The 2019 Energy Code includes requirements for alterations and additions affecting fenestration, including windows, skylights and exterior doors that include glass.

The Energy Code Prescriptive relative solar heat gain and visible transmittance (VT) requirements take effect when:

- More than 50 ft² of skylights are altered or added, or
- More than 150 ft² of fenestration is altered

Prescriptive fenestration U-factor requirements apply to any alterations or additions to an existing building.

For alterations, default U-factor and solar heat gain coefficient (SHGC) values in Tables 110.6-A and 110.6-B must be used when 200 ft² or more vertical site-built or skylight fenestration is replaced that does not have NFRC performance ratings. In this situation, the default performance values will not meet Prescriptive alterations requirements, and the Performance method must be used.
What Is Nonresidential Fenestration?

The 2019 Building Energy Efficiency Standards (Energy Code or Title 24, Part 6) include requirements for new construction, alterations and additions affecting fenestration, including windows, skylights, Tubular Daylighting Devices (TDD) and exterior doors that include glass.

Why?

Choosing the proper windows, glazed doors and skylights is one of the most important design decisions to ensure compliance with the Energy Code. The use of high performance fenestration can actually reduce energy consumption by decreasing the lighting and cooling loads in nonresidential and high-rise residential buildings, as well as in hotels/motels. The size, orientation and type of fenestration products can dramatically affect overall energy performance.

Relevant Code Sections

2019 California Building Energy Efficiency Standards, Title 24, Part 6:
• Section 10-111 – Certification and Labeling of Fenestration Product U-Factors, Solar Heat Gain Coefficients, Visible Transmittance and Air Leakage
• Section 110.6 – Mandatory Requirements for Fenestration Products and Exterior Doors
• Section 140.3 – Prescriptive Requirements for Building Envelopes
• Nonresidential Reference Appendix NA6 – Alternate Default Fenestration Procedure to Calculate Thermal Performance
• Nonresidential Reference Appendix NA7.4 – Installation and Acceptance Requirements for Nonresidential Buildings and Covered Processes - Building Envelope Acceptance Tests

Relevant Compliance Forms

• NRCC-ENV-E: Envelope Component Approach
• NRCI-ENV-01-E: Certification of Installation – Envelope
• NRCA-ENV-02-F: Fenestration Acceptance (required only for site-built fenestration)

Compliance Requirements

Fenestration requirements apply to new construction, alterations and additions. There are both Prescriptive and Performance compliance approaches for demonstrating compliance with the Energy Code. Requirements vary by the type and area of fenestration in the project, as well as by Climate Zone. This fact sheet provides information on how to assess your project type, whether your project can use the Prescriptive or Performance approach, and the code requirements for each.

Assessing Your Project: Applicable Prescriptive Requirements

To meet Prescriptive fenestration requirements, products may require features such as thermally-broken, double-paned windows with spectrally selective “low-e” coatings.

Newly Constructed

Newly constructed projects are newly constructed buildings or buildings that have never been occupied. The Energy Code places Prescriptive limits on window glazing and skylight area and defines minimum performance requirements.

For newly constructed projects, the following Prescriptive requirements for fenestration performance must be met:
• U-factor, solar heat gain coefficient (SHGC) and visible transmittance (VT) performance requirements – the fenestration performance can be determined by a variety of methods (see Table 2) (note that the area-weighted U-factor, SHGC and VT must meet Prescriptive requirements)
• Window area cannot exceed 40% of gross exterior wall area or 6 feet times the display perimeter (note that fenestration in demising walls is not included in the window-to-wall ratio)
• West-facing window area cannot exceed 40% of west-facing exterior wall area or 6 feet times the display area
• Skylight area cannot exceed 5% of gross roof area or 10% of roof area for spaces with high ceilings (note that skylights over unconditioned spaces, such as atria, do not count towards the daylight-to-roof ratio (DRR) limit)
• Sufficient fenestration area provides daylighting coverage to at least 75% of floor area, for both conditioned and unconditioned spaces over 5,000 ft² that are directly under a roof and have ceiling heights taller than 15 feet
If any of these Prescriptive requirements cannot be met, the Performance approach must be used to demonstrate compliance.

