



National Fenestration Rating Council Incorporated

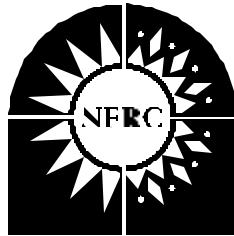
NFRC 100-SB: Procedure for Determining Site-Built Fenestration U-factors and Thermal Performance Characteristics

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National Fenestration
Rating Council

Foreword

This procedure has been developed by the National Fenestration Rating Council (NFRC) to meet the need for a uniform and accurate means for evaluating the U-factors of fenestration systems using state-of-the-art simulation procedures validated with physical testing. The U-factors established by this procedure are determined at a fixed set of environmental conditions. Consequently, the U-factors determined using this procedure may not be appropriate for directly determining seasonal energy performance.

Questions on the use of this procedure should be addressed to:

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Procedure for Determining Site-Built Fenestration System U-factors and Thermal Performance Characteristics

1.0 Purpose

To specify appropriate methods for determining the thermal transmittance (U-factor) and thermal performance characteristic of site-built fenestration systems.

Note: Reference should be made to NFRC 100 for additional terminology and procedures for the determination of thermal performance properties concerning U-factor.

The ratings derived from this procedure may be used to compare thermal performance characteristics of site-built fenestration products and/or to provide architects, code specifiers, builders, etc. with a uniform and accurate means of determining and evaluating thermal performance characteristics of a specifically designed site-built fenestration product.

2.0 Scope

- 2.1 Site-built fenestration systems covered by this method include products that are designed to be field glazed, or field assembled units comprised of specified framing and glazing components, including but not limited to:
 - 2.1.1 Transparent and translucent wall systems where the glazing material is glass, plastic or other light transmitting panels (including opaque spandrel panels within the system), except those products where no testing or calculation procedure exists;
 - 2.1.2 Glazed wall support and framing systems;
 - 2.1.3 Products of any size and design;
 - 2.1.4 Products with single or multiple glazing layers;
 - 2.1.5 Products with spacer systems between glazings;
 - 2.1.6 Horizontal, vertical and sloped systems;
 - 2.1.7 Products that, by design, may have multiple framing components and/or glazing combinations.
 - 2.1.8 Fenestration Systems using Unitized Construction, where a system is field assembled from factory assembled sub-units.
- 2.2 Systems not covered include totally opaque walls and pre-assembled or pre-glazed fenestration products (See Table 1 of NFRC 100).

3.0 Terminology

- 3.1 **Curtain Wall:** Any building wall, of any material, which carries no superimposed vertical load (a non-bearing wall).
- 3.2 **Curtain wall system:** That portion of the exterior wall which may consist entirely (or principally) of a combination of framing materials, glass and glazing, opaque in-fill and other surfacing materials supported by (or within) a framework, in varying percentages per the design of the system.
- 3.3 **Window wall:** A type of curtain wall installed between floors (or between floor and roof) that is typically composed of vertical and horizontal framing members containing operable or ventilators, fixed lights or opaque panels, or any combination thereof in varying percentages per the design of the system.
- 3.4 **Sunroom/Solarium:** A glazed envelope system that has one wall, or a portion thereof, which opens to a primary structure and remaining walls which may include a number of fenestration systems such as windows, doors, skylights, kneewalls, etc, in varying percentages per the design of the system.
- 3.5 **Structurally glazed framing:** A method of glazing where framing members are generally not exposed to the exterior. (i.e. 2-sided or 4-sided structural glazed)
- 3.6 **Thermally broken (TB) members:** System members with a minimum of 5.3 mm (0.210") separation provided by a low conductance material (where thermal conductivity $\leq 20.4 \text{ W/m}^2\cdot\text{K}$, $\leq 3.6 \text{ Btu/hr}\cdot\text{ft}^2\cdot\text{F}$) or open air space between the interior and exterior surfaces. Examples of such systems include pour and de-bridged urethane systems, crimped-in-place plastic isolator systems and pressure glazed systems with intermittent fasteners.
- Note 1: Intermittent fasteners shall be manufacturer's standard. Nominal spacing of fasteners shall be 150 mm (6 A) apart or greater.*
- Note 2: Non-metallic (i.e. wood, vinyl and fiberglass) systems qualify as thermally broken.*
- 3.7 **Thermally improved (TI) members:** System members with a separation greater than or equal to 1.6 mm (1/16") but less than 5.3 mm (0.210") separation provided by a low conductance material (where thermal conductivity $\leq 20.4 \text{ W/m}^2\cdot\text{K}$, $\leq 3.6 \text{ Btu/hr}\cdot\text{ft}^2\cdot\text{F}$) or open air space between the interior and exterior surfaces. Examples of such systems include members with exposed interior or exterior trim attached with low conductance clips.
- 3.8 **Non-thermally broken members:** System members with less than 1.6 mm (1/16") separation between metal or system members.
- 3.9 **Framing (framing members):** The structural members that support the glazing in-fill.
- 3.10 **Product Line Classification:** A distinctly defined series of site-built fenestration systems that exhibit similar heat transfer characteristics (i.e., frame U-factors). Typical site-built product lines are defined with the following characteristics: non-

