PROCEDURE FOR DETERMINING FENESTRATION PRODUCT THERMAL INDICES[1]

DRAFT 0.~~df~~
(~~14 November 2000~~ 24 January 2001)

Copies available on the NFRC website at nfrc.org[2]

[1] Explanatory information is included in footnotes.

[2] Not available at this point, but intended to be upon public release.

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PREFACE

This is the first edition of NFRC ~~(?)~~/CSA ~~(?)~~ A100 *Procedure for Determining Fenestration Product Thermal Indices*. This procedure resulted from an effort to harmonize existing NFRC and CSA International procedures: ~~It supersedes~~ NFRC 100/200/201/500 and CSA A440.2.

This Standard provides simulation and testing procedures for determining thermal indices including, but not limited to, U-factor, solar heat gain coefficient (SHGC), visible transmittance, and condensation. The scope includes all fenestration products: windows, doors, and skylights.

This Standard was approved by the National Fenestration Rating Council (NFRC) and ~~the~~ CSA International (formerly Canadian Standards Association ~~(CSA~~). This Standard will be submitted to the American National Standards Institute (ANSI) for approval as an American National Standard and to the Standards Council of Canada (SCC) for approval as a National Standard of Canada.

This is a metric document. For user information, I-P approximations are included in Appendix A: Approximate I-P Conversions for Information Purposes Only~~Appendix A: Approximate I-P Conversions for Information Purposes Only~~.

1. SCOPE

1.1 **Title.** This standard shall be known as the *Procedure for Determining Fenestration Product Thermal Indices* and shall be cited as such. It is referred to herein as "this standard".

1.2 **Intent.** This standard specifies methodology (ies) for determining fenestration product thermal indices. The indices include, but are not limited to:
(a) U-factor
(b) Solar heat gain coefficient
(c) Visible transmittance
(d) Condensation.

Where noted in this standard, simplifications are allowed in certain cases ~~where~~ when like products have essentially the same performance.

1.3 ~~Scope~~**Products Covered.** This standard addresses all fenestration products and components unless otherwise indicated in subsequent sections.[3]

(a) Products of all operator or unit types[4] (e.g., sliding windows (including vertical and horizontal, hung and non-hung), hinged windows (including casement, awning, hopper, projecting), fixed windows, non-standard shaped and non-rectangular windows, dual action windows, pivoting windows, glazed wall systems (including curtain walls, storefronts, windowwalls, and solariums), greenhouse/garden windows, bay or bow windows, basement windows, jalousie windows, ~~(including~~ jal-awning windows, ~~tropical vent),~~ tropical awning windows, unit skylights, unit roof windows, sloped glazing (glazed roof systems including solariums), exterior door products, both glazed and unglazed, including but not limited to sliding doors, swinging (hinged) doors, ~~and~~ fixed doors, and door sidelites and door transoms, revolving doors, ~~garage~~ vehicular access doors).

(b) Products of all frame materials used singly or in combination (e.g., aluminum, steel, thermally broken aluminum, thermally improved aluminum, wood, vinyl, reinforced vinyl, fiberglass, foam insulation, plastic, and cellulosic composites).

(c) Products of all glazing materials, tints, types (e.g., clear glass, tinted glass, stained glass, glass block, thin plastic films (internally suspended, internally applied, or externally applied), rigid plastics, and translucent fiberglass with or without any solar control, low-emissivity or any other partially transparent coating) and products with manufactured decorative opaque insulative glazing panels, designed for interchangeability with other glazing options.

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[3] The intent is to have a complete scope. Where modeling or testing limitations currently exist, those are to be indicated in the appropriate subsections. As the modeling and testing capabilities are improved, we can simply delete those limitations from the appropriate subsections, rather than needing to revise the scope.

[4] To match Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~.

(d) Products with any or no gap width between glazing layers (e.g., single and multiple glazing, laminated glass).

(e) Products with any spacer or spacer systems between glazing layers (e.g., metallic, non-metallic, or multi-material spacers).

(f) Products utilizing any true or simulated glazing dividers (e.g., grilles inside or, outside, or between glazing layers, muntin bars, true divided lites, or simulated divided lites).

(g) Products with any gas-fill mixture between glazing layers (e.g., atmospheric air, argon/air, krypton/air, krypton/argon/air).

2. ~~DEFINITIONS~~TERMINOLOGY

2.1 Definitions.

~~*(to be added as needed)*~~

~~**NAFS-1 Definitions**~~[5]

~~*(still need to be alphabetized)*~~

Area, center-of-glazing (A_c): all glazed areas except those within 63.5 mm (2.5 in.) of any part of a primary sash and/or frame and/or divider; or any part of a primary door and/or frame and/or divider. See Figures ??[6]

Area, divider (A_d): the projected area in the plane(s) parallel to the product's glazing of all interior or exterior applied non-removable dividers, true dividers, or between glazing dividers.[7] See Figures ??[8]

Area, divider-edge (A_{de}): all glazed vision areas within 63.5 mm of any part of a divider area. The divider edge area shall exclude any edge-of-glass area contained within the center-of-glazing area. See Figures ??[9]

Area, edge-of-glazing (A_e): all glazed vision areas within 63.5 mm of any part of the frame and sash or of the door lite frame sightline, excluding any area contained in the divider area . The edge-of-glass area shall exclude any divider area contained within the edge-of-divider area. See Figures ??[10]

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[5] Add definitions for product types not listed in NAFS-1.
[6] Need these figures.
[7] The definition had reference to "except those cases where the 3mm (1/8") rule applies". What does this mean? Is this necessary?
[8] Need these figures.
[9] Need these figures.
[10] Need these figures.

Area, frame (A_f): the sum of the projected areas of all frame and sash members in the plane(s) parallel to the glazing surface, summed over each glazing plane; except for doors, which shall include the projected areas of the door jambs, header, threshold, door bottom sweep and the peripheral structural elements of the door leaf, in a plane parallel to the door core surface. See Figures ??[11]

Area, projected fenestration product (A_{pf}): the area of the rough opening in the wall or roof, for the fenestration product, less installation clearances.
[Note: *Where a fenestration product has glazed surfaces facing in only one direction (typical windows), the sum of the divider-edge area, the edge-area, the divider area, the center-of-glass area, and the frame area will equal the total projected fenestration product area (A_{pf}). Where a fenestration product has glazed surfaces in more than one direction (e.g., greenhouse/garden, bay/bow windows) the sum of the areas will exceed the projected fenestration product area.]*

Awning window: **(**See **Hinged window, bottom/top – awning, hopper, projecting**.)