**TIP:** For the daylit area requirement in spaces with high ceilings, it is important to layout multiple skylights in an arrangement so that the skylight daylit zones of adjacent skylights do not overlap. For most spaces with high ceilings, daylight coverage can be achieved with a DRR of 3%-4%. Larger skylight areas may meet the daylighting requirement, but could result in excessive solar heat gain. The Energy Code now requires that the skylight area be at least 3% of the daylit floor area to ensure that there is adequate daylight for dimming.

### Additions

Fenestration products installed in additions trigger different U-factor requirements than those in alterations and trigger the following new construction requirements for fenestration performance:

- U-factor must meet the requirements of Table 140.3-B, 140.3-C or 140.3-D
- Window-to-wall ratio (WWR) and SRR Prescriptive limits must be met
- Skylights serving spaces over 5,000 ft² with ceiling heights above 15 feet trigger the minimum skylit and sidelit daylit area requirement in Section 140.3(c)

<table>
<thead>
<tr>
<th></th>
<th>Fixed Window</th>
<th>Operable Window</th>
<th>Curtainwall / Storefront</th>
<th>Glazed Door</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max U-factor</td>
<td>0.36</td>
<td>0.46</td>
<td>0.41</td>
<td>0.45</td>
</tr>
<tr>
<td>Max RSHGC</td>
<td>0.25</td>
<td>0.22</td>
<td>0.26</td>
<td>0.23</td>
</tr>
<tr>
<td>Min VT</td>
<td>0.42</td>
<td>0.32</td>
<td>0.46</td>
<td>0.17</td>
</tr>
<tr>
<td>Glass, Curb Mounted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glass, Deck Mounted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plastic, Curb Mounted</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tubular Daylighting Devices (TDD)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skylight</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max U-factor</td>
<td>0.58</td>
<td>0.46</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td>Max SHGC</td>
<td>0.25</td>
<td>0.25</td>
<td>NR</td>
<td>NR</td>
</tr>
<tr>
<td>Min VT</td>
<td>0.49</td>
<td>0.49</td>
<td>0.64</td>
<td>0.38</td>
</tr>
</tbody>
</table>

*Table 1 – Fenestration Performance Requirements: New Construction and Additions*

### Alterations

Prescriptive relative solar heat gain and VT requirements take effect when:

- More than 50 ft² of skylights are altered or added, or
- More than 150 ft² of fenestration is altered

Prescriptive fenestration U-factor requirements apply to any alterations or additions to an existing building.

Alterations (replacements) of fenestration trigger Prescriptive U-factor requirements by Climate Zone (CZ) shown in Table 2.

<table>
<thead>
<tr>
<th>CZ 3, 5</th>
<th>CZ 1, 16</th>
<th>All Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-factor</td>
<td>0.58</td>
<td>0.47</td>
</tr>
<tr>
<td>SHGC</td>
<td>0.41</td>
<td>0.41</td>
</tr>
<tr>
<td>VT</td>
<td>Same as New Construction Requirement</td>
<td></td>
</tr>
</tbody>
</table>

*Table 2 – Vertical Fenestration Performance Requirements: Alterations*
For alterations, default U-factor and SHGC values in Tables 110.6-A and 110.6-B must be used when 200 ft² or more vertical site-built or skylight fenestration is replaced that does not have NFRC performance ratings. When vertical site-built or skylight fenestration area is less than 200 ft², the U-factor and SHGC may be calculated using the Center of Glass (COG) rating from the manufacturer, using the relevant equation as set forth in Nonresidential Reference Appendix NA6.

Alternative Compliance for VT Requirement

An alternative method of demonstrating Prescriptive compliance is to show that the VT is at least 0.11/WWR, where WWR is the window area to gross wall area ratio for the entire building. This enables buildings with higher WWR to meet the Prescriptive standards with a lower VT value, since the VT requirement is tied to using daylighting potential. Note that the Prescriptive VT requirement is an area weighted average. For example, a façade that has high VT windows high along the wall for daylighting, combined with lower VT windows low along the wall is acceptable, provided that the window area-weighted VT meets the minimum Prescriptive requirement.

Mandatory Requirements for Certifying Fenestration Products

Fenestration products with spectrally selective (“low-e”) coatings are now available that provide lower SHGC and meet the VT value requirement.