thermally broken, thermally improved, thermally broken, structural glazing and/or any combination of each system.

- 3.11 **Glass/Glazing system/Glazing in-fill:** The glass, plastic or other envelope material used to enclose openings in a building created by a specific framing system(s).
- 3.12 **Outdoor Air Ventilator System (OAVA):** An assembly that allows for the exchange of air through the envelope that is an integral part of the fenestration assembly. If the OAVA area does not exceed 1.25% of the area of the glazed wall system it is considered to have the same U-factor as the glazed wall system. If the OAVA area exceeds this percentage, a separate U-factor must be determined for the OAVA and glazed wall system.
- 3.13 **Sloped glazing system:** A system that is mounted at a slope greater than 15 degrees from the vertical plane.
- 3.14 **Opaque in-fill systems:** Curtain wall systems that include opaque and/or glazing systems supported by a frame network.
- 3.15 **Site-Built Products:** Fenestration products that are designed to be field glazed or field assembled units comprised of specified framing and glazing components including: operable and fixed windows; curtain walls, window walls, storefronts, sloped glazing and skylights.

4.0 **Determining Thermal Transmittance (U-factor) for Vertical Glazed Wall Systems (Site-built), including Curtain Wall and Window Wall Components**

- 4.1 The thermal transmittance of Curtain Walls and Window Walls shall be determined in accordance with Section Part 1, Section 2.2 (Approved Total Fenestration Product U-factor Calculational Procedure) of NFRC 100. The U-factor for the fenestration product components (framing system and glazing system) shall be determined as follows:
- 4.2 Each Product Line shall have one baseline product be validated in accordance with NFRC 100, Part 1, Section 1 and 2 with the following exception:
 - 4.2.1 **Unspecified Product Sample Validation Criteria:** If the product to be used for validation purposes is not specified, then the individual product used for validation purposes shall be simulated and tested using the following criteria: The test specimen shall be constructed in such a manner as to be identical to the individual product simulated and have outside dimensions measuring 2032 mm by 2032 mm (an 80" width and an 80" height), having one vertical mullion and two glazed lites. The glazing system configuration for the validation testing shall be nominal 25mm (1") outside dimension insulating glass utilizing two lites of 6mm (1/4") clear (uncoated glass), a typical dual-sealed aluminum spacer system and air-filled. There shall be no insulation of any type applied to the test specimen during validation testing. Validation will be achieved per NFRC 100, Part 1, Section 1.6.1.1 .
 - 4.2.2 Section 4.2.1 is to be used only in those instances where the representative sample for validation purposes has not been prescribed by a specifying

authority such as an architect, project manager, engineering firm, building owner, contractor, etc.

