch layer of stucco, building paper, continuous insulation (as specified), the cavity insulation or framing layer, 1/2-inch gypsum board and an interior air film. The steel framing is assumed to be 0.038-inch thick. The framing factor is assumed to be 25% for 16-inch stud spacing.

**Table 13.** Example: How to Achieve a Wall Assembly U-factor in a Metal-framed Single-family Building - New Construction or Addition



**Figure 5.** Example of a Metal-framed Wall with Continuous Insulation

## Wood-framed Walls

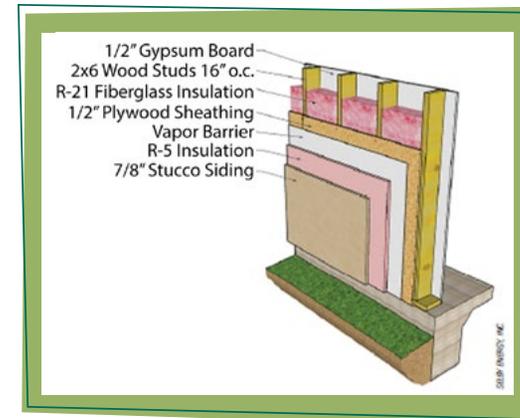
In New Construction and Additions with wood-framed walls, refer to Table 14 and Figure 6 for an example of how to achieve the required U-factor in a wall assembly.

### Example: How to Achieve a Wall Assembly U-factor in a Wood-framed Single-family Building - New Construction or Addition

Material Layers (exterior layer listed first)	 Prescriptive	 Performance
	<a href="#">Joint Reference Appendix 4.3.1-D7</a>	<a href="#">Layer Manager</a>
7/8" Stucco	U-factor = 0.048*	U-factor = 0.047
R-5 Rigid Insulation		
Vapor Barrier		
1/2" Plywood Sheathing		
2x6 Wood Studs at 16" oc with R-21 Cavity Insulation		
1/2" Gypsum Board		

\*Joint Reference Appendix JA4 assembly assumes an exterior air film, a 7/8-inch layer of stucco, building paper, continuous insulation (as specified), the cavity insulation or framing layer, 1/2-inch gypsum board and an interior air film. The framing factor is assumed to be 25% for 16-inch stud spacing.

**Table 14.** Example: How to Achieve a Wall Assembly U-factor in a Wood-framed Single-family Building - New Construction or Addition



**Figure 6.** Example of a Wood-framed Wall with Continuous Insulation



## Alterations

Insulation requirements for walls are based on whether the work on them is classified as an Alteration, New Construction or neither. See Table 15 for which project scopes related to changing walls are classified as Alterations and which as New Construction and then which Energy Code sections determine their U-factor requirements.

Mandatory and Prescriptive Insulation Requirements for Projects Changing Walls			
Project Scope	Exterior Wall Insulation Requirements	Demising Wall Insulation Requirements	Interior Wall Requirements *
	When associated with conditioned spaces		
	<a href="#">§§110.8(a)-(c), 150.0(c), 150.2(b)1</a>	<a href="#">§§110.8(a)-(c), 150.0(c), 150.2(b)1</a>	N/A
Altering a wall in an existing space by opening the wall or stripping it down to the studs	<b>Alteration</b> see Table 16	<b>Alteration</b> see Table 16	N/A
Non-altered wall in a space in which other walls are being altered	N/A	N/A	N/A
Rebuilding a wall in the same location	<b>Alteration</b> see Table 16	<b>Alteration</b> see Table 16	N/A
Conditioning an existing space for the first time (newly conditioned)	<b>New Construction</b> see Table 12	<b>New Construction</b> see Table 12	N/A

\* Interior walls are the walls that separate conditioned spaces from other enclosed conditioned spaces.

**Table 15.** Mandatory and Prescriptive Insulation Requirements for Projects Changing Walls

## Mandatory Requirements for Alterations to Walls

When planning a wall Alteration, see the New Construction and Additions subtopic on pp.12-13 for insulation criteria and how to determine the required U-factor.

When an exterior or demising wall is altered, insulation also must be provided to meet the assembly maximum U-factor requirements in Table 16.

Mandatory and Prescriptive Requirements for Alterations to Exterior and Demising Walls			
Wall Type		Altered Wall Requirements	
		Minimum R-Value	Maximum U-factor
<b>Wood-framed Walls</b>	<b>2 x 4</b>	R-13 cavity	≤ 0.102
	<b>2 x 6</b>	R-20 cavity	≤ 0.071
<b>Metal-framed Walls</b>	<b>2 x 4</b>	R-13 cavity + R-5 continuous*	≤ 0.102
	<b>2 x 6</b>	R-20 cavity + R-8 continuous*	≤ 0.071
<b>Non-framed Walls</b>		N/A	≤ 0.102
<b>Masonry Walls</b>		<b>Same as New Construction</b> See Table 12	<b>Same as New Construction</b> See Table 12

\* The minimum cavity and continuous insulation R-values shown for metal-framed walls are examples per [Joint Reference Appendix JA4 Table 4.3.4](#) that would comply with the Mandatory maximum U-factors.

**Table 16.** Mandatory and Prescriptive Requirements for Alterations to Exterior and Demising Walls



### WHAT'S NEW

There are no changes in the 2022 Energy Code for wall Alterations in single-family buildings.



# Floors and Soffits

## Why is compliance required for floors and soffits?

Envelope requirements apply to floors and floor soffits. Insulating floors and soffits improves energy efficiency by lessening conduction losses through building envelope components.

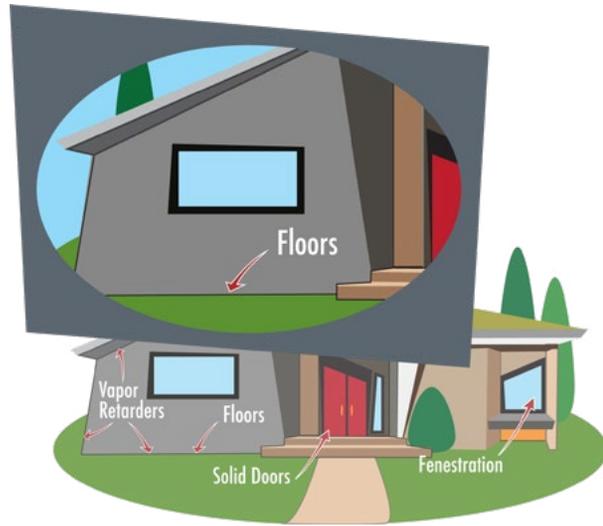


Figure 7. Exterior Floors in a Single-family Building

## Key Terms

**Exterior floor/soffit** is a horizontal exterior partition, or a horizontal demising partition, under conditioned space. For low-rise residential occupancies, exterior floors also include concrete slab floors on grade.

**R-value** is the measure of the thermal resistance of insulation or any material or building component expressed in ft<sup>2</sup>-hr-°F/Btu. All insulation must be certified by the Department of Consumer Affairs, Bureau of Household Goods and Services (BHGS) that the insulation conductive thermal performance is approved pursuant to the California Code of Regulations, Title 24, Part 12, Chapters 12-13, Article 3, "Standards for Insulating Material."

**U-factor** is the overall coefficient of thermal transmittance of a fenestration, wall, floor or roof/ceiling component, in Btu/(hr × ft<sup>2</sup> × °F), including air film resistance at both surfaces.