Basement window: any fenestration product operator type intended only for use at or below grade for the purpose of ventilating a basement or cellar.

Bay window: a combination window which is composed of two or more individual windows joined side by side and which projects away from the wall on which it is installed. Center windows, if used are parallel to the wall on which the bay window is installed. The two side windows are angled with respect to the outer window. Common angles are 30 degrees and 45 degrees, although other angles are sometimes employed.

~~or b~~Bow window: ~~*****need definition*****~~ Rounded bay window that projects from a wall in the shape of an arc.

Casement window: **(**See **Hinged window, side – casement**.)

Cellulosic composite: a composite whose ingredients include cellulosic elements. These cellulosic elements can appear in the form of, but are not limited to: distinct fibers, fiber bundles, particles, wafers, flakes, strands and veneers. These elements may be bonded together with naturally occurring or synthetic polymers. Also, additives such as wax or preservatives may be added to enhance performance.

Center-of-glazing area (A_c): (See **Area, center-of-glazing**.)

Combination units: three or more units installed in a common frame.

Curtain wall: an external nonbearing wall, intended to separate the exterior and interior environments, 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.

Divider area (A_d): (See **Area, divider**.)

Divider-edge area (A_{de}): (See **Area, divider-edge**.)

Door: (See ~~**Garage doors;**~~ **Hinged doors (swinging)**; **Revolving doors**; **Sliding doors**; **Vehicular access doors**; **Door sidelights**; **Door transoms**.)

[11] Need these figures.

Door sidelite: a non-operable fenestration product that is typically used as companion product installed on one or both sides of a door. Sidelites may consist of a glazed frame or a non-operable sash within a frame. For purposes of compliance with this standard, sidelites shall not exceed 700 mm ~~(27 in)~~ in width. For operable fenestration products, see the appropriate operator type.

Door slab: a side hinged attachment greater than 610 mm in width whose primary function is to allow human egress. (This is NOT intended for rating windows).

Door transom: a non-operable fenestration product that is typically used as companion windows installed above a door. Transoms may consist of a glazed frame or a non-operable sash within a frame. For purposes of compliance with this standard, transoms shall not exceed 700 mm ~~(27 in)~~ in height. For operable fenestration products, see the appropriate operator type.

Dual action windows: a fenestration product that consists of a sash that tilts from the top for ventilation and swings inward from the side for cleaning of the outside surface. Dual action windows are sometimes referred to as Tilt-Turn windows.

Edge-of-glazing area (A_e): (See **Area, edge-of-glazing**.)

Fixed window: a non-operable fenestration product and may consist of a glazed frame or a non-operable sash within a frame. This category does not include non-operable skylights. (See **Sash** and **Skylight**.)

Frame and sash: any structural member of the fenestration product, with the exception of muntins or other dividers used to create true or artificial divided lites.

Frame area (A_f): (See **Area, frame**.)

Garage door: ~~***need definition***~~ (See **Vehicular access door**.)

Glazed wall system: ~~***need definition***~~the non-operable portions of a curtain wall, solarium, storefront, or windowwall that are mounted at a slope less than or equal to 15 degrees from the vertical plane. (See **Curtain wall**, **Solarium**, **Storefront,** or **Windowwall**. For operable portions, see the appropriate operator type.)

Glazing: The glass, plastic or other envelope material used to enclose openings in a building created by a specific framing system.

Greenhouse/garden window: a fenestration product which~~s~~ consist of a three-dimensional, five-sided structure, with provisions made for supporting plants and flowers in the enclosed space outside the plane of the wall. Operating sash are allowed but are not required.

Hinged door: a fenestration product containing one or more operable panels within a common frame. The operable panels are side hinged and are either in-swinging or out-swinging, but not both directions.

Hinged window: a fenestration product comprised of a sash ~~which~~ that swings inward or outward.

Hinged window, bottom/top – awning, hopper, projecting: a fenestration product which has one or more sash hinged at the top or bottom which project outward or inward from

the plane of the window in the vertical plane. **Projected windows** have one or more sash hinged at the top or bottom which project outward or inward from the plane of the frame. An **awning** (POB or THPO) rotates about its top hinge and projects outward. A **hopper window** (PIT or BHPI) rotates about its bottom hinge and projects inward. Top Hinged Projecting In and Bottom Hinged Projecting Out are also included in this category. They may contain one or more operable sash, fixed lites, or transoms in various combinations.

Hinged window, side - casement: a fenestration product which has one or more sash hinged at the side (adjacent to the jambs) which project outward or inward from the plane of the window in the vertical plane. A conventional casement window rotates about its side hinge and projects outward. Casement windows may contain one or more operable sash, fixed lites, or transoms in various combinations.

Hopper window: **(**See **Hinged window, bottom/top – awning, hopper, projecting**.)

Horizontal sliding window: (See **Sliding window, horizontal**.)

Jalousie window: a fenestration product which consists of a series of overlapping, horizontal frameless louvers which pivot simultaneously in a common frame and are actuated by one or more operating devices so that the bottom edge of each louver swings outward and the top edge swings inward during operation.

Jal-Awning window: a fenestration product which consists of a multiplicity of top-hinged sash arranged in a vertical series within a common frame and each operated by its own control device which swings the bottom edges of the sash outward.

~~***Operator types:*** (See **Basement**; **Bay or Bow**; **Dual Action**; **Fixed**; **Glazed Wall System, vision**; **Glazed Wall System, opaque spandrel**; **Greenhouse/garden**; **Hinged, bottom/top – awning, hopper, projecting**; **Hinged, side – casement**; **Jalousie**; **Jal-Awning**; **Pivoted – vertical/horizontal**; **Sliding, horizontal**; **Sliding, vertical – hung & non-hung**; **Tropical awning**; **Garage doors**; **Hinged doors (swinging)**; **Revolving doors**; **Sliding doors**; **Door sidelights**; **Door transoms**; **Skylights/roof windows**; **Sloped glazing (glazed roof system).**)~~

Outdoor Air Ventilator Assembly (OAVA): An assembly that allows for the exchange of air through the envelope that is an integral part of the fenestration assembly.

