NFRC BOD and Technical Committee: (11/08/2006)

Motion: to forward NFRC 100 the Spacer Grouping, Frame Validation, NFRC 200 Low & High Case Scenario ballots to the Board of Directors for approval. Recommend that the Tech document be approved, but not be implemented until all other related CMA Program documents are complete.

Motion passes: 27-0

NFRC 100-2004 (Non-residential Fenestration Systems) – Ballot Language Approved

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, curtain walls, 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.

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 mulled as a composite structure; typically designed for high use/abuse and strength. The storefront system is usually installed between the floor and ceiling of the building.

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 the 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 systems, 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: A 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. A combination assembly with a 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 differs by more than 20% from 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 ISO 15099 except for the following provisions:

(a) Partially debridged 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 of 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:

Path I – Generic Spacer - Spacer System K_{eff} : (Default Spacer, Default Sealant, Default Geometry)

K_{eff} defined based on simple review of spacer drawings.

Group 1 – Spacer containing aluminum

If the spacer uses any aluminum in the design it shall be assigned a spacer system K_{eff} of 8.0 W/mC (0.096 Btu/hr-ft-F).

Group 2 – Spacer containing mild steel (i.e. galvanized steel, tin-plated steel)

If the spacer uses any mild steel in the design it shall be assigned a spacer system K_{eff} of 3.0 W/mC (0.036 Btu/hr-ft-F).

Group 3 – Spacer containing stainless steel

If the spacer uses any stainless steel in the design it shall be assigned a spacer system K_{eff} of 1.0 W/mC (0.012 Btu/hr-ft-F) .

Group 4 – Spacer containing all non-metallic materials

If the spacer uses only non-metallic materials in the design it shall be assigned a spacer system K_{eff} of 0.5 W/mC (0.006 Btu/hr-ft-F). If the spacer design incorporates any metal, it shall fall into either Group 1, 2, or

3.

In the event a spacer contains two metals, the higher conductivity metal shall be used in specifying the spacer group, regardless of the amount of that metal present in the spacer.

Path II – Specific Spacer - Spacer System K_{eff} : (Specific Spacer, Default Sealant, Limited Geometry)

K_{eff} defined based on simulation from spacer bar drawings

The Spacer manufacturer shall submit drawings to an NFRC accredited simulator to be evaluated. The spacer shall be evaluated using generic sealant materials to cover all sealant materials. The spacer is evaluated for each width available based on the drawings supplied by the spacer bar manufacturer at a spacer system height of 12.7mm (1/2"). If the spacer system does not incorporate secondary sealant, then the spacer system height is equal to spacer height. The spacer system with the highest K_{eff} value shall be used to represent all spacer system geometries for this spacer bar. Only one K_{eff} is submitted to NFRC staff for inclusion in the CMA database to represent a spacer system under this path.

The generic sealant material to be used in a single-sealant spacer system is "Generic sealant 2" as defined in the table below. The generic sealant materials to be used in a dual-sealant spacer system are "Generic sealant 1" for the primary sealant and "Generic sealant 2" for the secondary sealant as defined in the table below. The primary sealant thickness on either side of the spacer in a dual-sealant spacer system shall be smaller of the actual primary sealant thickness and 0.25mm (0.010"), which is based on the IGMA technical publication TM-1201-89(05) Sealant Manufacturers Minimum Sealant Dimensions and Placement Survey.

Spacer Sealant Materials	Sealant Conductivity W/m-K (Btu/hr-ft-F)
Generic sealant 1	0.25 (0.0030)
Generic sealant 2	0.40 (0.0048)

Path III – Detailed Spacer - Detailed Spacer System Calculation : (Specific Spacer, Specific Sealant, Detailed Spacer System Geometry)

K_{eff} defined based on simulation from spacer drawings

The spacer manufacturer shall submit drawings to an NFRC accredited simulator to be evaluated. The spacer shall be evaluated using specific sealant materials available with this spacer. The spacer geometry shall be evaluated based on the drawings supplied by the spacer manufacturer: spacer width, spacer system height, and primary sealant thickness are all variables that shall be evaluated. The effective conductivity of such spacer system is calculated on demand and shall be used in the whole fenestration product calculation. These values are not

stored in the component database.