Site-Built Fenestration

Site-built fenestration areas less than 200 ft² may use values based on glazing type and framing type and equations in Nonresidential Reference Appendix NA6. Fenestration areas of 200 ft² or more must use the default U-factor and SHGC default values in Tables 110.6-A and 110.6-B of the Energy Code or be NFRC rated. Note that the default values for the listed glazing and framing types will not meet Prescriptive requirements, so the Performance approach must be used in these situations.

<table>
<thead>
<tr>
<th>Method</th>
<th>Manufac-tured Windows</th>
<th>Manufac-tured Skylights</th>
<th>Site-Built Fenestration (windows, skylights)</th>
<th>Field-Fabricated Fenestration</th>
<th>Glass Block</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFRC-Certified Products</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>NFRC Component Modeling Approach (CMA)</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Tables 110.6-A &amp; 110.6-B</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Nonresidential Reference Appendix NA6</td>
<td>No</td>
<td>No</td>
<td>Yes*</td>
<td>No</td>
<td>No</td>
</tr>
</tbody>
</table>

* Applicable only for site-built fenestration with total area < 200 ft².

Table 3 – Methods for Determining Fenestration Performance

Using NFRC Ratings

NFRC has two rating methods:
1. The traditional method is commonly used in most residential products and in many commercial products such as punched opening products or custom products that will be made only once.
2. The Component Modelling Approach (CMA) is implemented in software named CMAST and is only available 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.
   - 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:
     - The whole product ratings are calculated at the time of certification by the simulation lab and already labeled before the product is shipped
     - The whole product ratings are calculated for a specific project with a specific insulating glass unit by an Accredited Calculation Entity (ACE) at the time the project is needed
Forms – Which & When

In addition to a Permit, you will need the following.

**During Design:**
- **NRCC-ENV-E:** Envelope Component Approach Table K. Fenestration and Glazed Door Schedule
  - Document thermal performance of fenestration construction (U-factor, SHGC, VT)
  - Completed and signed by the design professional

**Why?** To document all fenestration (windows and skylights) specified on plans that will be installed in the building. If some fenestration products do not meet Prescriptive requirements on their own, this table must be completed to show that the area-weighted average U-factor, SHGC and VT comply.

**During Construction:**
- **NRCA-ENV-01-E:** Envelope Certificate of Installation
  - Completed and signed by the installing contractor
- **NRCA-ENV-02-F:** Fenestration Acceptance
  - Completed and signed by the installing contractor

**Why?** To verify that the field installation meets code and matches information on the certification of compliance documents. Documentation of NFRC certificates is field verified and, where applicable, special procedures for verification of window films or electrochromic glazing must be followed and documented on this form.
For More Information

Primary Documents

- Energy Code Section 10-111 – Certification and Labeling of Fenestration Product U-Factors, Solar Heat Gain Coefficients, Visible Transmittance and Air Leakage:

- Energy Code Section 110.6 – Mandatory Requirements for Fenestration Products and Exterior Doors:

- Energy Code Section 140.3 – Prescriptive Requirements for Building Envelopes:

- Energy Code Nonresidential Reference Appendix NA6 – Alternate Default Fenestration Procedure to Calculate Thermal Performance:


- Energy Code Nonresidential Compliance Manual Section 3.2 – Building Envelope:

California Energy Commission Information & Services

- Energy Code Hotline: 1-800-772-3300 (Free) or Title24@energy.ca.gov

- Online Resource Center:
  www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/online-resource-center
  – The Energy Commission’s main web portal for the Energy Code, including information, documents and historical information

Additional Resources

- National Fenestration Rating Council (NFRC):
  nfrc.org/

- Component Modeling Approach (CMA):
  nfrc.org/CMA/default.aspx
  – To help select windows with the desired energy performance for institutional projects

- Energy Code Ace:
  EnergyCodeAce.com
  – An online “one-stop-shop” providing free resources and training to help appliance and building industry professionals decode and comply with Title 24, Part 6 and Title 20. The site is administered by California’s investor-owned utilities.

Of special interest:

- Trigger Sheet
  energycodeace.com/content/resources-ace/file_type=trigger-sheet
  – Nonresidential Fenestration 2019

- Application Guides
  energycodeace.com/content/resources-ace/file_type=application-guide
  – Nonresidential Envelope and Solar Ready 2019

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