## New Construction and Additions

When associated with conditioned spaces, New Construction and Additions must meet Energy Code requirements for floors and soffits. See Table 17 for applicable Mandatory and Prescriptive Energy Code sections.

### Mandatory and Prescriptive Single-family New Construction and Addition Floor Requirements Associated with Conditioned Spaces

Project Scope	Exterior and Demising Floor Insulation Requirements	Interior Floor Requirements*
	<i>When associated with conditioned spaces</i>	
	<a href="#">§§110.8(a)-(c), 150.1(c)1C-D, 150.0(d) and (f)</a>	N/A
<b>New Construction</b>	<b>Yes</b>	N/A
<b>Addition</b>	<b>Yes</b>	N/A
<b>Conditioning an existing building for the first time</b>	<b>Yes</b>	N/A

\* Interior floors are the floors that separate conditioned spaces from other enclosed conditioned spaces.

Table 17. Mandatory and Prescriptive Single-family Building New Construction and Addition Floor Requirements Associated with Conditioned Spaces



## Floor Insulation Requirements

U-factors for common construction assemblies can be determined based on framing type, spacing, cavity insulation and various thicknesses of continuous insulation. Determining proposed assembly U-factor can be done by either using the tables under [Joint Reference Appendix JA4.4 Floors](#) or the layers method in [CEC-certified software](#). Compliance for New Construction can use an area-weighted average U-factor calculation, although mass floors cannot be combined with any other floor type; wood-framed floors can be combined with SIP floor types. Area-weighted average calculations are not allowed for Alterations.

Exterior and demising raised floors can comply Prescriptively by having an overall assembly U-factor no greater than the applicable value from Table 150.1-A (Prescriptive Component Package for Single-family Standard Building Design) or by installing insulation that meets the R-values from Table 150.1-A in wood framing. Buildings with exterior or demising floors that do not meet the Prescriptive requirements must show compliance using the Performance Approach.

Heated slab-on-grade floors also must meet the Mandatory insulation requirements of [§110.8\(g\)](#).



### WHAT'S NEW

There are no changes in the 2022 Energy Code in 2022 for floors in Single-family Building New Construction and Additions.

## Alterations



### WHAT'S NEW

There are no changes in the 2022 Energy Code for requirements for floors in Single-family buildings Alterations.

## Floor Prescriptive Insulation Requirements

When planning an Alteration, see the Floor Insulation Requirements section on this page for insulation criteria and how to determine the required U-factor.

When an exterior or demising floor is altered, insulation also must be provided to meet the criteria in Table 19.

Alteration Project Scopes that Trigger Floor Requirements in Single-family Alterations		
Project Scope	Exterior and Demising Floor Insulation Requirements	Interior Floor Requirements*
	<i>When associated with conditioned spaces</i>	
	<a href="#">§§110.8(a)-(c), 150.0(d) and (f)</a>	N/A
<b>Altering a floor in an existing space by opening the floor, or stripping down to the stud</b>	<b>Alteration</b> See Table 19	N/A
<b>Non-altered floor in a space in which other floors are being altered</b>	<b>Alteration</b> See Table 19	N/A
<b>Rebuilding a floor in the same location</b>	<b>Alteration</b> See Table 19	N/A
<b>Conditioning an existing space for the first time (newly conditioned)</b>	<b>New Construction</b> See Table 17	N/A

\* Interior floors are the floors that separate conditioned spaces from other enclosed conditioned spaces.

**Table 18.** Alteration Project Scopes that Trigger Floor Requirements in Single-family Building Alterations

Mandatory Insulation Required for Exterior or Demising Floors in Prescriptive Single-family Alterations			
Floor Type		Altered Floors	
		Minimum R-Value	Maximum U-factor
<b>Raised Framed Floors</b>	<b>Wood-framed</b>	R-19 cavity*	≤ 0.037
	<b>Metal-framed**</b>	R-19 cavity + R-10 continuous*	≤ 0.037
<b>Slab Floors</b>		For heated slab floors, see <a href="#">Table 110.8-A</a> and the other Mandatory requirements in <a href="#">§§110.8(g)</a> and <a href="#">150.0(f)</a> .	

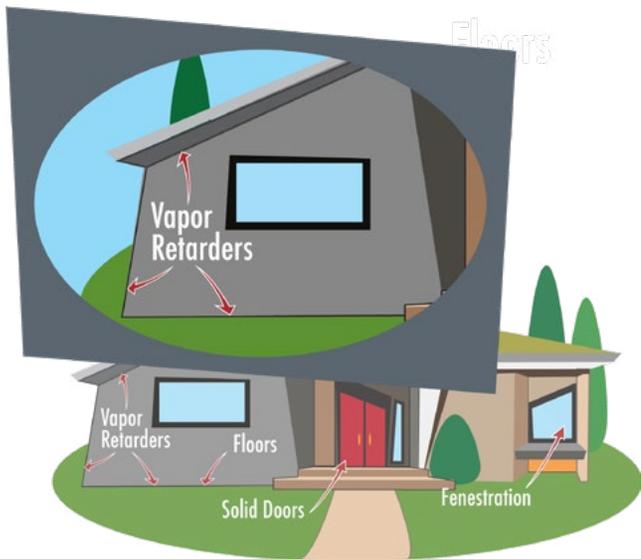
\* *Controlled ventilation and unvented crawl spaces do not require this insulation R-value if they meet the criteria of the §150.0(d) exception.*

\*\* *The minimum cavity and continuous insulation R-values shown for metal-framed raised floors are examples per Joint Reference Appendix JA4 Table 4.4.4 for a raised floor over a crawl space.*

**Table 19.** Mandatory Insulation Required for Exterior or Demising Floors in Single-family Building Alterations

# Vapor Retarders

**Why is compliance required for vapor retarders?** Vapor retarders or barriers are special coverings over framing and insulation or coverings over the ground of a crawl space that protect the assembly components from moisture condensation. Water build-up due to condensation can cause the insulation to lose effectiveness, cause structural damage and generate mold that may contribute to indoor air quality problems.



**Figure 8.** Vapor Retarders in a Single-family Building

## Key Terms

**Controlled Ventilation Crawlspace (CVC)** is a crawl space in a residential building where the side walls of the crawlspace are insulated rather than the floor above the crawlspace. A CVC has automatically controlled crawl space vents. Credit for a CVC is permitted for low-rise residential buildings that use the Performance Approach to compliance.

**Vapor Retarder Class** is a measure of the ability of a material or assembly to limit the amount of moisture that passes through the material or assembly meeting Section 202 of the California Building Code.

## New Construction, Additions and Alterations

When associated with conditioned spaces, New Construction, Additions and Alterations must meet Energy Code requirements for vapor retarders. See Table 20 for the applicable Mandatory and Prescriptive sections of the Energy Code.

## Mandatory and Prescriptive Single-family Building New Construction, Addition and Alteration Vapor Retarder Requirements Associated with Conditioned Spaces

Project Scope	Vapor Retarder Requirements
	<i>When associated with conditioned spaces</i>
	<b>§§110.8(b); 150.0(d) and (g), 150.1(c)1C, 150.2(b)1</b>
<b>New Construction: new building</b>	<b>Yes</b>
<b>Addition</b>	<b>Yes</b>
<b>Converting an existing floor to controlled ventilation crawlspace</b>	<b>Yes</b>
<b>Alterations to air-permeable insulation in exterior walls, vented attics or unvented attics in Climate Zone 14 or 16</b>	<b>Yes</b>

**Table 20.** Mandatory and Prescriptive Single-family Building New Construction, Addition and Alteration Vapor Retarder Requirements Associated with Conditioned Spaces



## WHAT'S NEW

There are no changes in the 2022 Energy Code for requirements for vapor retarders in single-family buildings.



