There are four acceptable methods for determining SHGC for use with the Standards (see Table 3-8). The preferred methods are two NFRC procedures:

1. NFRC 200 for manufactured fenestration, which includes manufactured skylights; and NFRC 100 for site-built fenestration, which includes site-built skylights. The NFRC standard for rating the SHGC of tubular daylighting devices (TDDs or tubular skylights) is appropriate only for attic configurations where the insulation layer is directly on top of the ceiling.

2. For spaces with insulated roofs, use the NFRC or default rating of the top dome only.

3. A third method is to use the SHGC Defaults from Standards Table 116-B or (see Table 3-7). These values are on the high side and do not account for special coatings and other technologies that may be part of a proposed fenestration product.

Table 3-7 – Standards Table 116-B Default Fenestration Product SHGC

<table>
<thead>
<tr>
<th>FRAME TYPE</th>
<th>PRODUCT</th>
<th>GLAZING</th>
<th>TOTAL WINDOW SHGC</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>SINGLE PANE</td>
<td>DOUBLE-PANE</td>
<td>GLASS BLOCK¹</td>
<td></td>
</tr>
<tr>
<td>Metal</td>
<td>Operable</td>
<td>Clear</td>
<td>0.80</td>
<td>0.70</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
<td>Clear</td>
<td>0.8</td>
<td>0.73</td>
<td>0.73</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operable</td>
<td>Tinted</td>
<td>0.67</td>
<td>0.59</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
<td>Tinted</td>
<td>0.68</td>
<td>0.60</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Metal, Thermal Break</td>
<td>Operable</td>
<td>Clear</td>
<td>N/A.</td>
<td>0.63</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
<td>Clear</td>
<td>N/A.</td>
<td>0.69</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operable</td>
<td>Tinted</td>
<td>N/A.</td>
<td>0.53</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
<td>Tinted</td>
<td>N/A.</td>
<td>0.57</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td>Nonmetal</td>
<td>Operable</td>
<td>Clear</td>
<td>0.74</td>
<td>0.65</td>
<td>0.70</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
<td>Clear</td>
<td>0.76</td>
<td>0.67</td>
<td>0.67</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operable</td>
<td>Tinted</td>
<td>0.60</td>
<td>0.53</td>
<td>N/A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fixed</td>
<td>Tinted</td>
<td>0.63</td>
<td>0.55</td>
<td>N/A</td>
<td></td>
</tr>
</tbody>
</table>

1. Translucent or Transparent panels shall use glass block values.

The fourth method, applicable only to skylights and site-built fenestration in buildings with less than 10,000 ft² of site-built fenestration, is to use Equation NA6-2 in the Reference Nonresidential Appendix NA6. This equation calculates an overall SHGC for the fenestration (SHGCₜ) assuming a default framing factor and using the center-of-glass SHGC value (SHGC₀) for the glazing from the manufacturer’s literature.

Note: Buildings that have 10,000 ft² or more of site-built fenestration cannot use the Alternative Default Fenestration Procedure, Equation NA6-1 or NA6-2.

Windows are not allowed SHGC credit for any interior shading such as draperies or blinds. Only exterior shading devices such as shade screens permanently attached to the building or structural components of the building can be modeled through performance standards compliance. Manually operable shading devices cannot be modeled. Only overhangs can be credited using the relative solar heat gain procedure for prescriptive compliance.
### Table 3-8 – Methods for Determining SHGC

<table>
<thead>
<tr>
<th>SHGC Determination Method</th>
<th>Manufactured Windows</th>
<th>Manufactured Skylights</th>
<th>Site-Built Fenestration</th>
<th>Field-Fabricated Fenestration</th>
</tr>
</thead>
<tbody>
<tr>
<td>NFRC 100</td>
<td>----</td>
<td>----</td>
<td>✓</td>
<td>----</td>
</tr>
<tr>
<td>NFRC 200</td>
<td>✓</td>
<td>✓ (Note 3)</td>
<td>---</td>
<td>----</td>
</tr>
<tr>
<td>Default SHGC values from Standards Table 116-B</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Alternate Default SHGC factor equation from Reference Nonresidential Appendix NA6 (^1,2)</td>
<td>----</td>
<td>✓</td>
<td>✓</td>
<td>----</td>
</tr>
<tr>
<td>Component Modeling Approach (CMA)(^4)</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>----</td>
</tr>
</tbody>
</table>

1. The default SHGC factors from Nonresidential Reference Nonresidential Appendix NA6 may also be used for site-built skylights. Non rated manufactured skylights must use default values.
2. The default SHGC factors from Reference Joint Appendix NA6 may be used only for site-built fenestration in buildings having less than 10,000 ft\(^2\) of site-built fenestration area. Non rated manufactured fenestration must use default values.
3. Tubular Daylight Device SHGC rating is appropriate only for insulated ceilings.
4. CMA can be used for site-built and manufactured fenestration regardless of building square footage.