Pivoted window – vertical/horizontal: a fenestration product comprised of a sash which pivots about an axis within the frame. These windows can be pivoted horizontally or vertically. The pivoting action of the window allows for easy access to clean the outside surfaces of the window. Two common types are the 180-degree compression seal pivoting window and the 360-degree pivoting window. **A 180-degree compression seal pivot** rotates about an axis of the sash and frame to permit cleaning of the outside surfaces. After cleaning the window is pivoted back to its closed position where the sash seals against the frame using a compression type seal. **A 360-degree pivot** rotates about the midspan of the sash and frame. When pivoted 180 degrees, it may be held for the purpose of cleaning the outside surfaces, it also provides a weather seal in this position. Upon completion of the cleaning operation, the sash can be pivoted another 180 degrees to its normal closed position.

Product types: (See **Basement**; **Bay or Bow**; **Dual Action**; **Fixed**; **Glazed Wall System, vision**; **Glazed Wall System, opaque spandrel**; **Greenhouse/garden**; **Hinged,**

bottom/top – awning, hopper, projecting; **Hinged, side – casement**; **Jalousie**; **Jal-Awning**; **Pivoted – vertical/horizontal**; **Sliding, horizontal**; **Sliding, vertical – hung & non-hung**; **Tropical awning**;; **Hinged doors (swinging)**; **Revolving doors**; **Sliding doors**; **Vehicular access doors**; **Door sidelights**; **Door transoms**; **Skylights/roof windows**; **Sloped glazing (glazed roof system)**.)

Projected fenestration product area (A_{pf}): (See **Area, projected fenestration product**.)

Projecting window: **(**See **Hinged window, bottom/top – awning, hopper, projecting**.)

Revolving door: ~~*****need definition*****~~An exterior door consisting of three or more leaves which pivot about a common vertical axis within a cylindrically shaped vestibule; prevents the direct passage of air through the vestible, thereby eliminating drafts from the outside.

Roof window, unit: a sloped application of a fenestration product that provides for in-reach operation or rotation of the sash to facilitate cleaning of the exterior surfaces from the interior of the building. This application may also allow for egress situations.

Sash: the portion of a fenestration assembly which is installed in a frame and includes the glazing, stiles and rails. Normally, the moving segment of a window, although sash are sometimes fixed. (See also **Frame and sash**.)

Sidelite, door: (See **Door sidelite**.)

Skylight, unit: a sloped or horizontal application of a fenestration product in an out-of-reach application, which allows for natural daylighting, excluding tubular skylights. (See **Tubular skylight**.) Skylights may be either fixed (non-operable) or venting (operating). Unlike roof windows, skylights need not provide provisions for cleaning of exterior surfaces from the interior of the building.

Skylights: (See **Skylights/roof windows, unit**; **Sloped glazing (glazed roof system)**.)

Sliding door: a fenestration product containing manually operated panels which slide horizontally within a common frame. Operating panel (X) and a fixed lite (O) comprising a unit are termed single slide (XO or OX). When two operating panels are separated by a fixed lite, the unit is termed a picture slide or end vent (XOX). When two fixed lites are separated by an operating panel, the unit is termed a center slide (OXO). When two bi-parting panels are located at the center of the unit with fixed lites at each end, the unit is termed a bi-part center slide (OXXO). When adjacent panels by-pass one another, the unit is termed as a double slide (XX, OXX or XXO) or a double slide end vent (XXX).

Sliding window, horizontal: a fenestration product which contains manually operated sash which slide horizontally within a common frame. Operating sash (X) and a fixed lite (O) comprising a unit are termed single sliders (XO or OX). When two operating sash are separated by a fixed lite, the unit is termed a picture slide or end vent (XOX). When two fixed lites are separated by an operating sash, the unit is termed a center slide (OXO). When two bi-parting sash are located at the center of the unit with fixed lites at each end, the unit is termed a bi-part center slide (OXXO). When adjacent sash by-pass one another, the unit is termed as a double slide (XX or XXO) or a double slide end vent (XXX).

Sliding windows, vertical – hung and non-hung: a fenestration product which contains at least one manually operated sash which slides vertically within a common frame. All provisions of testing apply whether there are one, two or three sash which operate. This category has two sub categories which are hung and non-hung windows. **Hung windows** utilize counter-balancing devices to allow the sash to be opened to any variable position between its fully open and fully closed limits. Common types are single hung, double hung and triple hung. **Non-hung windows** utilize mechanical retainers or slide bolts to allow the sash to be opened to any one of the pre-selected positions between its fully open and fully closed limits.

Sloped glazing (glazed roof system): a multiple-lite glazed system (similar to a curtain wall) that is mounted at a slope greater than 15 degrees from the vertical plane.

Solar heat gain coefficient (SHGC): the ratio of the solar heat gain entering the space through the projected area of a fenestration product to the incident solar radiation under specific environmental conditions. Solar heat gain includes directly transmitted solar heat and absorbed solar radiation, which is then reradiated, conducted, or convected into the space.

Solarium: a fenestration product typically consisting of a glazed wall system and sloped glazing, but which may include other product types. (See **Glazed wall system** and **Sloped glazing (glazed roof system)**.)[12]

Storefront: a nonresidential system of doors and windows mulled as a composite structure. Typically designed for high use/abuse and strength. The storefront system usually is installed between floor and ceiling.

Transom, door: (See **Door transom**.)

Tropical awning window: a fenestration product consisting of one or more top-hinged or pivoted sash operated by one control device which swings the bottom edge of the sash outward. A single control or operating device operates all sash, securely closing them at both jambs without the use of any additional manually controlled latching devices.

Tubular skylight: a device primarily designed to transmit daylight from a roof surface to an interior ceiling surface via a tubular conduit. The device consists of an exterior glazed weathering surface, a light transmitting tube with a reflective inside surface, and an interior sealing device such as a translucent ceiling panel.

U-factor (a.k.a. U-value): a measure of the heat transfer characteristics of a fenestration product under specific environmental conditions. The U-factor multiplied by the interior-exterior temperature difference and by the projected fenestration product area, yields the total heat transfer through the fenestration product due to conduction, convection, and infrared radiation. The U-factor is the heat transmission in a unit time through a unit area of a test specimen and its boundary air films, induced by a unit temperature difference between the environments on each side.

Vehicular access door: a door that is used for vehicular traffic at entrances of buildings such as garages, loading docks, parking lots, factories, and industrial plants, and that is not generally used for pedestrian traffic.

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[12] THTF: How should we define solarium?

Vertical sliding window: (See **Sliding window, vertical – hung and non-hung**.)

Visible transmittance (VT): the ratio of the visible light entering the space through the projected area of a fenestration product to the incident visible light under specific environmental conditions.[13]

Windowwall: 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.