## Mandatory Requirements for Vapor Retarders

When building a new home, adding on to a home or converting an existing crawlspace to a controlled ventilation crawlspace, a vapor retarder must be included as indicated in Table 21.

Mandatory Requirements for Vapor Retarders in Single-family Buildings		
Building Space	Climate Zone	Vapor Retarder Requirements
<b>Earth floors of unvented crawlspaces</b>	1-16	Class I or II vapor retarder covers crawlspace floors
<b>Conditioned sides of all insulation</b> in exterior walls and vented and unvented attics with air-permeable insulation	1-13 and 15	N/A
	14 and 16	Class I or II vapor retarder
<b>Controlled ventilation crawl spaces</b> for buildings complying with the exception to §150.0(d)	1-16	Class I or Class II vapor retarder covers crawlspace floors

**Table 21.** Mandatory Requirements for Vapor Retarders in Single-family Buildings



# Fenestration

**Why is compliance required for fenestration?** Windows, glazed doors, dynamic glazing, window films and skylights have a significant impact on energy use in a home when associated with conditioned space. 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.

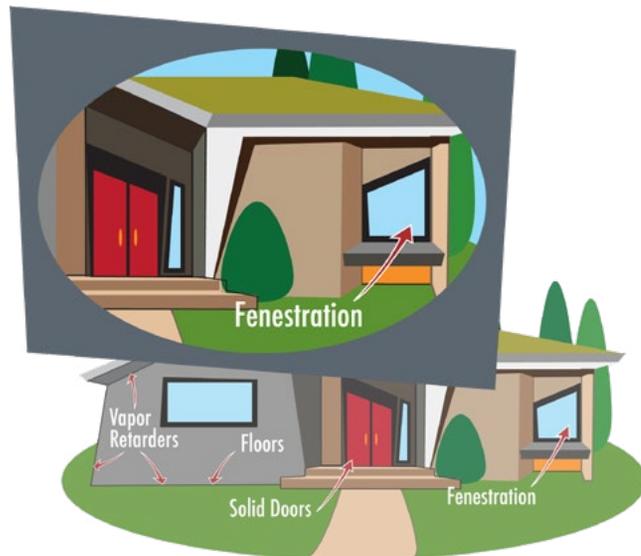


Figure 9. Fenestration in a Single-family Building

## Key Terms

**Clerestory Fenestration** is fenestration installed above a roofline greater than or equal to 60° from the horizontal, or any portion of exterior vertical glazing greater than eight feet per floor above the finished floor of a space.

**Fenestration Area** includes windows, glass doors and skylights. For Prescriptive compliance fenestration area cannot exceed a percentage of the conditioned floor area or a set maximum square footage depending on whether the project is considered New

Construction or an Addition. Additionally, some Climate Zones (CZ 2,4,6-15) have additional restrictions on west-facing fenestration. West-facing fenestration area includes skylights with pitch < 1:12 facing any direction, and west-facing skylights with pitch  $\geq$  1:12.

**Field-fabricated Fenestration** is when the windows are fabricated at the building site from elements that are not sold together as a fenestration product (that is, separate glazing, framing, and weatherstripping elements). Field-fabricated does not include site-assembled frame components that were manufactured elsewhere with the intention of being assembled on site (such as knocked-down products, sunspace kits, and curtain walls).

**Glazed Door** is an exterior door having a glazed area of 25% or greater of the area of the door. Glazed doors shall meet fenestration product requirements.

**Manufactured Fenestration** is a fenestration product constructed of materials that are factory-cut or otherwise factory-formed with the specific intention of being used to fabricate a fenestration product. Knocked down or partially assembled products may be sold as a fenestration product when provided with temporary and permanent labels, as described in §10-111, or as a site-built fenestration product when not provided with temporary and permanent labels, as described in §10-111.

**Overhang** is a contiguous opaque surface, oriented horizontally and projecting outward horizontally from an exterior vertical surface.

**Relative Solar Heat Gain Coefficient (RSHGC)** is the ratio of solar heat gain through a fenestration product (corrected for external shading) to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted or convected into the space.

**Shading** is the protection from heat gains because of direct solar radiation by permanently attached exterior devices or building elements, interior shading devices, glazing material or adherent materials.

**Shading Coefficient (SC)** is the ratio of the solar heat gain through a fenestration product to the solar heat gain through an unshaded 1/8-inch-thick clear double strength glass under the same set of conditions. For single-family, high-rise residential and

hotel/motel buildings, this must exclude the effects of mullions, frames, sashes, and interior and exterior shading devices.

**Site-built Fenestration** is designed to be field-glazed or field-assembled units, using specific factory-cut or other factory-formed framing and glazing units that are manufactured with the intention of being assembled at the construction site. These include storefront systems, curtain walls or large-track sliding glass walls and atrium roof systems.

**Skylight** is fenestration installed on a roof less than 60° from the horizontal.

**Skylight Area** is the area of the rough opening for the skylight.

**Skylight Type** is one of the following three types of skylights: glass mounted on a curb, glass not mounted on a curb or plastic (assumed to be mounted on a curb).

**Solar Heat Gain Coefficient (SHGC)** is the ratio of the solar heat gain entering the space through the fenestration area to the incident solar radiation. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted or convected into the space.

**Tinted Glass** is colored glass by incorporation of a mineral admixture resulting in a degree of tinting. Any tinting reduces both visible and radiant transmittance.

**U-factor** is the overall coefficient of thermal transmittance of a fenestration, wall, floor or roof/ceiling component, in Btu/(hr × ft<sup>2</sup> × °F), including air film resistance at both surfaces.

**Visible Transmittance (VT)** is the ratio (expressed as a decimal) of visible light that is transmitted through a glazing fenestration. The higher the VT rating, the more light is allowed through a window.

**Window Film** is a fenestration attachment product that consists of a flexible adhesive-backed polymer film which may be applied to the interior or exterior surface of an existing glazing system.



## New Construction and Additions

When associated with conditioned spaces, New Construction and Additions must meet Energy Code requirements for fenestration. See Table 22 for the Mandatory and Prescriptive Energy Code requirements.

Fenestration Requirements for Single-family Buildings			
Project Scope	Maximum U-factor Requirements	Maximum RSHGC Requirements	Fenestration Area Requirements*
		Mandatory: <a href="#">§§110.6, 150.0(q)</a> Prescriptive: <a href="#">150.1(c)3-4, 150.2(a)1A-B</a>	
New Building	Yes	Yes	Yes
Addition	Yes	Yes	Yes
Conditioning an existing building for the first time	Yes	Yes	Yes

**RSHGC** = relative solar heat gain coefficient.

\*Fenestration-to-conditioned-floor-area ratio

**Table 22.** Fenestration Requirements for Single-family Buildings



### WHAT'S NEW

The fenestration area-weighted Mandatory U-factor is now  $\leq 0.45$  (previously 0.58). Mandatory U-factor can be used only with the Performance Approach. Exceptions still apply for up to 10 ft<sup>2</sup> or 0.5% of conditioned floor area, whichever is greater, and for up to 30 ft<sup>2</sup> of greenhouse or garden windows.