- 4.3 For simulating and testing all other fenestration operator types other than glazed wall systems, sloped glazing and solarium/sunroom systems, model sizes shall be consistent with the sizes listed in Table 1 of NFRC 100.

5.0 Determining thermal transmittance (U-factor) for site-built skylight and sloped glazing systems

- 5.1 All sloped glazing systems shall be rated for thermal performance characteristics as noted in Section 4 and shall be rated at a slope of 20 degrees above the horizontal (See Part 1, Section 4 Skylights of NFRC 100 for more information).

6.0 Determining the thermal transmittance for solarium/sunroom systems

Note: This procedure is to be used when the solarium is glazed on-site. If manufactured window or door systems are used to create the glazed walls in a solarium, the thermal transmittance shall be determined in accordance with NFRC 100.

- 6.1 The thermal transmittance of solarium/sunroom systems shall be determined in accordance with Part 1, Section 2 (Approved Total Fenestration Product U-factor Calculation Procedure) of NFRC 100.
- 6.2 For simulating and testing site-built vertical glazed wall sections of solarium/sunroom systems, each Product Line shall have one baseline product be validated in accordance with NFRC 100, Part 1, Section 1 and 2, with the following exception: The individual product used for validation purposes shall be simulated and tested using the following criteria: The test specimen shall be constructed in such a manner as to be identical to the individual product simulated and have outside dimensions measuring 2032 mm by 2032 mm (an 80" width and an 80" height), having one vertical mullion and two glazed lites. The glazing system configuration for the validation testing shall be nominal 25 mm (1") outside dimension insulating glass utilizing two lites of 3 mm (1/8") clear (uncoated glass), a typical dual-sealed aluminum spacer system and air-filled. There shall be no insulation of any type applied to the test specimen during validation testing. Validation will be achieved per NFRC 100, Part 1, Section 1.6.1.1NFRC 100, Section 5.5..

- 6.3 Sloped glazing systems shall be rated in accordance with Section 5.1 utilizing sample construction as described in paragraph 6.2.
- 6.4 For simulating and testing all other fenestration operator types other than glazed wall systems and sloped glazing systems, model sizes shall be consistent with the sizes listed in Table 1 of NFRC 100.

7.0 Determination of System Solar Heat Gain Coefficients and Visible Light Transmittance Ratings

- 7.1 The system Solar Heat Gain Coefficient (SHGC) and Visible Light Transmittance (VT) ratings shall be determined, by an NFRC-accredited simulation laboratory, using a mathematical model which utilizes components of the total system design. The total system ratings shall be calculated using the procedures outlined in NFRC 200.
- 7.2 Specialty products SHGC and VT – Site-Built fenestration systems shall meet the requirements of Section 7.1 when utilizing the specialty products methodology as noted below:
- 7.2.1 Pre-Calculated Solar Heat Gain Coefficient And Visible Transmittance Tables. A table, or spread sheet matrix, is created by an NFRC-accredited simulation laboratory utilizing the thermal performance rating of particular product line and determining product SHGC ratings with two fictitious glazings: one product has a glazing with an SHGC of 0 and one with a glazing with an SHGC of 1.
- 7.2.2.1 If the product line includes dividers, the laboratory shall include the SHGC0 and SHGC1 values for cases with no dividers; cases with dividers less than or equal to 25.4 mm (1"); and cases with dividers greater than 25.4 mm (1").
- 7.2.3 Once the SHGC0 and SHGC1 ratings for the product line have been determined; the pre-calculated total fenestration product SHGC can be determined from the center-of-glass (cog) SHGC by the following equation:
- $$\text{Total Product SHGC} = \text{SHGC0} + \text{SHGC}_{\text{cog}} \times (\text{SHGC1} - \text{SHGC0})$$
- 7.2.4 Total fenestration product VT is determined in a similar manner, as follows:
- 7.2.5 A table is created by an accredited simulation laboratory utilizing the thermal performance rating of particular product line and determining product VT ratings with two fictitious glazings: one product has a glazing with a VT of 0 and one with a glazing with a VT of 1.
- 7.2.6 If the product line includes dividers, the laboratory shall include the VT0 and VT1 values for cases with no dividers; cases with dividers less than or equal to 25.4 mm (1"); and cases with dividers greater than 25.4 mm (1").
- 7.2.7 Once the VT0 and VT1 ratings for the product line have been determined; the pre-