Windows: (See **Basement**; **Bay or Bow**; **Dual Action**; **Fixed**; **Glazed Wall System, vision**; **Glazed Wall System, opaque spandrel**; **Greenhouse/garden**; **Hinged, bottom/top – awning, hopper, projecting**; **Hinged, side – casement**; **Jalousie**; **Jal-Awning**; **Pivoted – vertical/horizontal**; **Sliding, horizontal**; **Sliding, vertical – hung & non-hung**; **Tropical awning**.).

~~*** START HERE ***~~

~~**A skylight** is a sloped or horizontal application of a fenestration product in an out-of-reach application, which allows for natural daylighting. Skylights may be either fixed (non-operable) or venting (operating). Unlike roof windows, skylights need not provide provisions for cleaning of exterior surfaces from the interior of the building.~~

~~**A roof window** is a sloped application of a fenestration product that provides for in-reach operation or rotation of the sash to facilitate cleaning of the exterior surfaces from the interior of the building. This application may also allow for egress situations.~~

2.2 Abbreviations and Acronymns

3. REFERENCE PUBLICATIONS

~~*(to be added as needed)*~~

U-factor

ASTM C177 *Standard…*

ASTM C518 *Standard…*

[13] Do we have a better definition?

ASTM C1199-00 *Standard Test Method for Measuring the Steady State Thermal Transmittance of Fenestration Systems Using Hot Box Methods*

ASTM E1423-99 *Practice for Determining the Steady-State Thermal Transmittance of Fenestration Systems*

Solar Heat Gain Coefficient

NFRC 201 *Standard Test Method for Measuring the Solar Heat Gain Coefficient of Fenestration Systems Using Calorimetry Hot Box Methods (2000 edition)*

Visible Transmittance

~~???~~ASTM E1175-87 *Standard Test Method for Determining Solar Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere*

~~Condensation~~

~~???~~

Gas Fill

CAN/CGSB-12.8-~~M90~~97 *Insulating Glass Units*

4. COMPLIANCE

4.1 General. Fenestration products shall comply with Section 4 and with Sections 5 and/or 6 as follows:

(a) For the purposes of simulation, products shall be simulated in accordance with Section 5.

(b) For the purposes of testing, products shall be tested in accordance with Section 6.

(c) This standard does not preclude a certification program from requiring that either or both simulation and testing be done.

4.2 Standard Products for Rating Purposes. Each individual product or combination thereof shall be rated with the exact components in the product except where groupings ~~(simplifications)~~ are required or allowed in 4.3.

~~Operator Types and Sizes.~~ Products shall be rated using the ~~operator~~ product type, ~~opening/non-operator~~ configuration (opening/non-operating), and size in Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~. The sizes indicated in Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~ are intended to be representative of all variations in size. The configurations (opening/non-operating) indicated in Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~ are intended to be representative of all variations in configuration (opening/non-operating) for the product type and combinations of factory assembled units of the same product type and fixed units in a common frame, except where indicated in the footnotes. Separate ratings are required for other variations in configuration (opening/non-operating) that are not within a common frame.

******Rating of combination units in a common frame (in particular, three or more units in a common frame) is still under consideration. The THTF would welcome recommendations.******

Products shall be evaluated without screens, removable grilles, or any other applied devices.[14] Products shall be evaluated in the vertical position except where otherwise indicated in Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~.

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

[14] This language was from the simulation requirements in Chapter 5, but seems applicable to testing in Chapter 6. Consequently, the language has been moved to the general requirements in Chapter 4.

exceeds this percentage, a separate U-factor must be determined for the OAVA and glazed wall system.

Table ~~1~~1: Standard[15] Model Sizes and Configurations for Fenestration Products

Fenestration ~~Operator~~ Product Type	**Configuration: Opening (X) Non-operating (O) ~~Configuration~~**	**Model Size: Width x height in mm ~~(inches)~~[16]**
Windows		
Basement		See appropriate operator type(s)
Bay or bow		See appropriate operator type(s)
Dual action	X[17]	1200 x 1500 ~~(47 x 59)~~
Fixed (single)	O[18]	1200 x 1500 ~~(47 x 59)~~
Fixed (dual)	OO	1200 x 1500
Glazed wall system, vision	OO[19]	2000 x 2000 ~~(79 x 79)~~
Glazed wall system, opaque spandrel	OO[20]	2000 x 2000 ~~(79 x 79)~~
Greenhouse/garden	X[~~21~~ ; ~~22~~]	1200 x 1500 x 300 ~~(47 x 59 x 12)~~
Hinged, bottom/top – awning, hopper, projecting (single)	X[~~23~~]	1500 x ~~1200~~ 600 ~~(59 x 47)~~
Hinged, bottom/top – awning, hopper, projecting (dual)	XX	1500 x 1200
Hinged, side – casement (single)	X[~~24~~]	~~1200~~600 x 1500 ~~(47 x 59)~~
Hinged, side – casement (dual)	XX	1200 x 1500
Jalousie, Jal-Awning	X[~~325~~]	1200 x 1500 ~~(47 x 59)~~

[15] The sizes for the most common products are based on ISO 12567, but rounded to the nearest 100 mm.
[16] Rough opening minus installation clearances in mm ~~(inches)~~.
[17] Representative of all dual action windows and combinations of factory assembled dual action units and fixed units in a common frame.
[18] Representative of all fixed windows and combinations of factory assembled fixed units not in a common frame.
[19] Two vision panels with one vertical mullion. The vision portion of a curtain wall shall be simulated and tested with intermediate verticals as jambs and intermediate horizontals as head/sill frame members. The vision portion of a windowwall shall be simulated and tested with standard jamb, head, and sill members. The vision portion of a solarium shall be simulated and tested with standard jamb, head, and sill members.

[20] Two opaque spandrel panels with one vertical mullion. The opaque spandrel portion of a curtain wall shall be simulated and tested with intermediate verticals as jambs and intermediate horizontals as head/sill frame members. The opaque spandrel portion of a windowwall shall be simulated and tested with standard jamb, head, and sill members. The opaque spandrel portion of a solarium shall be simulated and tested with standard jamb, head, and sill members.

[21] Simulate or test the configuration with the greatest number of operable panels. If not manufactured with any operable panels, use O (fixed unit).

[22] If not manufactured, use O (fixed unit).
[23] Representative of all top or bottom hinged units and combinations of factory assembled top or bottom hinged units and fixed units not in a common frame.
[24] Representative of all side hinged units and combinations of factory assembled side hinged units and fixed units not in a common frame.

