

## SECTION 116 – MANDATORY REQUIREMENTS FOR FENESTRATION PRODUCTS AND EXTERIOR DOORS

(a) **Certification of Fenestration Products and Exterior Doors other than Field-fabricated.** Any fenestration product and exterior door, other than field-fabricated fenestration products and field-fabricated exterior doors, may be installed only if the manufacturer has certified to the commission, or if an independent certifying organization approved by the commission has certified, that the product complies with all of the applicable requirements of this subsection.

1. **Air leakage.** Manufactured fenestration products and exterior doors shall have air infiltration rates not exceeding 0.3 cfm/ft.<sup>2</sup> of window area, 0.3 cfm/ft.<sup>2</sup> of door area for residential doors, 0.3 cfm/ft.<sup>2</sup> of door area for nonresidential single doors (swinging and sliding), and 1.0 cfm/ft.<sup>2</sup> for nonresidential double doors (swinging), when tested according to NFRC-400 or ASTM E 283 at a pressure differential of 75 pascals or 1.57 pounds/ft.<sup>2</sup>, incorporated herein by reference.
2. **U-factor.** A fenestration product's U-factor shall be rated in accordance with NFRC 100, or the applicable default U-factor set forth in TABLE 116-A.

**EXCEPTION to Section 116 (a) 2:** If the fenestration product is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration or is a skylight, the default U-factor may be the applicable U-factor as set forth in the ~~Nonresidential ACM Manual~~ [Reference Joint Appendices](#).

3. **SHGC.** A fenestration product's SHGC shall be rated in accordance with NFRC 200, or NFRC 100 for site-built fenestration, or the applicable default SHGC set forth in TABLE 116-B.

**EXCEPTION to Section 116 (a) 3:** If the fenestration product is site-built fenestration in a building covered by the nonresidential standards with less than 10,000 square feet of site-built fenestration or is a skylight, the default SHGC may be calculated according to Equation 116-A.

*EQUATION 116-A DEFAULT SHGC CALCULATION (SUBJECT TO ABOVE EXCEPTION)*

$$SHGC_t = 0.08 + 0.86 \times SHGC_c$$

### WHERE

- SHGC<sub>feint</sub> = The solar heat gain coefficient for the fenestration including glass and frame.
- SHGC<sub>c</sub> = The center of glass solar heat gain coefficient for the glass alone as documented in the glazing manufacturer's literature. Documentation shall be provided as specified in the Nonresidential ACM Manual.

4. **Labeling.** Fenestration products shall:
  - A. Have a temporary label (or label certificate for site-built fenestration) meeting the requirements of Section 10-111 (a) 1, not to be removed before inspection by the enforcement agency, listing the certified U-factor and SHGC, and certifying that the air leakage requirements of Section 116 (a) 1 are met for each product line; and
  - B. Have a permanent label (or label certificate for site-built fenestration) meeting the requirements of Section 10-111 (a) 2 if the product is rated using NFRC procedures.

**EXCEPTION to Section 116 (a):** Fenestration products removed and reinstalled as part of a building alteration or addition.

(b) **Installation of Field-fabricated Fenestration and Exterior Doors.** Field-fabricated fenestration and field-fabricated exterior doors may be installed only if the compliance documentation has demonstrated compliance for the installation using U-factors from TABLE 116-A and SHGC values from TABLE 116-B. Field-fabricated fenestration and field-fabricated exterior doors shall be caulked between the fenestration products or exterior door and the building, and shall be weatherstripped. ~~Buildings with 10,000 or more square feet of vertical glazing shall have no more than 1,000 square feet of field-fabricated fenestration.~~

