Community & Economic Development Department

Building Division

2010 CALIFORNIA BUILDING CODE
CALIFORNIA RESIDENTIAL CODE
2008 BUILDING ENERGY EFFICIENCY STANDARDS

STANDARDS REVIEW WITH REPLACEMENT WINDOW PERMIT APPLICATION

ATTENTION CONTRACTORS AND HOMEOWNERS

NEW REQUIREMENTS FOR WINDOWS IN RESIDENTIAL NEW CONSTRUCTION AND WINDOW REPLACEMENT WENT INTO EFFECT

JANUARY 1, 2010

2008 California Energy Standards
Fenestration Alterations

Windows, glazed doors, and skylights have a significant impact on energy use in a home. They may account for up to 50 percent of residential space heating loads, and for homes that are air-conditioned, up to 50 percent of the cooling load. The size, orientation, and types of fenestration products can dramatically affect the overall energy performance of a house. Glazing type, orientation, an shading not only play a major role in the building's energy use but can affect the operation of the HVAC system and comfort of the occupants.
Applications require:
1. Owner authorization form or Contractor Authorization form is required. Forms are available @ www.madera-county.com

The Standards deal with fenestration in several ways and in several places:

1. §10-111 (Administrative Standards) establishes the rules for rating and labeling fenestration products and establishes the NFRC as the supervising authority.
2. §116(a)1 sets air leakage requirements for all manufactured windows whether they are used in residential or nonresidential buildings.
3. §116(a)2 and 3 require that the U-factor and the solar heat gain coefficient (SHGC) for manufactured fenestration products be determined using NFRC procedures or use default fenestration values in Standards Table 116-A and Table 116-B.
4. §116(a)4 requires that manufactured fenestration products have both a temporary and permanent label. The temporary label shall show both the U-factor and the SHGC and verify that the window complies with the air leakage requirements.
5. §116(b) has default U-factors and SHGC values that are to be used for field-fabricated fenestration and exterior doors that do not have an NFRC rating.
6. §117 requires that openings around windows and doors be caulked, gasketed, weatherstripped or otherwise sealed to limit air leakage.
7. §151(f)3 Exception allows up to 3 square feet of the glazing installed in doors and up to 2 square feet of tubular skylight with dual-pane diffusers to have an assumed U-factor equivalent to the Package requirements.
8. §151(f)3 and 4 have the prescriptive requirements for fenestration in low-rise residential buildings. These include requirements for maximum glazing area, maximum U-factor, and for some climate zones, a maximum SHGC requirement.
9. §152(a) sets the fenestration area requirements for residential additions and requires that new windows meet the prescriptive requirements.
10. §152(b) establishes that replacement windows in existing residences meet the prescriptive requirements. Performance compliance options (existing plus alteration) are also available.

Mandatory Measures

The Standards define three types of fenestration products that face different mandatory measures:

- Manufactured products are delivered pre-assembled from the factory. This is the most common type of fenestration in residential construction.
- Site-built products are glazed or assembled on site using factory prepared systems. These are more common in nonresidential construction and include storefront and curtainwall systems. The glazing contractor may also pre-assemble site-built fenestration at his or her shop before final installation. For unlabeled site-built fenestration use default values from Standards Table 116-A for U-factor and Table 116-B for SHGC, otherwise, select site-build fenestration from NFRC Certified Products Directory. See http://www.NFRC.org. Field-fabricated products are built on site using standard dimensional lumber or other materials not intentionally prepared for use as a fenestration product. For field-fabricated fenestration use default values from Standards Table 116-A for U-factor and Table 116-B for SHGC.

Complete definitions can be found in the Reference Joint Appendices, JA1.

Air Leakage

§116(a)1

Manufactured Fenestration Products. Manufactured fenestration products, including exterior doors, must be tested and certified to leak not more than 0.3 cubic feet per minute (CFM) per ft2 of window area. For a window that has an area of 10 ft^2, the maximum leakage would be 10 ft^2 times 0.3 cfm/ft^2 or a total

leakage of 3 CFM. This is equal to about 86 in^3 per second or about a quart and a half of air each second. This mandatory measure applies to all manufactured windows whether they are used in new residential or nonresidential buildings.

To determine leakage, the test procedure that manufacturers use is either NFRC 400 or ASTM E283, which are essentially the same.

Site-built Products. There are no specific air leakage requirements for site-built fenestration products, the Standards require limiting air leakage through weather stripping and caulking.