Fenestration ~~Operator~~ Product Type	**Configuration: Opening (X) Non-operating (O) ~~Configuration~~**	**Model Size: Width x height in mm ~~(inches)~~[16]**
Pivoted – vertical/horizontal	X[26]	1200 x 1500 ~~(47 x 59)~~
Sliding, horizontal	XX[27],[28],[29]	1500 x 1200 ~~(59 x 47)~~
Sliding, vertical – hung & non-hung	XX[30],[31],[32]	1200 x 1500 ~~(47 x 59)~~
Tropical awning	X[33]	1500 x 1200 ~~(59 x 47)~~
Doors[34]		
~~Garage doors~~[35]	~~X or multiple X~~	~~3000 x 2400 (118 x 94)~~[36]

[25] Representative of units with multiple vents.
[26] Representative of all pivoted windows and combinations of factory assembled pivoted units and fixed units in a common frame.

[27] ~~Or~~ Use XO if manufacturer does not make an XX, or OO if manufacturer does not make an XX or XO. XX represents XO and OO, and XO represents OO.
[28] XO is allowed to be used where the manufacturer does not provide XX.

[29] Representative of all horizontal sliding units and combinations of factory assembled horizontal sliding units and fixed units in a common frame.

[30] ~~Or~~ Use XO if manufacturer does not make an XX, or use OO if manufacturer does not make an XX or XO. XX represents XO and OO, and XO represents OO.

Do we want to specifically address double hung sash kits? Here is the NFRC 100 language for reference:

> Double hung sash kits shall be rated with one of the following two options:
>
> Option #1: Double hung sash kits shall be simulated and tested in a default frame of similar material and design as proposed for installation.
>
> Option #2: Double hung sash kits that are identical in material and design as a manufacturer's double hung product line is allowed to use the same ratings provided that the laboratory authorized to do the simulation states that the frame qualifies as a default frame per Option #1.

[31] XO is allowed to be used where the manufacturer does not provide XX

Do we want to specifically address double hung sash kits? Here is the NFRC 100 language for reference:

> Double hung sash kits shall be rated with one of the following two options:
>
> Option #1: Double hung sash kits shall be simulated and tested in a default frame of similar material and design as proposed for installation.
>
> Option #2: Double hung sash kits that are identical in material and design as a manufacturer's double hung product line is allowed to use the same ratings provided that the laboratory authorized to do the simulation states that the frame qualifies as a default frame per Option #1.

[32] Representative of all vertical sliding units and combinations of factory assembled vertical sliding units and fixed units in a common frame.

[33] Can represent multiple vents.
[34] What to do about door-lite manufacturers? Do not include for now.

Fenestration ~~Operator~~ Product Type	**Configuration: Opening (X) Non-operating (O) ~~Configuration~~**	**Model Size: Width x height in mm ~~(inches)~~[16]**
Hinged doors (swinging)	X[5,6~~37~~]	1000 x 2000 ~~(39 x 79)~~
Revolving doors	X[7~~38~~]	2000 x 2000 ~~(79 x 79)~~
Sliding doors	XO[8~~39~~, ~~40~~]	2000 x 2000 ~~(79 x 79)~~
Vehicular access doors	X or multiple X	3000 x 2400[9]
Door sidelights	O[10~~41~~, ~~42~~]	600 x 2000 ~~(24 x 79)~~
Door transoms	O[10~~43~~, ~~44~~]	2000 x 600 ~~(79 x 24)~~
Skylights[11~~45~~]		
Unit s~~S~~kylights/ roof windows	X[12~~46~~]	1200 x 1200 ~~(48x 48)~~[13~~47~~]
Sloped glazing (glazed roof system)	OO[14~~8~~]	2000 x 2000 ~~(79 x 79)~~

Footnotes to Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~

[35] Need to define standard frame.
[36] Test samples are allowed to be 2400 x 2400 mm ~~(94 x 94 in.)~~ if the test chamber can not handle the size in the table. In all cases, ratings are to be based on 3000 x 2400 mm ~~(118 x 94 in.)~~.
[37] If ~~you have~~the manufacturer makes a single door and a double door, the single shall represent the double door. If ~~you have~~ the manufacturer only makes a double door, then use 2000 x 2000 mm[37] ~~(79 x 79 in.)~~ .
[38] Rated in the closed position (i.e. the position with the most enclosed cavities). Calculated for the size specified in this table and using the heat flow through the entire revolving door and its enclosure including sidewalls and roof. Separate ratings are required for various wing configurations (e.g. with three, four, and five wings).
[39] Use XX ~~is allowed to be used~~ where the manufacturer does not ~~provide~~ make an XO.

[40] Representative of all sliding door units and combinations of factory assembled sliding door units and fixed units in a common frame.

[41] If operable, rate as the appropriate operator type.
[42] Representative of all door sidelites and combinations of factory assembled door sidelite units and fixed units in a common frame.

[43] If operable, rate as the appropriate operator type.
[44] Representative of all door transoms and combinations of factory assembled door transom units and fixed units in a common frame.

[45] Units to be rated at a 20 degree slope.
[46] If not manufactured, use O (fixed unit).
[47] Fits over a nominal 1180 x 1180 mm ~~(46.5 x 46.5 in.)~~ rough opening.
[48] Two vision panels with one vertical mullion. The vision portion of a curtain wall shall be simulated and tested with intermediate verticals as jambs and intermediate horizontals as head/sill frame members. The vision portion of a windowwall shall be simulated and tested with standard jamb, head, and sill members. The vision portion of a solarium shall be simulated and tested with standard jamb, head, and sill members.

[1] Two panels with one vertical mullion. A curtain wall shall be simulated and tested with intermediate verticals as jambs and intermediate horizontals as head/sill frame members. A windowwall shall be simulated and tested with standard jamb, head, and sill members. A solarium shall be simulated and tested with standard jamb, head, and sill members.

[2] Simulate or test the configuration with the greatest number of operable panels. If not manufactured with any operable panels, use O (fixed unit).

[3] Representative of units with multiple vents.

[4] Use XO if manufacturer does not make an XX, or OO if manufacturer does not make an XX or XO. XX represents XO and OO, and XO represents OO.

[5] If the manufacturer makes a single door and a double door, the single shall represent the double door. If the manufacturer only makes a double door, then use 2000 x 2000 mm.

[6] For manufacturers who provide door slabs only without the frame, the following default frames shall be used for ratings:

Wood default frame: 116 mm softwood single rabbetted frame of 8 to 12% moisture content, with a specific gravity of 0.35 to 0.45, and with a dual durometer plastic compression weatherstrip and flexible sweep. The door sill shall be a standard 116 mm extruded aluminum sill with a wall thickness of 1.4 mm to 1.6 mm with a poured-in-place polyurethane filled and a 3mm debridged thermal break with a conductivity of ??[49] without a wood substrate.