**EXCEPTION to Section 116 (b):** Unframed glass doors and fire doors need not be weatherstripped or caulked.

TABLE 116-A DEFAULT FENESTRATION PRODUCT U-FACTORS

FRAME TYPE <sup>1</sup>	PRODUCT TYPE	SINGLE PANE U-FACTOR	DOUBLE PANE U-FACTOR <sup>2</sup>	GLASS BLOCK U-FACTOR <sup>1</sup>
Metal	Operable	1.28	0.79	<u>N.a.</u>
<del>Metal</del>	Fixed	1.19	0.71	<u>N.a.</u>
<del>Metal</del>	Greenhouse/garden window	2.26	1.40	<u>N.a.</u>
<del>Metal</del>	Doors	1.25	0.77	<u>N.a.</u>
<del>Metal</del>	Skylight	1.98	1.3	<u>N.a.</u>
	<u>Glass Block</u>	<u>N.a.</u>	<u>N.a.</u>	<u>0.72</u>
Metal, Thermal Break	Operable	N.a	0.66	<u>N.a.</u>
<del>Metal, Thermal Break</del>	Fixed	N.a	0.55	<u>N.a.</u>
<del>Metal, Thermal Break</del>	Greenhouse/garden window	N.a	1.12	<u>N.a.</u>
<del>Metal, Thermal Break</del>	Doors	N.a	0.59	<u>N.a.</u>
<del>Metal, Thermal Break</del>	Skylight	N.a	1.11	<u>N.a.</u>
	<u>Glass Block</u>	<u>N.a.</u>	<u>N.a.</u>	<u>0.72</u>
Nonmetal	Operable	0.99	0.58	<u>N.a.</u>
<del>Nonmetal</del>	Fixed	1.04	0.55	<u>N.a.</u>
<del>Nonmetal</del>	Doors	0.99	0.53	<u>N.a.</u>
<del>Nonmetal</del>	Greenhouse/garden windows	1.94	1.06	<u>N.a.</u>
<del>Nonmetal</del>	Skylight	1.47	0.84	<u>N.a.</u>
	<u>Glass Block</u>	<u>N.a.</u>	<u>N.a.</u>	<u>0.57</u>

<sup>1</sup>Metal includes any field fabricated product with metal cladding. Nonmetal framed manufactured fenestration products with metal cladding must add 0.04 to the listed U factor. Nonmetal frame types can include metal fasteners, hardware, and door thresholds. Thermal break product design characteristics are:

a.— The material used as the thermal break must have a thermal conductivity of not more than 3.6 Btu inch/hr/ft<sup>2</sup>/°F,

b.— The thermal break must produce a gap of not less than 0.210 inch, and

c.— All metal members of the fenestration product exposed to interior and exterior air must incorporate a thermal break meeting the criteria in Items a and b above.

In addition, the fenestration product must be clearly labeled by the manufacturer that it qualifies as a thermally broken product in accordance with this standard. Thermal break values shall not apply to field fabricated fenestration products.

<sup>2</sup>For all dual glazed fenestration products, adjust the listed U factors as follows:

a.— Subtract 0.05 for spacers of 7/16 inch or wider.

b.— Subtract 0.05 for products certified by the manufacturer as low E glazing.

c.— Add 0.05 for products with dividers between panes if spacer is less than 7/16 inch wide.

d.— Add 0.05 to any product with true divided lite (dividers through the panes).

TABLE 116-B DEFAULT SOLAR HEAT GAIN COEFFICIENT (SHGC)

FRAME TYPE	PRODUCT	GLAZING	TOTAL WINDOW SHGC <sup>2</sup>	
			Single Pane	Double Pane
Metal	Operable	Clear	0.80	0.70
<del>Metal</del>	Fixed	Clear	0.83	0.73
<del>Metal</del>	Operable	Tinted	0.67	0.59
<del>Metal</del>	Fixed	Tinted	0.68	0.60
Metal, Thermal Break	Operable	Clear	N.a	0.63
<del>Metal, Thermal Break</del>	Fixed	Clear	N.a	0.69
<del>Metal, Thermal Break</del>	Operable	Tinted	N.a.	0.53
<del>Metal, Thermal Break</del>	Fixed	Tinted	N.a.	0.57

Nonmetal	Operable	Clear	0.74	0.65
<del>Nonmetal</del>	Fixed	Clear	0.76	0.67
<del>Nonmetal</del>	Operable	Tinted	0.60	0.53
<del>Nonmetal</del>	Fixed	Tinted	0.63	0.55
<sup>2</sup> <del>SHGC – Solar Heat Gain Coefficient.</del>				

## SECTION 117 – MANDATORY REQUIREMENTS FOR JOINTS AND OTHER OPENINGS

Joints and other openings in the building envelope that are potential sources of air leakage shall be caulked, gasketed, weatherstripped, or otherwise sealed to limit infiltration and exfiltration.