### 3.2.9 Determining Visible Transmittance (VT)

Visible Transmittance (VT) is a property of glazing materials that has a varying relationship to SHGC. VT is the ratio of light that passes through the glazing material to the light that is incident on the outside of the glazing. Light is the portion of solar energy that is visible to the human eye. VT is an important characteristic of glazing materials, because it affects the amount of daylight that enters the space and how well views through windows are rendered. Glazing materials with a very low VT have little daylighting benefit and views appear dark, even on bright days. The ideal glazing material for most of California’s summer climates would have a high VT and a low SHGC. Such a glazing material would allow solar radiation in the visible spectrum to pass while blocking radiation in the infrared and ultraviolet spectrums. Materials that have this quality are labeled “spectrally selective” and have a VT that is 20 percent or so higher than the SHGC. Higher VT can result in energy savings in lighting systems. The value of VT for a given material is found in the manufacturer’s literature.
The visible light transmittance is used in the calculation of the effective aperture of daylighting systems and daylighting control power adjustment factors. This is discussed in more detail in Chapter 5 of this manual.

### 3.2.10 Site-Built Fenestration Roles and Responsibilities

Manufactured fenestration products are factory-assembled as a unit, and the manufacturer is able to assume the responsibility of testing or using CMA and labeling. However, with site-built fenestration, multiple parties are responsible. Architects and/or engineers design the basic glazing system by specifying the components, the geometry of the components, and sometimes, the method of assembly. An extrusion manufacturer provides the mullions and frames that support the glazing and is responsible for thermal breaks. A glazing manufacturer provides the glazing units, cut to size and fabricated as insulated glass (IG) units. The glazing manufacturer is responsible for tempering or heat strengthening, the tint of the glass, any special coatings, the spacers, and the sealants. A glazing contractor (usually a subcontractor to the general contractor) puts the system together at the construction site or their shop and is responsible for many quality aspects. Predetermining the energy performance of site-built fenestration as a system is more challenging than for manufactured units.

One of the parties or specifiers (architect, glazing contractor, extrusion manufacturer, IG fabricator, or glass manufacturer) must take responsibility for testing and labeling of the site-built fenestration or manufactured system under the most recent NFRC 100 and NFRC 200 procedure. The responsible party must obtain a label certificate as described in Section 3.2.1.

It is typical for the glazing contractor to assume responsibility for the team and to coordinate the certification and labeling process. A common procedure is for the design team to include language in the contract with the general contractor that requires that the general contractor be responsible; the general contractor typically assigns this responsibility to the glazing contractor, once the responsible party has established a relationship with an NFRC by using CMA.
It is not necessary to complete the NFRC testing and labeling prior to completing the compliance documentation and filing the building permit application. CMA has the capability to produce a pre-bid report that can be submitted along with the energy compliance documentation. However, plans examiners should verify that the fenestration performance shown in the plans and specifications and used in the compliance calculations is “reasonable” and achievable. This requires some judgment and knowledge on the part of the plans examiner. Generally, designers will know the type of glass that they plan to use and whether or not the frame has a thermal break or is thermally improved. This information is adequate to consult the default values for U-factor and SHGC in Nonresidential Reference Nonresidential Appendix NA6 or CMA’s pre-bid report. If the values used for compliance are within 5 percent of the Reference Nonresidential Appendix NA6 values, then the values may be considered reasonable for plan check. If the compliance values are outside the 5 percent range, the plans examiner should request information from the designers to justify the proposed values.

After the construction contract is awarded, the glazing contractor or other appropriate party assumes responsibility for acquiring the NFRC Label Certificate using CMA or using NFRC 100SB. Each label certificate has the same information as the NFRC temporary label for manufactured products, but includes other information specific to the project such as the name of the glazing manufacturer, component information such as, frames, spacers and glass and Certified product Directory ID number, the places in the building where the product line is used, and other details. The label certificate remains on file in the construction office for the building inspector to view. The installer verifies the accuracy of the NFRC Label Certificate against the plans specifications and purchase orders when Acceptance is completed. After construction is complete, the label certificate should be filed in the building office with the as-built drawings and other operations and maintenance data. This will give building managers the information needed for future repairs or replacements.