## Fenestration Requirements

The Energy Code places Prescriptive limits on window glazing and skylight area and defines performance requirements when associated with conditioned spaces. Newly constructed projects have the following Prescriptive requirements for fenestration performance:

- ✦ U-factor and solar heat gain coefficient (SHGC) performance requirements must be met.
- ✦ Fenestration area, which includes windows, glass doors and skylights, cannot exceed a percentage of the conditioned floor area or, for Additions, a maximum square footage, whichever is greater. That percentage is determined by whether the project is New Construction or an Addition. Climate Zones 2, 4 and 6-15 have additional restrictions on west-facing fenestration.

If any of these Prescriptive requirements cannot be met, the Performance Approach must be used to demonstrate compliance.

Prescriptive Fenestration Ratings and Ratios for Single-family Buildings					
Project Scope	Climate Zone	Maximum U-factor*	Maximum SHGC*	Maximum Area Allowed	
				Total**	West Facing***
New Construction	2, 4, 6-15	$\leq 0.30$	$\leq 0.23$	20% of the CFA	5% of the CFA
	1, 3, 5, 16		NR		No Limit
Addition > 700 ft <sup>2</sup>	2, 4, 6-15	$\leq 0.30$	$\leq 0.23$	$\leq 175$ ft <sup>2</sup> or 20% of the CFA, whichever is greater	$\leq 70$ ft <sup>2</sup> or 5% of the CFA, whichever is greater
	1, 3, 5, 16		NR		No Limit
Addition $\leq 700$ ft <sup>2</sup> > 400 ft <sup>2</sup>	2, 4, 6-15	$\leq 0.30$	$\leq 0.23$	$\leq 120$ ft <sup>2</sup> or 25% of the CFA, whichever is greater	$\leq 60$ ft <sup>2</sup>
	1, 3, 5, 16		NR		No Limit
Addition $\leq 400$ ft <sup>2</sup>	2, 4, 6-15	$\leq 0.30$	$\leq 0.23$	$\leq 75$ ft <sup>2</sup> or 30% of the CFA, whichever is greater	$\leq 60$ ft <sup>2</sup>
	1, 3, 5, 16		NR		No Limit

**CFA** = conditioned floor area; **CZ** = Climate Zone; **SHGC** = solar heat gain coefficient.

\* Exceptions:

1. For each dwelling unit, up to 3 ft<sup>2</sup> of new glazing area in doors and up to 3 ft<sup>2</sup> of new tubular skylights with dual pane diffusers are exempt from Prescriptive U-factor and SHGC requirements.
2. For each dwelling unit, up to 16 ft<sup>2</sup> of new skylight area with U-factor  $\leq 0.55$  and SHGC  $\leq 0.30$  is exempt.

\*\* Total fenestration area includes skylights and west-facing glazing.

\*\*\* West-facing fenestration area includes skylights with pitch < 1:12 facing any direction, and west-facing skylights with pitch  $\geq 1:12$ .

**Table 23.** Prescriptive Fenestration Ratings and Ratios for Single-family Buildings

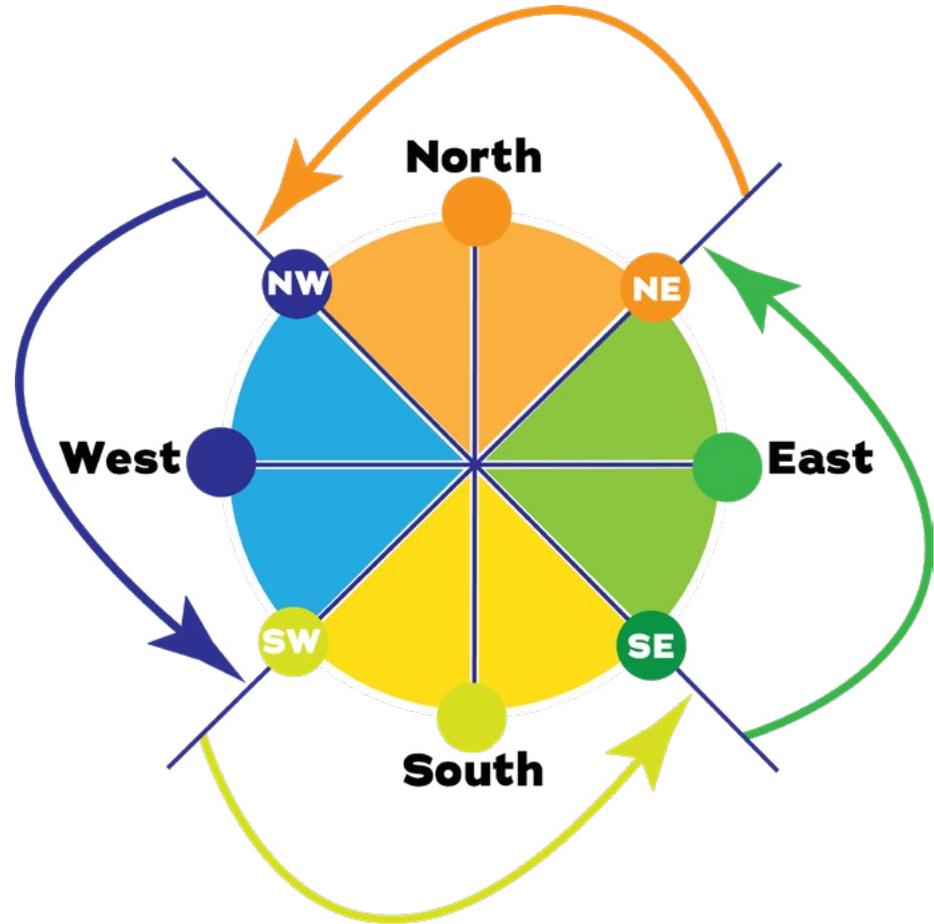


## Orientation and West-facing Fenestration

Orientation refers to the direction that the fenestration faces.

West-facing fenestration is a consideration in Climate Zones 2, 4, and 6-15 and includes:

- ✦ A window (or door with glass) that faces from  $\leq 45^\circ$  north of true west to  $< 45^\circ$  south of true west
- ✦ Skylights tilted:
  - ◇ 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

**Figure 10.** How to Determine the Orientation of Fenestration



## Mandatory Methods for Determining Fenestration U-factor and Solar Heat Gain Coefficient

**Site-built fenestration in single-family buildings** can comply with the Energy Code in one of the following ways:

- ✦ Use the default U-factor and SHGC default values in [Tables 110.6-A](#) and [110.6-B](#) of the Energy Code.
- ✦ Be NFRC rated and certified using the Component Modeling Approach (CMA).
- ✦ For  $\leq 250$  ft<sup>2</sup> or 5% of CFA (whichever is greater), use the [Nonresidential Reference Appendix NA6](#) approach that considers the center of glass (COG) and the framing type. Note that the default values for the listed glazing and framing types do not meet Prescriptive requirements, so the Performance Approach must be used in these situations.

**Manufactured fenestration** must have a Mandatory air infiltration rate of  $\leq 0.3$  CFM/ft<sup>2</sup> of window area at a pressure differential of 75 Pa.