Steel default frame shall consist of a 146 mm - 16 Ga. pressed steel frame with a minimum 121 mm throat depth, applied weather-strip, and an aluminum non-thermally broken sill with a sill wall thickness of 1.4 mm to 1.6 mm and no substrate. Frame shall consist of a head jamb, hinge jamb, lock jamb, and necessary anchors and reinforcings for hinges and locks. See Figures ?? [50]

[7] Rating to include the heat flow through the A_{pf} (i.e. the rough opening in the wall) from all components of the revolving door assembly (including the revolving door wings and the walls and roof of the revolving door enclosure). Revolving door to be rated in the closed position (i.e. with the maximum number of enclosed cavities). Separate ratings are required for various wing configurations (e.g. with three, four, and five wings).

[8] Use XX where the manufacturer does not make an XO.

[9] Where ratings are determined by physical testing, test samples are allowed to be 2400 x 2400 mm if the test chamber can not handle the size in the table. However, in all cases, ratings are to be based on 3000 x 2400 mm.

[10] For operable configurations, rate as the appropriate operator type.

[11] Ratings to be at a 20 degree slope.

[12] If not manufactured, use O (fixed unit).

[13] Fits over a nominal 1180 x 1180 mm rough opening.

---

[49] Need standard value for conductivity.
[50] Need these figures.

4.2 Product Line.[51]

Groupings are provided as a means of simplifying and reducing the number of ratings. Groupings generally result in a more conservative rating. The use of groupings is optional. In all cases, the reports shall indicate where grouping has been used and what grouping has been done. *(Note that labeling and certification requirements may affect groupings.)*

Groupings shall be done in the order ~~specified~~that follows.

4.2.1 Frame Types.

4.2.1.1 Base Profile. Products shall be rated using the actual frame profile for all configurations or grouped with minor product variations required for alternate installation situations (e.g. removable brick moulds, mounting flanges, or jamb extensions). Cladding is considered a different base profile.

4.2.1.2 Base Profile Reinforcement. Products shall be rated using the actual frame profiles with and without reinforcement for all configurations or grouped with the frame profile having the highest heat loss. For simulation, multiple simulations shall be done for the frame alone. For testing, multiple tests shall be done for an overall fenestration product.

4.2.1.3 Base Frame Material. Products shall be rated using the actual frame material of the base profile identified in 4.4.1.1 for all configurations or grouped using the highest conductivity.

4.2.1.4 Outdoor Air Ventilator Assembly: Products with an outdoor air ventilator assembly (OAVA) in the frame that is 1.25% or more of the frame area shall be rated using the actual OAVA. For products where the OAVA area does not exceed 1.25% of the frame area, the product is allowed to be considered as having the same performance as the same product without an OAVA.

~~4.3.1.4**Base Profile Absorptance.** Products shall be rated using the following frame absorptances:~~

~~(a)a frame absorptance of 0.5 for glazed wall systems and sloped glazing systems.~~

~~(b)a frame absorptance of 0.3 for all other operator types products.~~

4.2.2 Multiple Glazing Units.

4.2.2.1 Gap Width. Products shall be rated using the actual gap width for all configurations or grouped using the narrowest gap width.

4.2.2.2 Gas Fill. Products shall be rated using the actual gas concentration for all configurations or grouped using air.

4.2.2.3 Spacer Type. Products shall be rated using the actual spacer type for all configurations or grouped using the spacer with the highest conductivity. The spacer with the highest conductivity is identified as follows. Once all spacer

[51] Deal only with groupings within a product line.

options have been identified within a product line, the frame and edge-of-~~glass~~glazing heat loss is simulated for each option using a representative cross-section with the lowest center-of-~~glass~~glazing U-factor in the product line. These products can then be grouped with each group represented by the spacer group leader which is the option with the highest frame and edge-of-~~glass~~glazing heat loss.

4.2.2.4 Dividers Widths. Products shall be rated using the actual divider widths for all configurations or grouped using the divider with the highest conductivity. The divider with the highest conductivity is identified as follows. Once all spacer options have been identified within a product line, the frame and edge-of-~~glass~~glazing heat loss is simulated for each option using a representative cross-section with the lowest center-of-~~glass~~glazing U-factor in the product line. These products can then be grouped with each group represented by the spacer group leader which is the option with the highest frame and edge-of-~~glass~~glazing heat loss.

Table 2~~2~~: Allowed Divider Groupings

Divider Range (DR) number	Divider Range in mm ~~(inches)~~	Represented by Divider in mm ~~(inches)~~
A	x ≤ 25 ~~(x ≤ 1.0)~~	40 ~~(1.6)~~
B	25 < x ~~(1.0 < x)~~	20 ~~(0.8)~~

4.3.2.5 Dividers Patterns. Products shall be rated using the actual divider patterns for every configuration or grouped using the pattern in Table 2: Allowed Divider Groupings~~Table 2: Allowed Divider Groupings~~.

4.2.3 Glass/Film Types.

4.2.3.1 Glass/Film Thickness. Products shall be rated using the actual thickness for all configurations or grouped as in Table 3: Allowed Glass Thickness Groupings~~Table 3: Allowed Glass Thickness Groupings~~:

Table 3~~3~~: Allowed Glass Thickness Groupings

Glass Thickness Range (GTR) category	Glass Thickness Range in mm ~~(inches)~~	Nominal Glass Thickness name	Represented by size in mm
A	X ≤ 2.0 ~~(x ≤ 0.079)~~	film	Actual

B	2.0 < x ≤ 4.5 ~~(0.079 ≤ x ≤ 0.177)~~	2.5, 3.0, 4.0	3.0
C	4.5 < x ≤ 6.5 ~~(0.177 < x ≤ 0.256)~~	5.0, 6.0	6.0
D	6.5 < x ~~(0.256 < x)~~	8 and larger	Actual

4.2.3.2 Glass/Film Emissivity[52]. Products shall be rated using the actual emissivity of the glass/film for all configurations or grouped as in Table 4: Allowed Glass/Film Emissivity Groupings~~Table 4: Allowed Glass/Film Emissivity Groupings~~:

Table ~~4~~4: Allowed Glass/Film Emissivity Groupings

Glass/Film Emissivity Range (GER) number	Glass/Film Emissivity Range	Represented by Emissivity
A	x ≤ 0.05	0.05
B	0.05 < x ≤ 0.10	0.10
C	0.10 < x ≤ 0.25	0.25
D	0.25 < x ≤ 0.40	0.40
E	0.40 < x ≤ 0.60	0.60
F	0.60 < x ≤ 0.80	0.80
G	0.80 < x	0.84

4.2.3.3 Tintings[53]. Products shall be rated using the actual tinting of the coatings or grouped as in Table 5: Allowed Glass Tinting Groupings~~Table 5: Allowed Glass Tinting Groupings~~:

Table ~~5~~5: Allowed Glass Tinting Groupings

Glass Tinting Range (G?R) number	Glass Tinting Range	Represented by Tint

[52] Decide whether grouping is allowed for emissivity.
[53] Decide whether grouping is allowed for tintings.