Example 3-5

Question
A designer is using a U-factor of 0.57 for compliance with a curtain wall system. The glazing system uses two lites of 1/4 in (6mm) glass with a low-e=0.1 coating on the second surface. The air gap is 1/2 in (12 mm). A standard metal frame is proposed for the curtain wall system. Is 0.57 a reasonable U-factor for compliance, and can it reasonably be achieved by the glazing contractor through the NFRC process for site-built fenestration?

Answer
The default U-factor for this glazing combination from Nonresidential Reference Appendix NA6 is 0.59. The proposed factor of 0.57 is within 5 percent and should be considered reasonable.

Example 3-6

Question
The envelope and space conditioning system of an office building with 120,000 ft² of conditioned floor area is being altered. The building has 24,000 ft² of vertical fenestration. Which of the following scenarios does the NFRC label certificate requirement apply to?
1. Existing glazing remains in place during the alteration.

2. Existing glazing is removed, stored during the alteration period and then re-installed (glazing is not altered in any way).

3. Existing glazing is removed and replaced with new site-built glazing with the same dimensions and performance specifications.

4. Existing glazing on the north façade (total area 6000 ft²) is removed and replaced with site-built fenestration.

**Answer**

NFRC label certificate or California Energy Commission default values requirements do not apply to scenarios 1 and 2 but do apply to scenario 3.

1. Requirement does not apply because the glazing remains unchanged and in place.

2. *Exception* to §116(a)1 applies in this case (this exception applies to fenestration products removed and reinstalled as part of a building alteration or addition).

3. Use either NFRC Label Certificate or use Table 116-A default values; applies in this case as 24,000 ft² (more than the threshold value of 10,000 ft²) of new fenestration is being installed.

4. Since the site-built fenestration area is less than 10,000 ft², use either NFRC label certificate, the applicable default U-factor and SHGC set forth in Nonresidential Reference Appendix NA6, or California Energy Commission default values.

### 3.3 Opaque Envelope Insulation

The requirements for opaque surfaces include both mandatory measures and prescriptive requirements.

Sloping surfaces are considered either a wall or a roof, depending on their slope (see Figure 3-10). If the surface has a slope of less than 60° from horizontal, it is considered a roof; a slope of 60° or more is a wall. This definition extends to fenestration products, including the windows in walls and any skylights in roofs.

![Figure 3-10 – Slope of a Wall or Window (Roof or Skylight slope is less than 60°)](image)

The window is considered part of the wall because the slope is over 60°. Where the slope less than 60°, the glazing indicated as a window would be a skylight.
3.3.1 Mandatory Measures

Certification of Insulation Materials

§118(a)

The California Quality Standards for Insulating Materials ensure that insulation sold or installed in the state performs according to the stated R-value and meets minimum quality, health, and safety standards.

Manufacturers must certify that insulating materials comply with California Quality Standards for Insulating Materials (CCR, Title 24, Part 12, Chapters 12-13), which ensure that insulation sold or installed in the state performs according to stated R-values and meets minimum quality, health, and safety standards. Builders may not install insulating materials, unless the product has been certified by the Department of Consumer Affairs, Bureau of Home Furnishing and Thermal Insulation. Builders and enforcement agencies shall use the Department of Consumer Affairs Directory of Certified Insulation Material to verify the certification of the insulating material. The Standards no longer allow using the R-value of the cavity or continuous insulation to demonstrate compliance with the insulation values of the Reference Joint Appendix JA4; only U-factors may be used to demonstrate compliance. The stated R-values for insulation are nominal values and cannot be used for compliance purposes; the U-factors represent the actual thermal conductance of the assembly, including air film coefficients and all layers used to construct the assembly. If an insulating product is not listed in the most recent edition of the directory, contact the Department of Consumer Affairs, Bureau of Home Furnishing and Thermal Insulation Program, at (916) 574-2041.

Urea Formaldehyde Foam Insulation

§118(b)

The mandatory measures restrict the use of urea formaldehyde foam insulation. The restrictions are intended to limit human exposure to formaldehyde, which is a volatile organic chemical known to be harmful to humans.

If foam insulation is used that has urea formaldehyde, it must be installed on the exterior side of the wall (not in the cavity of framed walls), and a continuous barrier must be placed in the wall construction to isolate the insulation from the interior of the space. The barrier must be 4-mil (0.1 mm) thick polyethylene or equivalent.

Flamespread Rating

§118(c)

The California Quality Standards for Insulating Materials also require that all exposed installations of faced mineral fiber and mineral aggregate insulations use fire retardant facings that have been tested and certified not to exceed a flame spread of 25 and a smoke development rating of 450. Insulation facings that do not touch a ceiling, wall, or floor surface, and faced batts on the