

3.0 Definitions

Non-Residential Building – All buildings over three stories in height above grade or buildings, other than residential buildings, that are three stories or less in height above grade.

Non Residential Fenestration Systems – Common types of Non Residential fenestration systems installed in Non Residential buildings include windows, curtain wall, window wall, storefront and doors.

Fenestration :

The placement of openings in a building wall, such as windows, doors, skylights, curtainwalls, etc., designed to permit the passage of air, light, or people; one of the important elements in controlling the exterior appearance of a building. Also, associated interior or exterior elements, such as shades or blinds. From the Latin word, "fenestra", meaning window.

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Spacer: The linear object that separates and maintains the space between the glass surfaces of insulating glass.

Storefront — a non-residential system of doors and windows mullied as a composite structure. Typically designed for high use/abuse and strength. The storefront system usually is installed between floor and ceiling.

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).

Spandrel — the opaque areas of a building envelope which typically occur at locations of floor slabs, columns and immediately below roof areas.

Spandrel Area: The area of the spandrel infill between the primary sash or frame members.

Non-thermally broken members: System members with less than 1.6 mm (1/16 in.) or no separation between metal or system members to provide a resistance heat transfer path from exterior to interior.

5.6 Non Residential Building Fenestration Products:

This section covers methods for determining fenestration product U-factor (thermal transmittance), for fenestration products installed in Non Residential buildings, including but not limited to fenestration products that are site assembled (built). This section also covers methods for determining fenestration product U-factor (thermal transmittance), for solarium/sunroom systems

5.6.1 Scope

To specify a method for determining the thermal transmittance (U-factor) of Non Residential fenestration system, including site-built fenestration systems for Non Residential buildings.

The ratings derived from this procedure may be used to compare thermal performance characteristics of Non Residential fenestration systems 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 Non Residential fenestration system. As an alternative, ratings determined in accordance with section 4 are permitted.

5.6.2 Variations from Standard Product Lines

Non Residential fenestration systems covered by this method include products that are listed in Table 4, including but not limited to:

- a) 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;
- b) Glazed wall support and framing systems;
- c) Changes made to a Product type to address structural loads, e.g. changes made to frame components to build different size products, address wind-loads and aesthetics.
- d) Products with single or multiple glazing layers;
- e) Products with spacer systems between glazings;
- f) Horizontal, vertical and sloped systems;
- g) Products that, by design, may have multiple framing components and/or glazing combinations.
- h) Fenestration Systems using Unitized Construction, where a system is field assembled from factory assembled sub-units.
- i) Spandrel Panels
- j) Non Residential products or systems not covered by section 4.4 table 4 of this standard.

Combination assembly with common frame treatment: combination assembly that includes common frame members that wrap around the assembly and/or contain common mullion members that connect various individual products, so that the fenestration assembly is a single product and installed as such. combination assembly with common frame shall be treated as an assembly, consisting of individual products and rated as such, unless the heat flow through the common frame members is different by more than 20% than the heat flow through the frame assemblies of individual products; The heat flow shall be calculated using the best glazing option for individual cross sections of common frame members and their frame U-factors shall be compared to the respective frame U-factor of the individual cross-sections in the assembly.

5.6.3 Variations from Standard Individual Products

5.6.4 Variations from Standard Simulation and Test Conditions

5.6.4.1 Simulation

All ratings shall be based on computer simulations that comply with the ISO 15099 except for the following provisions:

- (a) Partially de-bridged thermal bridges, like poured-and-debridged thermal breaks which are not fully debridged (i.e., skip and de-bridged frame sections), thermally slotted sections, etc. These situations shall be simulated following the procedure in section 6.3.1 in ISO15099. For additional details see reference [2].

5.6.4.2 Simplifications to a Product Line

This section presents additional product line simplification rules specific to Non Residential fenestration systems and site built products.

Spacer:

Each individual spacer shall be modeled to determine its effective conductivity. Two generic spacers, representing low and high end in thermal conductance are identified by their effective conductivity in section 5.6.5.1.