Field-fabricated Products. No testing is required for field-fabricated fenestration products; however, the Standards require limiting air leakage through weather stripping and caulking.

Exterior Doors. Exterior doors must meet the following requirements:

- Manufactured exterior doors must be certified as meeting an air leakage rate of 0.3 cfm/ft2 of door area of §116(a)1, which is the same as windows.
- They must comply with the requirements of §117, as described below in "Joints and Other Openings," e.g., they must be caulked and weatherstripped if field-fabricated.
- Any door that is more than one-half glass is a fenestration product and must comply with the mandatory and prescriptive measures and other Standards requirements for fenestration products.

U-factor and SHGC Ratings

§116(a)2 and §116(a)3
Table 116-A
Table 116-B

Manufactured Fenestration Products. The mandatory measures require that both the U-factor and the SHGC of manufactured fenestration products be determined from NFRC Certified Product Directory or from Energy Commission-approved default tables. At the time of inspection, the actual fenestration U-factor and SHGC values as shown on NFRC labels or in the default tables must result in equal or lower overall energy consumption than the values indicated on the compliance documents. The default U-factors are contained in Standards Table 116-A, and the default SHGC values are contained in Standards Table 116-B (also in Appendix B of this compliance manual). A directory of NFRC certified ratings is available at http://www.NFRC.org.

Commission default values in both Standards Tables 116-A and 116-B are on the poor side of the performance range for windows. To get credit for advanced window features such as low-e (low-emissivity) coatings and thermal break frames, the window manufacturer must have the window tested, labeled, and certified according to NFRC procedures. Figure 3-2 is an example of an NFRC approved temporary fenestration label.

Figure 3-2 – NFRC Temporary Label

Table 3-1 – Allowable Methods for Determining U-factors

	Fenestration Category		
U-factor Determination Method	Manufactured Windows	Site-Built Fenestration	Field-Fabricated Fenestration
NFRC-100	✓	✓	N/A
Standards Table 116-A	✓	✓	✓

Table 3-2 – Methods for Determining Solar Heat Gain Coefficients

	Fenestration Category		
SHGC Determination Method	Manufactured Windows	Site-Built Fenestration	Field-Fabricated Fenestration
NFRC-200	✓	✓	N/A
Standards Table 116-B	✓	✓	✓

Requiring that SHGC and U-factor be calculated using a common procedure ensures that the performance data for fenestration products are more accurate and that data provided by different manufacturers can be more easily compared. The test procedure for U-factor is NFRC 100, and the test procedure for SHGC is NFRC 200.

Site-built Fenestration Products. For low-rise residential construction, site-built products are treated the same as manufactured products: U-factor and SHGC values must come from NFRC ratings or from Standards Tables 116-A and 116-B. Note that different alternative default values apply to nonresidential projects; default values may be found in the Reference Nonresidential Appendices NA6.

Field-fabricated Products §116(b). Field-fabricated fenestration must always use the Energy Commission default U-factors from Standards Table 116-A and SHGC values from Table 116-B.

For non-field-fabricated products, acceptable methods of determining U-factor are shown in Table 3-1. Acceptable methods of determining SHGC are shown in Table 3-2.

Temporary and Permanent Labels

See §10-111(a) and §116(a)4

Manufactured Fenestration Products. The Standards require that manufactured windows have both temporary and permanent labels that show the NFRC performance characteristics. The temporary label shows the U-factor and

SHGC, for each rated window. The label must also show that the window meets the air infiltration criteria. The temporary label must not be removed before inspection by the enforcement agency.

The permanent label must, at a minimum, identify the certifying organization and have a number or code to allow tracking back to the original information on file with the certifying organization. The permanent label also can be inscribed on the spacer, etched on the glass, engraved on the frame, or otherwise located so as not to affect aesthetics.

Site-Built Fenestration Products. Labeling requirements apply to site-built fenestration products as well, except that a label certificate may be provided in accordance with NFRC 100 in place of an attached temporary label. The label

certificate is a document that verifies the performance of the site-built fenestration product but that is not physically attached to the product. The label certificate is kept at the job site by the contractor for field inspector verification.

Field-Fabricated Fenestration Products. A label is not required for field fabricated fenestration products, but must use the default values in Table 116-A and Table 116-B from the Standards.