A	X ≤ 0.05	?

~~4.2.4~~

~~Grouping is permitted in the standard to reduce the potential exponential growth of ratings due to the combination of fenestration product components. To provide technically accurate product thermal performance indices, simulate or test every variation of every product type. Grouping is permitted where the result satisfies all four of the following conditions:~~

~~(a)the highest U-factor~~
~~(a 0.60 may represent 0.59 or lower, but not U-0.61 or higher)~~

~~(b)the lowest CI~~
~~(a 65 may represent a 66 or higher, but not a 64 or lower)~~

~~(c)the highest SHGC, limited to groupings of 0.02 lower~~
~~(a 0.46 may represent a 0.45 or 0.44, but not 0.47 or higher or 0.43 or lower)~~

~~(d)the lowest VT, limited to groupings of 0.02 higher~~
~~(a 0.52 may represent a 0.53 or 0.54, but not 0.55 or higher or 0.51 or lower)~~

~~Grouping using a worst-case spacer (e.g., aluminum).~~

~~*Option A:* A product line is defined by an operator type and a frame material type. Groupings of products are allowed provided that~~

~~(a)The U-factor does not increase (i.e., is based on the worst case U-factor)~~

~~(b)The CI does not decrease (i.e., is based on the worst case CI)~~

~~(c)the glass to frame ratio does not change by more than ?% (SHGC).~~

~~(d)frame material is the same (U-factor)~~

~~(e)spacer type? (condensation)~~

~~A product line is a given series of fenestration products of the same operator type as listed in Table XX that differ only in:~~

~~(a) size;~~

~~(b) center-of-glass and edge-of-glass characteristics such as glazing types, glazing coatings, gas-fills, gap widths, use of dividers, use of spacers;~~

~~(c) opening/non operating configurations, e.g., XO vs. XOX;~~

~~(d) changes[54] to accommodate smaller/larger glazing unit widths;~~

~~(e) minor changes to operating hardware to accommodate higher/lower loads and stresses (including the use of reinforcing in vinyl framed fenestration products);~~

~~(f) frame or sash changes where one component is replaced by another component of the same physical shape with a thermal conductivity that does not differ by more than a factor of 10; and~~

~~(h)interior/exterior appendages added to the main web of the frame that are not exposed after product installation, i.e., nailing fins.~~

~~A product line is thus defined by an operator type and a set of basic frame profiles. For each frame/sash element, a **base profile** must be defined. Frame/sash profiles which differ from these base profiles are part of the same product line as long as the differences are limited to lengthening, shortening, expanding, or deleting specific elements[55] of the base profile (typically incorporated into the product line for different installations). Such differences in the base profile constitute different individual products within the product line. Material changes where the conductivity changes by more than a factor of 10 are not part of the same product line except for the addition of cladding materials applied to the base profile.~~

~~Multipurpose fenestration products incorporating nearly identical frame/sash base profiles can be classified and rated as one product line. The products shall be classified in separate groups by operator type within the product line.~~

~~Clad products and unclad products can be incorporated into one product line if and only if the cladding system represents a minor change to the frame/sash base profile. The clad and unclad products would be separate individual products within the product line.~~

~~Non-rectangular fenestration products shall be rated as though they are rectangular fenestration products. Identify all the frame cross sections of the non-rectangular fenestration product. Find or develop a product line with the same frame cross sections as the non-rectangular fenestration product, and choose the rectangular sizes closest to residential and nonresidential for simulation and testing. If there are no rectangular sizes available in those ranges, a non-rectangular fenestration product with the same frame cross sections, and the closest possible total area (see Section ??) can be used for simulation or testing~~

~~4.3**Individual Products.** An individual product is any one specific fenestration product, of any size, within a product line specific to:~~

~~(a) center-of-glass and edge-of-glass characteristics;~~

~~(b) minor frame differences (variations on the base profile--see Section 4.1);~~

[54] Need to define how much change is allowed and under what terms (U-factor, dimensions, etc.)
[55] We need to clarify this so that it is workable.

~~(c) sealing characteristic variables and elements;~~

~~(d) opening/non-opening configurations, e.g., XO vs. XOX; and~~

~~(d)operator type.~~

~~Variations in frame or sash interior/exterior finish, paint, varnish, or stain do not constitute different products provided that each of these variations do not change the surface emittance by more than 0.1 or overall thickness by more than 0.41 mm (0.016 in.).~~

~~Continuous hardware, reinforcing, or other frame component changes to the same base profile are considered different individual products within the same product line.~~

~~Individual products where the sill design changes to accommodate different installation requirements but the materials remain the same shall be considered different individual products within the same product line.~~

~~Reinforced vinyl products and products without reinforcement with the same base profile are considered different individual products within the same product line.~~

~~Inswinging and outswinging doors with the same base profile are considered different individual products within the same product line.~~

~~Products with different glazing divider patterns do not need to be treated as different individual products. The manufacturer may define a standard glazing divider pattern (which is a standard product offering) and which uses glazing dividers 200 mm (8 in.)[56] on-center or less. If no standard product offerings exist with glazing divider patterns 200 mm (8 in.) on-center or less, a glazing divider pattern with an on-center dimension closest to but not greater than 200 mm (8 in.) shall be used as the glazing divider pattern.~~

~~Fenestration products which include an outdoor air ventilator assembly (OAVA) are considered to be the same individual product if the OAVA area, expressed as a percentage of the model size area, is less than the value computed in Equation 1. Products with an area percentage larger than given in Equation 1 are treated as separate individual products.~~

$$P_{OAVA} = \frac{\left(W_{OAVA} \cdot H_{OAVA}\right)}{\left(W_m \cdot H_m\right)} \cdot 100 \qquad \text{[Equation 1]}$$

~~Where:~~

[56] Module size based on preferred sizes from *Preferred Metric Numbers for Building Construction*. See footnote to Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~.