calculated total fenestration product VT can be determined from the center-of-glass (cog) VT by the following equation:

$$\text{Total Product } VT = VT_0 + VT_{\text{cog}} \times (VT_1 - VT_0)$$

APPENDIX A

(Non-mandatory Information)

A.1 Determination of U-factors at Non-Standard Sizes

A U-factor-rating matrix that is size specific may be developed in accordance with NFRC 100 procedures and requirements. A matrix shall only be developed for those Product Lines, and Individual Products of a Product line, that have been submitted to an NFRC-Licensed Independent Certification and Inspection Agency (IA) for certification authorization purposes at the product size as defined in NFRC 100 Table 1. Products that have previously received certification authorization may also have a matrix developed. Each matrix shall be specific to an Individual Product within a Product Line.

The matrix shall include the standard rating size and sizes that are defined by the manufacturer.

The fenestration thermal performance parameter ratings (i.e.: U-Factor,) shall be determined by an NFRC-accredited simulation laboratory, using NFRC-approved software tools, which utilizes components of the NFRC-certified system, specifically with the frame, edge-of-glass and center-of-glass thermal performance ratings, where applicable. Each component of the total system shall be assigned percentages of the total product, and the total system thermal performance parameter shall be calculated using the procedures outlined in NFRC 100, Section 2.2 .

Note: Until such time that a certification change is made in the NFRC Product Certification Program, the thermal performance parameters that are determined at sizes other than the product size in NFRC 100 Table 1 are for informational purposes only.

U-Factor Size Matrix for Series XXXX Curtain Wall

EXAMPLE ONLY - Widths, Heights and U-factors

		Width								
		36	48	60	72	80	84	96	108	120
H e i g h t	36	0.55	0.52	0.49	0.48	0.47	0.47	0.46	0.45	0.45
	48	0.53	0.49	0.47	0.46	0.45	0.44	0.44	0.43	0.42
	60	0.52	0.48	0.46	0.44	0.43	0.43	0.42	0.41	0.41
	72	0.51	0.47	0.45	0.43	0.42	0.42	0.41	0.40	0.40
	80	0.51	0.47	0.44	0.43	0.42	0.41	0.41	0.40	0.39
	84	0.51	0.47	0.44	0.42	0.42	0.41	0.40	0.40	0.39
	96	0.50	0.46	0.44	0.42	0.41	0.41	0.40	0.39	0.38
	108	0.50	0.46	0.43	0.42	0.41	0.40	0.39	0.39	0.38
	120	0.50	0.46	0.43	0.41	0.40	0.40	0.39	0.38	0.38
Indicates NFRC 100 Standard Size for Certification and Rating Purposes										

The values stated, other than the identified standard size, in the matrix above are for informational purposes only and have not been authorized for certification. The standard size rating is also shown on the Label Certificate, to which this matrix is attached. For additional information, contact the IA stated on the Label Certificate.

APPENDIX B

(Non-mandatory Information)

B.1 Determination of Project Specific U-Factors

The system U-factor ratings for project specific U-factors shall be determined by an NFRC-accredited simulation laboratory, using NFRC-approved software tools which utilizes components of the NFRC-certified system, specifically with the frame, edge-of-glass and center-of-glass U-factors. Each component of the total system shall be assigned percentages of the total product, and the total system U-factor shall be calculated using the procedures outlined in NFRC 100, Section 2.2