Prescriptive Requirements

Prescriptive requirements described in this chapter typically refer to Package D. For a list of Package C and Package E features, refer to Tables 151-B and 151-D of the Standards (also in Appendix B of this document).

The prescriptive requirements specify a maximum U-factor, and in climate zones where air conditioning is common, a maximum SHGC. In addition, the prescriptive requirements limit total glass area to a maximum of 20 percent of

the conditioned floor area and west-facing glass to a maximum of 5 percent of the conditioned floor area in climate zones 2, 4, and 7-15. West-facing fenestration area includes skylights tilted to the west or tilted in any direction when the pitch is less than 1:12 (§151(f)3C).

Fenestration U-factor

With the 2008 update, the U-factor prescriptive Package D requirement for all climate zones is 0.40 or lower (see Table 3-3 for all packages U-factor requirements). However, for each building, up to 3 square feet of the glazing installed in doors and up to 2 square foot of tubular skylights with dual-pane diffusers at the ceiling are exempt from the prescriptive U-factor requirements. See Exception §151(f)3A. When using the prescriptive criteria, some windows may exceed the prescriptive requirement as long as the area-weighted average U-factor meets the requirement. Decorative or stained glass is an example that

might not meet the prescriptive requirements unless weight-averaged with other fenestration. To calculate weight-averaged U-factors for prescriptive envelope compliance, see Form WS-2R in Appendix A of this manual.

The U-factor criterion applies to both windows and skylights. Most skylights are mounted on a curb, and the U-factor of such skylights according to NFRC procedures includes heat loss through a standardized portion of curb included in the tests. NFRC 100 includes the following:

If a skylight can be installed using more than one of the installation methods

listed below, the skylight product line shall include all the pertinent options as

individual products. The method in which a skylight is mounted will affect its U factor.

Mounting variations include these:

1. Inset mount, where the curb of the skylight extends into the rough opening on the roof;
2. Curb mount, where the outside of the curb is equal to the rough opening in the roof; and
3. Curb mount, where the inside of the curb is equal to the rough opening in the roof.

NRFC 100 also states the following:

- Curb mounted skylights that do not have an attached integral curb when manufactured shall be simulated and tested installed on a nominal 2 x 4 (actual size 40.0 mm x 90.0 mm or 1.5 in. x 3.5 in.) wood curb made from Douglas Fir, with no knots.
- The heat transfer characteristics of site-built curbs are not included in the NFRC rating and must be modeled as a part of the opaque building envelope. For compliance purposes with the low-rise residential standards, the U-factor for a skylight rated with any of the three mounting variations described above is applied to the area of the rough opening.

U-factors for skylights are therefore significantly higher than they are for windows, even when the construction of the skylight and the window are similar. This means that skylights will not generally comply with the prescriptive requirements, and any building that uses skylights will be forced to use the performance approach unless weight-averaging with other fenestration is used.

Table 3-3 – Maximum U-factors by Climate Zone in Packages C, D and E

Climate Zone	1	2-15	16
Package C			
Maximum U-factor	0.38	0.38	0.38
Package D			
Maximum U-factor	0.40	0.40	0.40
Package E			
Maximum U-factor			

SHGC

The standards set a maximum SHGC of 0.40 for homes constructed in all climate zones except 1, 3, and 16 where there are no SHGC requirements. The maximum SHGC requirements are in the climate zones where homes are more likely to be air conditioned. This requirement applies to the fenestration product without consideration of insect screens or interior shading devices. Other than skylights, the SHGC of windows and doors can be weight-averaged to meet the prescriptive requirement. West-facing glazing may not be averaged with non-west facing glazing. Weight-averaging must be done within the limitations on west-facing area allowance in §151(f)3C. The SHGC of all west facing glazing may be averaged. The SHGC of all non-west-facing glazing may be averaged. Skylights must meet the SHGC requirement without weight averaging. However, the skylight area and required SHGC must be included with calculations of the west-facing area.

A window or fenestration product that meets the SHGC criterion will typically have a special low-e coating that reduces solar gains. The coating also has other benefits, such as reducing the admittance of UV energy, which is the principal cause of fabric fading.

While a low-e coating is the most common way to comply with the SHGC requirements, the Standards offer other options: use an exterior shade screen or louver on the outside of the window or, for south facing windows, use a properly sized overhang. Both sunscreens and overhangs are discussed in the Compliance Options section.