## SECTION 118 – MANDATORY REQUIREMENTS FOR INSULATION AND COOL ROOFS

- (a) **Certification by Manufacturers.** Any insulation of the type and form listed [below in Table 118-A](#) may be installed only if the manufacturer has certified that the insulation complies with the California Code of Regulations, Title 24, Part 12, Chapter 12-13, Standards for Insulating Material.
- (b) **Installation of Urea Formaldehyde Foam Insulation.** Urea formaldehyde foam insulation may be applied or installed only if:
1. It is installed in exterior side walls; and
  2. A four-mil-thick plastic polyethylene vapor barrier or equivalent plastic sheeting vapor barrier is installed between the urea formaldehyde foam insulation and the interior space in all applications.
- (c) **Flamespread Rating.** All insulating material shall be installed in compliance with the flamespread rating and smoke density requirements of the CBC.
- (d) **Installation of Insulation in Existing Buildings.** Insulation installed in an existing attic, or on an existing duct or water heater, shall comply with the applicable requirements of this subsection. If a contractor installs the insulation, the contractor shall certify to the customer, in writing, that the insulation meets the applicable requirements of this subsection.
1. **Attics.** If insulation is installed in the existing attic of a low-rise residential building, the R-value of the total amount of insulation (after addition of insulation to the amount, if any, already in the attic) shall be at least R-38 in climate zones 1 and 16; and R-30 in all other climate zones.  
**EXCEPTION to Section 118 (d) 1:** Where the accessible space in the attic is not large enough to accommodate the required R-value, the entire accessible space shall be filled with insulation provided such installation does not violate Section 1505.3 of Title 24, Part 2.
  2. **Water heaters.** If external insulation is installed on an existing unfired water storage tank or on an existing back-up tank for a solar water-heating system, it shall have an R-value of at least R-12, or the heat loss of the tank surface based on an 80°F water-air temperature difference shall be less than 6.5 Btu per hour per square foot.
  3. **Ducts.** If insulation is installed on an existing space-conditioning duct, it shall comply with Section 605 of the CMC.
- (e) **Placement of roof/ceiling insulation.** Insulation installed to limit heat loss and gain through the top of conditioned spaces shall comply with the following:
1. Insulation shall be installed in direct contact with a continuous roof or ceiling which is sealed to limit infiltration and exfiltration as specified in Section 117, including but not limited to placing insulation either above or below the roof deck or on top of a drywall ceiling; and
  2. When insulation is installed at the roof in nonresidential buildings, fixed vents or openings to the outdoors or to unconditioned spaces shall not be installed and the space between the ceiling and the roof is either directly or indirectly conditioned space and shall not be considered an attic for the purposes of complying with CBC attic ventilation requirements; and

3. Insulation placed on top of a suspended ceiling with removable ceiling panels shall be deemed to have no effect on envelope heat loss; and

**EXCEPTION to Section 118(e) 3:** When there are conditioned spaces with a combined floor area no greater than 2,000 square feet in an otherwise unconditioned building, and when the average height of the space between the ceiling and the roof over these spaces is greater than 12 feet, insulation placed in direct contact with a suspended ceiling with removable ceiling panels shall be an acceptable method of reducing heat loss from a conditioned space and shall be accounted for in heat loss calculations.

4. Insulation shall be installed below the roofing membrane or layer used to seal the roof from water penetration unless the insulation has a maximum water absorption of 0.3 percent by volume when tested according to ASTM Standard C 272.

**NOTE:** Vents, which do not penetrate the roof deck, that are designed for wind resistance for roof membranes are not within the scope of Section 118 (e) 2.

- (f) **Demising Walls in Nonresidential Buildings.** The opaque portions of framed demising walls in nonresidential buildings shall be insulated with an installed R-value of no less than R-13 between framing members.
- (g) **Insulation Requirements for Heated Slab Floors.** Heated slab floors shall be insulated according to the requirements in TABLE 118-B.
  1. Insulation materials in ground contact must:
    - A. Comply with the certification requirements of Section 118 (a); and
    - B. Have a water absorption rate for the insulation material alone without facings that is no greater than 0.3% when tested in accordance with Test Method A – 24 Hour-Immersion of ASTM C272.
  2. Insulation installation must:
    - A. Cover the insulation with a solid guard that protects against damage from ultraviolet radiation, moisture, landscaping operation, equipment maintenance, and wind; and
    - B. Include a rigid plate, which penetrates the slab and blocks the insulation from acting as a conduit for insects from the ground to the structure above the foundation.
- (h) **Wet Insulation Systems.** When insulation is installed on roofs above the roofing membrane or layer used to seal the roof from water penetration, the effective R-value of the insulation shall be as specified in Appendix IV of the Joint Appendices.
- (i) **Mandatory Requirements for Cool Roofs.** In order to qualify for compliance credit as a cool roof or meet the requirements of Section 143 (a) 1 or 149 (b) 1 B, a cool roof shall be certified and labeled according to the requirements of Section 10-113 and meet conditions 1 or 2 and, for liquid applied roofing products, 3 below.
  1. Any roofing product with an initial thermal emittance greater than or equal to 0.75 when tested in accordance with CRRC-1 shall have a minimum initial solar reflectance of 0.70 when tested in accordance with CRRC-1.