## Mandatory Methods for Determining Fenestration U-factor and SHGC for Single-family Buildings New Construction, Additions and Alterations

Methods for Determining Fenestration U-factor and SHGC	Manufactured	Site Built	Field Fabricated
<b>NFRC-rated Products</b>	Yes	No	No
<b>NFRC Component Modeling Approach (CMA)</b>	No	Yes	No
<b>Default <a href="#">Tables 110.6-A</a> and <a href="#">110.6-B</a></b>	Yes	Yes	Yes
<b><a href="#">Nonresidential Reference Appendix NA6</a></b>	No	Yes for $\leq 250$ ft <sup>2</sup> or 5% of CFA (whichever is greater)	No

**CFA** = conditioned floor area; **NFRC** = National Fenestration Rating Council; **SHGC** = solar heat gain coefficient.

**Table 24.** Mandatory Methods for Determining Fenestration U-factor and SHGC for Single-family Buildings New Construction, Additions and Alterations



## Using National Fenestration Rating Council Ratings

The National Fenestration Rating Council (NFRC) has two rating methods. Both methods result in whole product ratings that include all components (e.g., frame, glass, spacer and gas fill). Both methods require initial simulation and testing typically done by the frame manufacturer. The principal difference is when the insulating glass unit properties are included in the calculations:

1. The NFRC-rated method is commonly used for manufactured products such as punched opening. The NFRC-rated products are calculated at the time of certification by the simulation laboratory and already labeled before the product is shipped to a distributor.
2. The component modeling approach (CMA) is implemented in software named CMAST and is available only for nonresidential products. The CMA method is convenient when the frames have already been approved and added to the approved CMAST software. If the frame choice and the glass choice are in the CMAST software, CMA certifications can be provided very quickly for specified products at a particular project address. The CMA is used for a specific project with a specific insulating glass unit by an NFRC Accredited Calculation Entity (ACE) at the time the project is needed.

The NFRC issues certificates and provides labels for the products it rates. For an example of an NFRC label, see Figure 11. For an example of a certificate, see Figure 12.

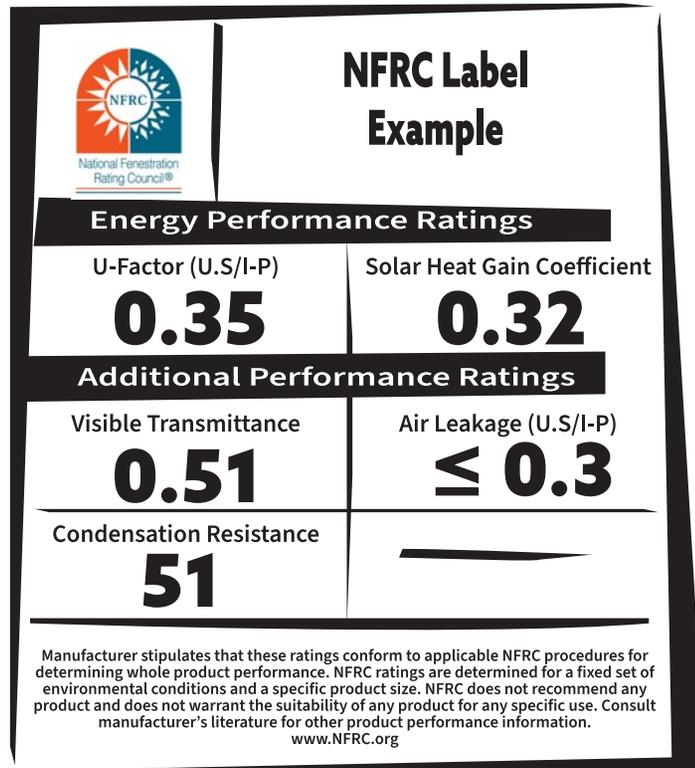


Figure 11. Example of a National Fenestration Rating Council (NFRC) Label

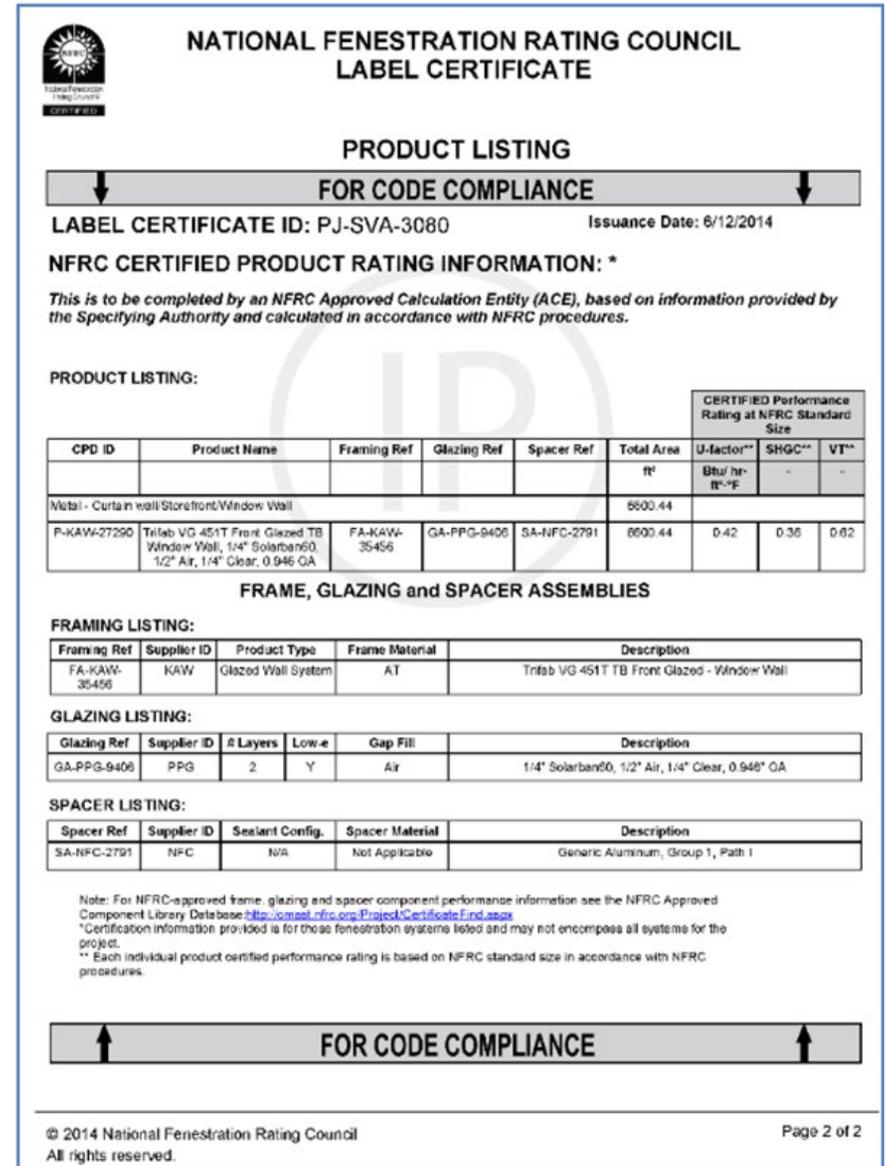


Figure 12. Example of a National Fenestration Rating Council (NFRC) Certificate



## Alterations

### Mandatory and Prescriptive Requirements for Fenestration Alterations

**Mandatory air infiltration rates** for manufactured fenestration must be  $\leq 0.3$  CFM/ft<sup>2</sup> of window area at a pressure differential of 75 Pa. See Table 25 to identify the Energy Code requirements that apply to the fenestration in your project.