Table 3-4 – Package C D, and E SHGC Criteria by Climate Zone

Package C															
Climate Zone	1, 16	3	4	5	6	7	8, 9	10	2, 11-13	14	15				
Maximum Solar Heat Gain Coefficient (SHGC)	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40				
Maximum total area	14%	14%	14%	16%	14%	14%	14%	16%	16%	14%	16%				
Maximum West facing area	NR	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%				
Package D															
Climate Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Maximum Solar Heat Gain Coefficient (SHGC)	NR	0.40	NR	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.40	0.35	NR
Maximum total area	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Maximum West facing area	NR	5%	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR
Package E																
Climate Zone	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Maximum Solar Heat Gain Coefficient (SHGC)	NR	0.40	0.40	0.25	0.40	0.40	0.25	0.40	0.40	0.40	0.25	0.25	0.30	0.25	0.25	NR
Maximum total area	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%	20%
Maximum West facing area	NR	5%	NR	5%	NR	NR	5%	5%	5%	5%	5%	5%	5%	5%	5%	NR

Window Area

§101(b), §151(f)3C, §151(e)

With the prescriptive requirements, window area is limited to a maximum of 20 percent of the conditioned floor area in all climate zones. In climate zones 2, 4, and 7 through 15, the window area facing west is limited to a maximum of 5 percent of the conditioned floor area.

The west-facing area requirement is intended to reduce peak demand, since west-facing windows have more solar gain during the peak cooling period and contribute more to the peak cooling load.

Rules for Doors that include Glass Areas

§116 and RACM 3.7

The following rules apply to doors that have glass areas embedded in them.

- Any door that is more than one-half glass is a fenestration product and must comply with the mandatory and prescriptive measures and other Standards requirements for fenestration products.
- In the prescriptive approach, doors with less than 50 percent glass area, the U-factor and SHGC shall be based on either the NFRC values for the entire door including glass area, or use default values in Table 116 -A or Table 116-B from the Standards. The opaque part of the door is ignored in the prescriptive approach
- In the performance approach, for doors with less than 50 percent glass area, the U-factor shall be based on either the NFRC values for the entire door including glass area, or a default U-factor of 0.50 for the opaque portion. The glass area of the door shall be calculated as the sum of all glass surfaces plus 2 inches on all sides of the glass (to account for a frame) ; the opaque area of the door shall be considered the total door area minus this calculated glass area. If the default U-factor is used for the opaque portion, then the glass area shall be modeled under the rules for fenestration. Doors with 50 percent or more glass area shall be modeled under the rules for fenestrations using the total area of the door.

In the prescriptive approach, the glass area of the door, calculated as the sum of all glass surfaces plus 2 inches on all sides of the glass (to account for a frame).

Compliance Options

While the prescriptive requirements and mandatory measures establish a minimum level of performance, the opportunities to exceed the requirements of the Standards are considerable. Some of these compliance options are discussed in this section. Those compliance options that are recognized for credit through the performance method are called compliance options. Most of the compliance options discussed in this section may be used only with the performance approach, but a few such as exterior shading devices and south facing overhangs may be used to comply with the prescriptive requirements.

Fenestration Area

With the 2008 update to the Standards, no credit is offered through the performance approach for reducing fenestration area below the maximum allowed 20 percent of the conditioned floor area (CFA).

While there is no credit for window area less than 20 percent of CFA, there is a penalty for buildings that have a window area that exceeds 20 percent of CFA. Such buildings are permitted only with the performance approach, where the standard design has a window area equal to the proposed design (up to 20 percent of the conditioned floor area), and the glass area in the standard design is uniformly distributed among cardinal orientations. The proposed design, on the other hand, has the exact proposed glass area and orientation.

Orientation

Window and skylight orientation has a huge impact on both energy use and peak electric demand. Orientation is a compliance option that is recognized in the performance approach, since the standard design has windows uniformly distributed on the north, south, east, and west sides of the building.

With the 2005 update and continuing under the 2008 update, the currency used to compare whole building performance is TDV energy. With TDV energy, savings during peak periods are worth more than savings at non-peak times. Window and skylight orientation was always an important feature and one for which the Standards have always offered a credit. The change to TDV makes window orientation even more important in the context of compliance.