**EXCEPTION to Section 118 (i) 1:** For low-rise residential buildings, concrete tile (as defined in ASTM C55) and clay tile (as defined in ASTM C1167) roofing products shall have a minimum initial thermal emittance of 0.75 and a minimum initial solar reflectance of 0.40 when tested in accordance with CRRC-1.
  2. Any roofing product with a minimum initial thermal emittance  $\epsilon_{\text{initial}}$  less than 0.75 when tested in accordance with CRRC-1, including but not limited to roof products with metallic surfaces, shall have a minimum initial solar reflectance of  $0.70 + 0.34 * (0.75 - \epsilon_{\text{initial}})$  when tested in accordance with CRRC-1.
  3. Liquid applied roof coatings applied in the field as the top surface of a roof covering shall be applied at a minimum dry mil thickness of 20 mils across the entire roof surface, and meet the minimum performance requirements listed in TABLE 118-C.

**EXCEPTION 1 to Section 118 (i) 3:** Aluminum-pigmented asphalt roof coatings shall meet the requirements of ASTM D2824 or ASTM D6848 and be installed as specified by ASTM D3805.

**EXCEPTION 2 to Section 118 (i) 3:** Cement-based roof coatings shall be applied at a minimum dry mil thickness of 30 mils when installed over a capsheet surface, 40 mils when installed over a metal surface, and 200

mils when installed over a rock or gravel surface. Cement-based roof coatings shall contain a minimum of 20% cement, and shall meet the requirements of ASTM D822.

TABLE 118-A INSULATION REQUIRING CERTIFICATION TO STANDARDS FOR INSULATING MATERIALS

TYPE	FORM
Aluminum foil	Reflective foil
Cellular glass	Board form
Cellulose fiber	Loose fill and spray applied
Mineral aggregate	Board form
Mineral fiber	Blankets, board form, loose fill
Perlite	Loose fill
Phenolic	Board form
Polystyrene	Board form, molded or extruded
Polyurethane	Board form and field applied
Polyisocyanurate	Board form and field applied
Urea formaldehyde	Foam field applied
Vermiculite	Loose fill

TABLE 118-B SLAB INSULATION REQUIREMENTS FOR HEATED SLAB-ON-GRADE

Insulation Location	Insulation Orientation	Installation Requirements	Climate Zone	Insulation R-Factor
Outside edge of heated slab, either inside or outside the foundation wall	Vertical	From the level of the top of the slab, down 16" or to the frost line, whichever is greater. Insulation may stop at the top of the footing where this is less than the required depth. For below grade slabs, vertical insulation shall be extended from the top of the foundation wall to the bottom of the foundation (or the top of the footing) or to the frost line, whichever is greater.	1 – 15	5
			16	10
Between heated slab and outside foundation wall	Vertical and Horizontal	Vertical insulation from top of slab at inside edge of outside wall down to the top of the horizontal insulation. Horizontal insulation from the outside edge of the vertical insulation extending 4 feet toward the center of the slab in a direction normal to the outside of the building in plan view.	1 – 15	5
			16	10 vertical and 7 horizontal

TABLE 118-C MINIMUM PERFORMANCE REQUIREMENTS FOR LIQUID APPLIED ROOF COATINGS

Physical Property	ASTM Test Procedure	Requirement
Initial percent elongation (break)	D 2370	Minimum 60% 0 °F (-18 °C) Minimum 200% 73 °F (23 °C)
Initial tensile strength (maximum stress)	D 2370	Minimum 100 psi (1.38 Mpa) 73 °F (23 °C) Minimum 200 psi (2.76 Mpa) 0 °F (-18 °C)
Final percent elongation (break) after accelerated weathering 1000 h	D 2370	Minimum 40% 0 °F (-18 °C) Minimum 100% 73 °F (23 °C)
Permeance	D 1653	Maximum 50 perms
Accelerated weathering 1000 h	D 4798	No cracking or checking <sup>1</sup>

<sup>1</sup> Any cracking or checking visible to the eye fails the test procedure.

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## **End Notes**

The following notes are an explanation of the changes that have been made. These notes are not part of the Standard.

<sup>1</sup> This column was added to the Table in order to include the glass block information and make it accessible to the Residential and Nonresidential sectors. Formatting changes were made to the Frame Type column(s) in Tables 116A and 116B to visually simplify the information and make table interpretation easier.