Prescriptive Requirements for Altered Fenestration					
Project Scope		Maximum U-factor	Maximum SHGC	Maximum Area	
				Whole House**	West Facing***
		 <b>Mandatory: §§110.6, 150.0(q)</b>		 <b>Prescriptive: §§150.2(b)1A-B</b>	
Skylights	Repair*	N/A	N/A	N/A	
	Altering	$\leq 0.55$	$\leq 0.30$	N/A	
	Adding $\leq 16$ ft <sup>2</sup>	$\leq 0.55$	$\leq 0.30$	N/A	
	Adding $> 16$ ft <sup>2</sup>	$\leq 0.30$	CZ 2, 4, 6-15: $\leq 0.23$ CZ 1, 3, 5, 16: N/A	All CZ: 20%	CZ 2, 4, 6-15: 5% CZ 1, 3, 5, 16: N/A
Vertical Fenestration	Repair*	N/A	N/A	N/A	
	Altering $\leq 75$ ft <sup>2</sup>	$\leq 0.40$	CZ 2, 4, 6-15: $\leq 0.35$ CZ 1, 3, 5, 16: N/A	N/A	
	Altering $> 75$ ft <sup>2</sup>	$\leq 0.30$	CZ 2, 4, 6-15: $\leq 0.23$ CZ 1, 3, 5, 16: N/A	N/A	
	Adding $\leq 75$ ft <sup>2</sup>	$\leq 0.30$	CZ 2, 4, 6-15: $\leq 0.23$ CZ 1, 3, 5, 16: N/A	N/A	
	Adding $> 75$ ft <sup>2</sup>	$\leq 0.30$	CZ 2, 4, 6-15: $\leq 0.23$ CZ 1, 3, 5, 16: N/A	All CZ: 20%	CZ 2, 4, 6-15: 5% CZ 1, 3, 5, 16: N/A

**CZ** = Climate Zone; **SHGC** = solar heat gain coefficient.

\* Repair includes replacing glass within the existing sash or framing, provided that the replacement is at least equivalent to the original in performance.

\*\* Total whole house fenestration area includes skylights and west-facing glazing.

\*\*\* Total west-facing fenestration area includes skylights with pitch  $< 1:12$  facing any direction, and west-facing skylights with pitch  $\geq 1:12$ .

**Table 25.** Prescriptive Requirements for Altered Fenestration

### Window Films

NFRC window films may be used for Alterations in the Performance Approach to lower the effective U-factor and solar heat gain coefficient of the glazing. The *2022 Single-family Residential Alternative Calculation Method Reference Manual* has a detailed description of the procedures used to calculate SHGC. For Alterations involving the application of window films, see [Residential Reference Appendix RA4.2.2.2](#) and [§110.6](#) of the Energy Code.



#### WHAT'S NEW

Fenestration area-weighted Mandatory U-factor is now  $\leq 0.45$  (previously 0.58). Mandatory U-factor can only be used with the Performance Approach. Exceptions still apply for up to 10 ft<sup>2</sup> or 0.5% of conditioned floor area, whichever is greater, and for up to 30 ft<sup>2</sup> of greenhouse or garden windows.



# Solid Doors

**Why is compliance required for solid doors?** Solid doors impact energy use in a home when associated with conditioned space. Energy-efficient solid doors that separate the home's conditioned space from unconditioned space and from the outside can help increase comfort and reduce energy use.

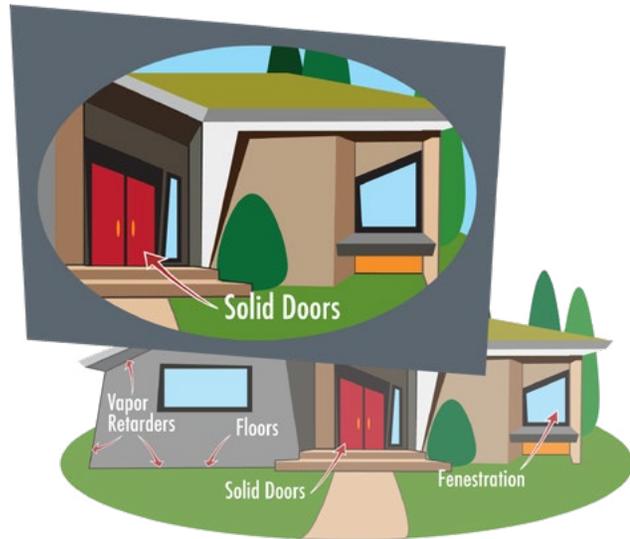


Figure 13. Solid Doors in a Single-family Building

## Key Terms

**Door (or Solid Door)** is an operable opening in the building envelope, including swinging and roll-up doors, fire doors, pet doors and access hatches with less than 25 percent glazed area. When that operable opening has 25 percent or more glazed area, it is a glazed door.

**Glazed Door** is an exterior door having a glazed area of 25 percent or greater of the area of the door. Glazed doors must meet fenestration product requirements.

## New Construction, Additions and Alterations

New Construction, Additions and Alterations must all meet the same Energy Code requirements for new and replacement solid doors.

See Table 26 for the applicable Energy Code sections.



### WHAT'S NEW

There are no changes in the 2022 Energy Code for requirements for solid doors in Single-family Building New Construction, Additions or Alterations.

Mandatory and Prescriptive Solid Door Requirements for Single-family Buildings

Project Scope	Swinging Door NFRC-rated U-factor	Air Leakage*
	<b>Mandatory: §§110.6, 150.0(q)</b> <b>Prescriptive: 150.1(c)5</b>	<b>Mandatory: §110.6</b>
<b>New Building</b>	<b>Yes</b>	<b>Yes</b>
<b>Addition</b>	<b>Yes</b>	<b>Yes</b>
<b>Conditioning an existing building for the first time</b>	<b>Yes</b>	<b>Yes</b>
<b>Alteration</b>	<b>Yes</b>	<b>Yes</b>

NFRC = National Fenestration Rating Council.

\* Manufactured doors, including pet doors, must be ≤ 0.3 CFM/ft<sup>2</sup> of window area at a pressure differential of 75 Pa.

Table 26. Mandatory and Prescriptive Solid Door Requirements for Single-family Buildings



## Mandatory Methods for Determining Solid Door U-factor

Table 27 summarizes the methods that are available to determine compliance for solid doors. The default solid door U-factors from [Joint Reference Appendix JA4 Table 4.5.1](#) are shown in Table 28.

## Prescriptive Requirements for Swinging Solid Doors

The Energy Code places a Prescriptive limit on a swinging door's maximum U-factor of  $\leq 0.20$  when it is associated with a conditioned space. Garage doors separating the conditioned home from the garage are not required to meet these requirements if the door is required to be fire protection. If any of the Prescriptive requirements cannot be met, the Performance Approach must be used to demonstrate compliance.

## Mandatory Methods Available to Determine Solid Door U-factors for Compliance

Method	Manufactured Solid Door	Field-Fabricated Door
<b>NFRC-Rated Products</b>	<b>Yes</b>	No
<b>Default per Joint Reference Appendix JA4 Table 4.5.1*</b>	<b>Yes</b>	<b>Yes</b>

**NFRC** = National Fenestration Rating Council.

\* Non-NFRC Rated Doors must use the Performance Approach to show compliance.