Improved Window Performance

With the 2008 update, the U-factor has been reduced to 0.40 in all climate zones in Package D. This means there is less credit available for installing high performance windows that could be traded off or be used to avoid other measures, such as duct sealing and verification. However, choosing high performance windows that perform better than the prescriptive requirements can still earn significant credit through the performance method. In air conditioning climates, choosing a window with an SHGC lower than 0.40 will reduce the cooling loads compared to the standard design.

The magnitude of the impact will vary by climate zone; in mild coastal climates the benefit to reducing window U-factor will be smaller than in cold mountain climates. Computer compliance programs can be a useful tool to compare the impact of different windows and can help the designer determine when an investment in better windows is worthwhile.

Several factors affect window performance. For windows with NFRC ratings, these performance features are accounted for in the U-factor and SHGC ratings:

- Frame materials, design, and configuration (including cross-sectional characteristics). Fenestration is usually framed in wood, aluminum, vinyl, or composites of these. Frame materials such as wood and vinyl are better insulators than metal. Some aluminum-framed units have thermal breaks that reduce the conductive heat transfer through the framing element as compared with similar units that have no such conductive thermal barriers.
- Number of panes of glazing, coatings, and fill gases. Double-glazing offers opportunities for improving performance beyond the dimension of the air space between panes. For example, special materials that reduce emissivity of the surfaces facing the air space, including low-e or other coatings, improve the thermal performance of fenestration products. Fill gases other than dry air – such as carbon dioxide, argon, or krypton – also improve thermal performance.
- Gap width (i.e., the distance between panes).
- Window type (i.e., casement versus double hung).
- Spacer material (i.e., the type of material separating multiple panes of glass).

Fixed Shading Devices

Shading of windows is also an important compliance option. Overhangs or side fins that are attached to the building or shading from the building itself are compliance options for which credit is offered through the performance approach. However, no credit is offered for shading from trees, adjacent buildings, or terrain.

Shading devices for which there is credit are those that are a part of the building design. For these, the designer and the builder have control over the measure and can assure that it will be constructed correctly and will perform properly. Non-credit devices are those that the designer has little or no control over, such as the height of a neighboring house or tree.

Compliance and Enforcement

Construction

The fenestration product installer needs to understand the required U-factors and product SHGC values for the specific project, based on the compliance documentation such as the Certificate of Compliance (CF-1R). The installer should check the documentation to ensure that the products have the temporary label with information documenting that the window meets the compliance requirements.

NFRC labels include U-factor and SHGC data for residential (and nonresidential) windows. Verify that the residential data complies. The temporary label must remain on the product until the field inspector has inspected it.

The fenestration contractor must complete the Installation Certificate (CF-6R-ENV-01).

Field Inspection

The field inspector will verify that the windows and other fenestration products installed have performance characteristics that are documented on the temporary NFRC labels and that comply with the U-factor and SHGC used in the compliance documentation, including the CF-6R-ENV-01. All fenestration products must have a temporary label indicating U-factor, SHGC, and air infiltration rate (only field-fabricated products are exempt from labeling requirements).

The field inspector will compare the actual installed glass area with the glass area indicated on the CF-6R-ENV-01 and with the maximum allowed glass areas indicated on the CF-1R-ALT. If more glass is installed, then the appropriate action depends on the compliance approach. If the prescriptive method was used, the glass area must not exceed the prescriptive limit (20 percent of floor area and in some climates a separate 5 percent west-facing limit). If the performance approach was used, then the compliance calculations must be redone to demonstrate compliance with the higher glass area.

Window Replacement Permit Application

Effective January 1, 2010

SITE ADDRESS:_____

APN:_____–_____–_____

OWNER:_____

ADDRESS:_____

PHONE NUMBER: _____

PROJECT VALUE: _____

WINDOW MANUFACTURER: _____

WINDOW MODEL/STYLE: _____

PROPOSED WINDOW U-FACTOR : _____ PROPOSED WINDOW SHGC:_____

Sq. Ft. of WINDOW AREA :_____ PERCENT OF FLOOR AREA:_____

WEST WINDOW AREA:_____ PERCENT OF FLOOR AREA:_____

ADDITIONAL INFORMATION:

_____

_____

_____

_____

I, the installer of the fenestration at the location listed above, certify the materials noted above shall be installed in accordance with the manufacturer's listing and as required by the California Building Code and California Residential Code.

_____

INSTALLER NAME: _____

INSTALLER ADDRESS: _____

_____

PHONE NUMBER: _____

LICENSE NUMBER:

_____ _____

SIGNATURE DATE