As an option, at the discretion of the spacer manufacturer, the product may be evaluated with the generic sealant materials defined under Path II to limit the number of system configurations.

For the purpose of calculating the 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. In order to provide a uniform rating procedure, as well as size specific information, the component modeling procedure, as described in this section, shall be used [as the primary method]. For the comparison rating of non-residential systems, the U-factor rating for model (standard) size per Table 1 is calculated. A U-factor rating for sizes other than standard size can be calculated for informational purposes when applicable.

5.6.5.2 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 (Low and High), as defined in Table 5.6.1, and which gives a template for reported U-factors.

5.6.5.3 Definition of the Low and High configurations

A total of four Low/High or L/H configurations are defined. These configurations are assembled from two different glazing options at the extreme of thermal performance and two spacer configurations at the extreme of thermal performance.

The glazing and spacers used in L/H configurations are defined as follows:

Low/High Glazing Systems

Single Glazing

- Low Glazing –Low-e -– U_{cog} = 3.24 W/m^2-K (0.57 Btu/hr-ft^2-F).
- High glazing –clear

Glass thickness standardized to 3mm (1/8”) for residential products and 6mm (1/4”) for commercial.

Insulating

- Low Glazing – Double glazed, dual Low-e -– U_{cog} = 0.45 W/m^2-K (0.08 Btu/hr-ft^2-F).

- High glazing – Double glazed clear Air.

Glass thickness standardized to 3mm (1/8") for residential products and 6mm (1/4") for commercial. Overall (nominal) thickness of Low/High glazing systems should match nominal thickness (± tolerance) of the real glazing systems (i.e. 19.1mm (3/4"); 22.2mm (7/8"); 25mm (1"); etc.) that the simulated product is designed for.

Low/High Spacer Systems (Not applicable to monolithic applications)

- Best Spacer – generic low conductivity spacer – k_{eff} = 0.01 W/m-K (0.006 Btu/hr-ft-F).
- High Spacer – generic high conductivity spacer – k_{eff} = 10.0 W/(m-K) (5.8 Btu/hr-ft-F).
- Spacer height standardized to 12.7 mm (1/2").
- Spacer width variable in order to match gap width of Low/High glazing systems.

(a) b1 in Table 5.6.1: Low glazing with Low spacer

(b) b2 in Table 5.6.1: Low glazing with High spacer

(c) w1 in Table 5.6.1: High glazing with Low Spacer

(d) w2 in Table 5.6.1: High glazing with High Spacer

Table 5.6.1. Template for Reporting Component U-factors

	Frame			
	w1	w2	b1	b2
U_f [W/m^{2}K] (Btu/hr-ft^2-ºF)				
U_e [W/m^{2}K] (Btu/hr-ft^2-ºF)				
PFD [mm] (inch)				

Center of Glass: U_c = W/m^2-K (Btu/hr-ft^2-ºF)

Spacer: k_{eff} = W/m-K (Btu/hr-ft-ºF)

The 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 U-factor is done using procedure detailed in Reference [15].

5.6.5.4 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/(m^2-K) (0.01 Btu/h•ft^2•°F). All variables used in the formula shall be expressed to at least three (3) significant decimal places.

5.6.5.5 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).

5.6.5.6 Test Procedures

Framing components shall be tested as a whole product using an insulating glass package as selected by the manufacturer, according to NFRC 102 and according to all frame and validation grouping rules. Validation shall be determined by the equivalence criteria of section 4.7.1 of this document.

(i)

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

The procedure in Reference [15] and NFRC-approved 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*"