**Table 27.** Mandatory Methods Available to Determine Solid Door U-factors for Compliance

## Default U-factors by Door Type

Solid Door Type	Maximum U-factor
Uninsulated single-layer metal swinging doors or non-swinging doors, including single-layer uninsulated access hatches and uninsulated smoke vents	$\leq 1.45$
Uninsulated double-layer metal swinging doors or non-swinging doors, including double-layer uninsulated access hatches and uninsulated smoke vents	$\leq 0.70$
Insulated metal swinging doors, including fire-rated doors, insulated access hatches and insulated smoke vents	$\leq 0.50$
Wood doors with a minimum nominal thickness of 1-3/4 inches (44 mm), including panel doors with a minimum panel thickness of 1-1/8 inches (28 mm), solid core flush doors and hollow core flush doors	$\leq 0.50$
Any other wood door	$\leq 0.60$
Uninsulated single-layer metal roll-up doors, including fire-rated doors	$\leq 1.45$
Insulated single-layer metal sectional doors with a minimum insulation nominal thickness of 1-3/8 inches expanded polystyrene (R-4 per inch)	$\leq 0.179$

**Table 28.** Default U-factors by Door Type (excerpted from Joint Reference Appendix JA4 [Table 4.5.1](#))



# Envelope HERS Measures

**Why does compliance require HERS verification of envelope performance and materials?** Decades of research have concluded that just specifying an efficient piece of equipment or high levels of insulation is not sufficient for good performance. Correct installation of the assembly or component is essential to its long-term efficiency. However, understanding the correct installation and testing procedures requires more specialized knowledge than commonly included in training of building inspectors, so the CEC created the Home Energy Rating System (HERS) program to maintain an industry of third-party verifiers who are specifically trained in each measure.

Verifications are performed by a HERS Rater, who must be a third-party inspector who is not financially involved in the project or employed by the contractor. HERS Raters are certified to verify compliance on behalf of the building owner and receive special training from the HERS Providers. CEC has approved HERS Providers who train HERS Raters and maintain registries for project documentation. For more information on the HERS Program, see the [Single-family Buildings Just the Basics: HERS Verification 2022 Fact Sheet](#).

Table 29 lists key HERS measures required for the Prescriptive pathway or available for Performance compliance credit for the envelope in single-family buildings.

Envelope HERS Verification Measures for Single-family Buildings		
Verification Measure	Trigger	Description
<b>Quality Insulation Installation (QII)</b>	<p><b>Prescriptive pathway:</b> Required for new building and additions &gt; 700 ft<sup>2</sup></p> <p><b>Performance pathway:</b> As indicated on CF1R-PRF-01-E</p>	The building envelope is inspected for proper air sealing prior to insulation installation. Insulation is verified as correctly installed per manufacturer's instructions to the appropriate R-value indicated in the CF1R-PRF-01-E, CF1R-NCB-01-E or CF1R-ADD-01-E. See <a href="#">Residential Reference Appendix RA3.5</a> .
<b>Building Envelope Air Leakage Blower Door Testing</b>	<p><b>Prescriptive pathway:</b> N/A</p> <p><b>Performance pathway:</b> CF1R-PRF-01-E including a building envelope leakage credit and target</p>	The project has included a Performance credit for a tight envelope, which is to be verified by through a blower-door test with results that meet or exceed the air-tightness target indicated in the CF1R-PRF-E.
<b>Spray Polyurethane Foam (SPF) R-Value</b>	<p><b>Prescriptive pathway:</b> N/A</p> <p><b>Performance pathway:</b> CF1R-PRF-01-E includes a "High R-value Spray Foam Insulation" HERS feature</p>	<p>A HERS Rater must verify the installation of SPF insulation whenever R-values greater than the default R-value per inch are used for compliance.</p> <p>Default Values</p> <ul style="list-style-type: none"> <li>✦ Open Cell: ≤ 3.6 per inch</li> <li>✦ Closed Cell: ≤ R5.8 per inch</li> </ul>
<b>HERS Verification of Existing Conditions</b>	<p><b>Prescriptive pathway:</b> N/A</p> <p><b>Performance pathway:</b> CF1R-PRF-01-E may include HERS-verified existing building envelope features as part of Existing+Addition+Alteration compliance modeling</p>	An Alteration to an existing building has included Performance credit for improving existing building envelope features beyond HERS-verified existing conditions. To qualify for this credit, the HERS Rater must verify existing conditions and complete form CF3R-EXC-20 before any changes are made to the existing building envelope.

**Table 29.** Envelope HERS Verification Measures for Single-family Buildings



## Quality Insulation Installation

Quality insulation installation (QII) is the process of verifying the insulation and air barrier at the wall, roof and floor have been installed correctly according to the CEC's verification procedures found in the Energy Code's [Residential Reference Appendix RA3.5](#). A HERS Rater carries out the inspection to verify the necessary building components by making site visits at multiple stages during the construction process.

### Quality Insulation Installation in the Performance Approach

When using the Performance Approach, note that when QII is not included in the modeled design, the wall and floor insulation R-values are modeled at 70% of the recognized value with assumptions for attic deficiencies as well as increased heat transfer between the conditioned zone and attic. This results in a Performance penalty because QII is part of the Standard Design as the Prescriptive baseline.

## Commonly Applicable Project Scopes

Requirements for Quality Insulation Installation for Single-family Buildings	
Project Scope	QII Prescriptive Requirements §§150.1(c)1E, 150.2(a)1A
New Construction: new building	Yes
Addition ≤ 700 ft <sup>2</sup>	N/A
Addition > 700 ft <sup>2</sup>	Yes
Conditioning an existing building space > 700 ft <sup>2</sup> for the first time	Yes*
Alterations	N/A

Project Scope	QII Performance Requirements §§150.1(b)3B, 150.2(a)2
Any Addition or New Construction project using the Performance Approach where QII is noted on the CF1R-PRF-E form	Yes

*QII = quality insulation installation.*

*\* Existing window and door headers are not required to be insulated, and air sealing is not required when the existing air barrier is not being removed or replaced.*

**Table 30.1 and 30.2** Requirements for Quality Insulation Installation for Single-family Buildings

## Prescriptive Requirements

The Energy Code Prescriptively requires that conditioned spaces associated with New Construction and Additions of a certain size be designed, constructed and verified as meeting the QII requirements. If any of the Prescriptive requirements cannot be met, the Performance Approach must be used to demonstrate compliance.

### Take careful note of the QII HERS timeline:

- ✦ **Design Phase:** The energy consultant and designer determine if QII should be part of the project. In this phase, a HERS Rater should be brought into the project to identify building features that are unique to QII such as window and door headers, attic knee walls, framed corners and architectural bump outs.
- ✦ **Construction Phase:** The contractor is aware of QII requirements and schedules the HERS Rater before the project begins. The HERS Rater works closely with contractor to ensure a successful QII process.
- ✦ **Rough Install:** The first inspection occurs during the framing stage and verifies features associated with the air barrier before any insulation is installed. Although air sealing has been a Mandatory requirement in [§110.7](#) since the 1990s, this is the most likely part of QII to be missed because different trades are involved. In the rough install stage, the contractor completes the CF2R-ENV-21-H form, and the HERS Rater completes the CF3R-ENV-21-H form. The building inspector confirms that QII is in progress at the rough install stage and verifies that appropriate compliance forms are submitted.
- ✦ **Insulation Installation:** The second inspection occurs when the insulation is installed. The HERS Rater may need multiple site visits depending on the construction schedule. The contractor completes the CF2R-ENV-22-H form, and the HERS Rater completes the CF3R-ENV-22-H form.
- ✦ **Final Stage:** The building inspector verifies that the HERS inspection was satisfactorily completed. The inspector verifies that all CF2R and CF3R forms have been completed and registered to the HERS Provider.