For the purpose of calculating overall product rating at the standard NFRC size, the spacers may be grouped with the spacer with the higher effective conductivity, which then becomes the group leader.

For the purpose of component performance, each spacer assembly performance shall be provided in terms of its effective conductivity.

5.6.5 Calculation of Total Product Rating

5.6.5.1 Component Modeling Procedure

The U-factor of a fenestration product may vary by size. To provide uniform rating procedure and size specific information, the component modeling procedure, as described in this section, shall be used [as primary method]. For the comparison rating of non-residential systems, the U-factor for model (standard) size per table 1 is calculated. Non-Residential systems U-factor for sizes other than standard size can be used for comparison for information purposes and when applicable.

Basic Product Line Model and Component information for calculation and Reporting of U-factors

U-factors shall be reported on a component basis for each frame assembly (i.e., sill, jambs, head, etc.), each spacer configuration and each glazing system (center-of-glass). The U-factors for Frame components shall be reported as U_f (i.e. frame U-factor) and U_e (i.e., edge-of-glass U-factor), using the four representative options (best and worst), as defined in Table 5.6.1, and which gives a template for reported U-factors.

Definition of the Best and Worst configurations

Total of four best/worst or B/W configurations is defined. These configurations are assembled from two different glazing options at the extreme of the thermal performance and two spacer configurations at the extreme of thermal performance. The following are four Best and Worst configurations:

- (a) b1 in Table 5.6.1: Best glazing with Best spacer
- (b) b2 in Table 5.6.1: Best glazing with Worst spacer
- (c) w1 in Table 5.6.1: Worst glazing with Best Spacer
- (d) w2 in Table 5.6.1: Worst glazing with Worst Spacer

Table 5.6.1. Template for Reporting Component U-factors

	Frame			
	w1	w2	b1	b2
U_f [W/m ² K]				
U_e [W/m ² K]				
Pdf [m]				

Center of Glass: $U_c =$

Spacer: $k_{eff} =$

Quantities w1, w2, b1, and b2 are defined in Reference [15].

For each individual product, total fenestration product U-factors shall be reported for the specified configuration at the model size, as shown in Table 1 of NFRC 100. The calculation of this total product Ufactor is done using procedure detailed in Reference [15].

5.6.5.2 Approved Total Fenestration Product U-factor Calculation Procedure

The total fenestration product U-factor calculation procedure shall be calculated as per procedure detailed in Reference [15].

Approved software shall be used for calculating the total fenestration product U-factor. NFRC approved software is listed in Reference [5].

Follow NFRC approved procedure for rounding the final result. The U-factor shall be reported to 0.05 W/(m²-K) (0.01 Btu/h•ft²•°F). All variables used in the formula shall be expressed to at least three (3) significant decimal places.

Determining thermal transmittance (U-factor) for sloped glazing systems

All sloped glazing systems shall be rated for thermal performance characteristics at a slope of 20 degrees above the horizontal (See Skylights for more information).

5.6.5.3 Test Procedures

Test procedure consistent with Section 4.6 shall be used. The following are exceptions to standard testing requirements:

- (i) Unspecified Product Sample Validation Criteria: If the product to be used for validation purposes is not specified, then the following criteria shall be used: The test specimen shall be constructed in such a manner as to be identical to the individual product simulated and have outside dimensions in accordance with Table 1. The glazing system configuration for the validation testing shall be glazed with representative insulating glass unit. There shall be no insulation of any type applied to the test specimen during validation testing. Validation will be achieved per Section 4.7
- (ii) This section 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, etc.
- (iii) 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 4 of this standard.
- (iv) Sloped glazing systems shall be tested for thermal performance characteristics at 90 degrees above the horizontal (i.e., vertical orientation). Validation for this sample shall be done against simulations performed at vertical orientation.

5.6.5.4 Approved Total Fenestration Product U-factors for Non-Model Sizes

Procedure in Reference [15] and approved NFRC software as defined in section 5.6.5.2 shall be used to determine size specific product indices.

References:

- [15] **Curcija, D.C. 2003.** *“Component Model Approach In Modeling Non-Residential Fenestration Products”*