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## Building Envelope Air Leakage Blower Door Testing

### Performance Requirements

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#### Commonly Applicable Project Scopes

The air-sealing measures in [§110.7](#) are Mandatory for all construction, but there is no specific air-leakage Performance target. Testing of building air-leakage with a blower door diagnostic tool can be used as a Performance compliance option to demonstrate that the infiltration is less than the standard design infiltration rate of 5 ACH at 50 Pa pressure difference (5 ACH50).

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#### Performance Requirements

The target infiltration for the credit is modeled in the Performance software and indicated in the CF1R-PRF-01-E compliance report. If the blower door test shows worse infiltration performance, then either the building must be tightened to achieve the target or the Performance model must be re-run to show compliance at the higher infiltration rate.

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## Spray Polyurethane Foam R-value

### Performance Requirements

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#### Commonly Applicable Project Scopes

If a spray polyurethane foam product is specified that can exceed the default R-values and that R-value is used in Performance compliance calculations, then it triggers a HERS verification to verify that the specific product was used and was installed to meet the appropriate overall R-value required for compliance.

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#### Performance Requirements

For the purposes of total R-value, spray polyurethane foam products are assigned an R-value per inch of 3.6 R/in for open-cell (low density) foam products, and 5.8 R/in for closed cell (medium density) products. There are products which can exceed these R/in defaults that are listed in the [Department of Consumer Affairs, Bureau of Household Goods and Services](#) registry.

For example, if a 2 x 6 wall is insulated with open-cell spray foam, then the default cavity R-value is R-19.8 (3.6 R/in x 5.5 in.). However, if a product is specified that provides R-4 per inch, then the Performance calculation can model a cavity R-value of R-22 along with a HERS verification for quality insulation installation for spray polyurethane foam.



# Compliance Forms

For single-family buildings, forms are supported on the Energy Code Ace Get Forms landing page: [www.energycodeace.com/content/get-forms](http://www.energycodeace.com/content/get-forms).

- ✦ The CF1R form defines Energy Code requirements for a whole project, including envelope requirements. If there are HERS requirements, the form must be registered via a HERS Provider. Find a HERS Provider at the CEC [Home Energy Rating System Providers](#) website.
- ✦ The CF2R forms must be provided by installers to match the CF1R form requirements and registered via a HERS Provider.
- ✦ The CF3R forms, when required, are completed by a HERS Rater and registered via a HERS Provider.

## Additional Single-family HERS Measures

Single-family buildings often require other types of HERS measures besides those for the building envelope. For example, new construction will almost always require HERS verification for indoor air quality (IAQ), kitchen range hood, and most HVAC systems. When showing compliance using the Performance Approach, all applicable HERS measures would be found in the same CF1R-PRF-01-E Certificate of Compliance to be registered with a HERS Provider.

Energy Code Compliance Forms for Single-family Building Envelope Projects

Compliance Approach	Project Type	HERS Measures	Certificates of Compliance	Certificates of Installation	Certificates of Verification
Performance Approach	New Construction	YES	CF1R-PRF-01-E*	CF2R-ENV-##-H*	CF3R-ENV-##-H*
	Additions	No	CF1R-PRF-01-E	CF2R-ADD-02-E	N/A
		YES	CF1R-PRF-01-E*	CF2R-ENV-##-H*	CF3R-ENV-##-H*
	Alterations	No	CF1R-PRF-01-E	CF2R-ALT-05-E	N/A
		YES	CF1R-PRF-01-E*	CF2R-ENV-##-H*	CF3R-ENV-##-H*
	Prescriptive Approach	New Construction	YES	CF1R-NCB-01-E*	CF2R-ENV-##-H*
Additions		No	CF1R-ADD-02-E	CF2R-ADD-02-E	N/A
		YES	CF1R-ADD-01-E*	CF2R-ENV-##-H*	CF3R-ENV-##-H*
Alterations		No	CF1R-ALT-05-E	CF2R-ALT-05-E	N/A
		YES	CF1R-ALT-01-E*	CF2R-ENV-##-H*	CF3R-ENV-##-H*
Worksheets		U-factor or SHGC	N/A	CF1R-ENV-02**	N/A
	Fenestration SHGC	N/A	CF1R-ENV-03**	N/A	N/A
	Cool Roof and SRI	N/A	CF1R-ENV-04**	N/A	N/A

**CRRC** = Cool Roof Rating Council; **HERS** = Home Energy Rating System; **SHGC** = solar heat gain coefficient; **SRI** = solar reflectance index.

\* Form must be registered with a HERS Provider.

\*\* Worksheets must be submitted with Prescriptive CF1R forms when the worksheets are used to calculate compliance requirements. **When used for a project with any HERS measures, the worksheets must be registered with a HERS Provider along with the rest of the compliance documentation.** Worksheets are not required for the Performance Approach.

**Table 31.** Energy Code Compliance Forms for Single-family Building Envelope Projects



## For More Information

### CALIFORNIA ENERGY COMMISSION

#### [www.energy.ca.gov](http://www.energy.ca.gov)

Learn more about the California Energy Commission (CEC) and its programs on its website.

#### [2022 Building Energy Efficiency Standards](#)

Explore the main CEC web portal for the 2022 Energy Code, including information, documents and historical information.

#### [2022 Building Energy Efficiency Standards Summary](#)

View or download this visual summary of the Energy Code's purpose, current changes and impact.

#### **Energy Code Hotline**

Call: 1-800-772-3300 (Free)

Email: [Title24@energy.ca.gov](mailto:Title24@energy.ca.gov)

#### [Online Resource Center](#)

Use these online resources developed for building and enforcement communities to learn more about the Energy Code.



#### [www.energycodeace.com](http://www.energycodeace.com)

Stop by this online "one-stop-shop" for no-cost tools, training and resources designed to help you comply with California's Title 24, Part 6 and Title 20.



Tools

#### [www.energycodeace.com/tools](http://www.energycodeace.com/tools)

Explore this suite of interactive tools to understand the compliance process, required forms, installation techniques and energy efficiency regulations in California.

#### **Reference Ace**

Navigate the Title 24, Part 6 Energy Code using an index, keyword search and hyperlinked text.

#### **Q&Ace**

Search our online knowledge base or submit your question to Energy Code Ace experts.



Training

#### [www.energycodeace.com/training](http://www.energycodeace.com/training)

On-demand, live in-person and online training alternatives are tailored to a variety of industry professionals and address key measures.

Of Special Interest:

- ◇ [2022 Title 24, Part 6 Essentials – Residential Standards: What's New](#)
- ◇ [2022 Title 24, Part 6 Essentials – Single-family Standards for Architects and Designers](#)



Resources

#### [www.energycodeace.com/resources](http://www.energycodeace.com/resources)

Downloadable materials provide practical and concise guidance on how and when to comply with California's building and appliance energy efficiency standards.

Of Special Interest:

#### **Fact Sheets**

- ◇ [Single-family Buildings: What's Changed in 2022](#)

**Create an account on the Energy Code Ace site and select an industry role for your profile in order to receive messages about all our offerings!**

Check [EnergyCodeAce.com](http://EnergyCodeAce.com) for our latest 2022 tools, training and resources!



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