~~P_{OAVA} = percentage of OAVA rounded up to the nearest 0.5%~~
~~W_{OAVA} = width of glazing in mm (in.)~~
~~H_{OAVA} = a constant, 50 mm (2.0 in.)~~
~~W_m, H_m = width, height of model size in mm (in.)~~

~~OAVA's are defined as devices, other than a sash unit, for the purpose of controlling the passage of air through a fenestration product. An OAVA shall not allow outside air access to cavities within the cross-sectional boundaries of the sash, frame, or glazing. Any components that are added to the fenestration product to facilitate the installation of the OAVA shall be considered to be an integral part of the OAVA for the purpose of calculating the total area of the ventilator assembly.~~

~~4.~~4.3 Material Values

~~4.5.1~~ ~~4.~~3.1 **Material Conductivities.** Material conductivities shall be determined in accordance with Appendix B: Material Conductivities~~Appendix B: Material Conductivities~~~~Appendix ?? ***need to insert appendix***~~.

~~4.5.2~~ ~~4.~~3.2 **Material Absorptance.** Material ~~conductivities~~ absorptances shall be determined in accordance with Appendix B: Material Conductivities~~Appendix B: Material Conductivities~~~~Appendix ?? ***need to insert appendix***~~.

~~4.5~~4.4 Product Specimens.

~~4.5.1~~4.4.1 **Production Line Specimens.** All simulation and/or test samples shall be production line specimens.

EXCEPTION: For new products, which are defined as products not in production, the simulation and/or test shall be conducted with a prototype specimen that is replicates the expected production line product to the greatest extent possible.

~~4.5.2~~4.4.2 **Size of Specimen.** For simulation, the size dimensions shall be as shown in Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~. For test, the size dimensions shall comply with the least deviation equation for the size in Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~ using the following formula:

D = *need square root symbol over brackets* $[(W_p - W_m)^2 + (H_p - H_m)^2]$[57]

Where:

D = deviation in mm ~~(in.)~~

[57] Fix equation.

W_p, H_p= width, height of product test specimen

W_m, H_m = width, height of standard size of operator type from Table 1: Standard Model Sizes and Configurations for Fenestration Products~~Table 1: Standard Model Sizes and Configurations for Fenestration Products~~.

~~4.5.3~~4.4.3 Gas Fill. Simulation specimens shall assume standard air as the gas fill and test specimens shall have standard air as the gas fill, unless the manufacturer demonstrates otherwise per the procedures of **CAN/CGSB-12.8-~~M90~~97** *Insulating Glass Units*.

~~4.5.4~~4.4.4 Gap Width. Simulation specimens shall be assumed to have planar layers with a constant gap width. Test specimens shall have an initial glazing deflection, either concave (collapsed) or convex (over-filled), measured upon arrival at the test laboratory of:

(a) for products with an edge-of-~~glass~~glazing gap width of 13 mm ~~(1/2 in.)~~, a center-of-~~glass~~glazing deflection (concave or convex) of 3 mm ~~(1/8 in.)~~ or less.

(b) for products with an edge-of-~~glass~~glazing gap width of more than 13 mm ~~(1/2 in.)~~, a center-of-~~glass~~glazing deflection (concave or convex) of 6 mm ~~(1/4 in.)~~ or less.

EXCEPTION: Products which are intended to have non-planar surface, such as dome skylights.

(See Appendix C: Glazing Deflection~~Appendix C: Glazing Deflection~~**.)**

~~4.5.5~~4.4.5 Specimen Handling and Processing. For testing,

(a) The testing laboratory shall maintain records documenting the condition of the test specimen upon its arrival at the testing facility.

(b) The testing laboratory shall notify the manufacturer in writing if the product arrives damaged (i.e. broken ~~glass~~glazing, damaged frame/~~sash~~stile or rail components, etc.).

(c) Prior to the issuance of a final report, the testing laboratory shall disassemble the test specimen in such a manner after testing in order to verify the description of the product in the test report.

~~4.5.6~~4.4.6 Retention of Information. Simulation/test laboratories shall maintain electronic records of the information used as the basis for the simulation/test index for a period of not less than four years. In addition, the test laboratory shall retain, in a safe and protected location, each whole fenestration product tested or representative corner and cross sections of all the fenestration product components for a period not less than one year after the date a test report is first issued by the laboratory.

~~4.6~~4.5 Simulation and Test Reports.

~~4.6.1~~4.5.1 Contents. The following material shall be included in all simulation and test reports:

(a) Name, address, and phone number of simulation/test laboratory.

(b) Location and identification of simulation program and/or test equipment utilized.

(c) Simulation/test date.

(d) Name and address of client.

(e) Serial number, date or other appropriate means of identifying each individual product report.

(f) Simulation/test method employed.

(g) A statement that the simulation/tests were conducted in full compliance with the applicable requirements.

(h) A bill of materials, assembly drawings, extrusion drawings, and a description of the specimen including the following (Note: some items listed may not be applicable in certain cases):

1. Manufacturer, name of location, and series or model number.
2. General description of product (operator type, size, framing type, glazing type, spacer type).
3. Bill of materials including vendor name and part numbers.
4. Parts drawings (i.e., frame, ~~sash~~stile or rail, glazing, hardware, etc.).
5. Physically measured parameters (sizes and thicknesses measured to 1 mm ~~(1/32 inches)~~; i.e., overall window dimensions, operable and/or fixed sash dimensions, glazing daylight openings, and door component parts).
6. Glazing material(s), including thickness, coatings, and/or internal films (emissivity, if known) and their location (surface) per *NFRC 100(?)*[58].
7. Measured air space at the edge-of-glazing, and at the center-of-glazing. For test, the test laboratory shall measure and report the glazing deflection of the specimen upon initial arrival at the test facility and immediately following the test. The report shall indicate the amount of deflection and whether the deflection is concave (collapsed) or convex (over-filled).
8. Verification of documented design gas fill concentration and fill method, including actual measurement of the oxygen concentration in the air cavity(ies).
9. Spacers—materials and construction per *NFRC 100@*.
10. Grilles—materials, placement and pattern.
11. Detailed description of the framing, ~~sash~~stile or rail, frame and sash corner/joint construction, glazing installation, weatherstripping (types and locations), drainage and finish.

[58] List numbering sequence instead, e.g. “measured from the outside to the inside”?

12. All hardware—operator and other components.
13. All descriptive items in the simulation/test report which have not been measured or verified by the test lab must be clearly indicated in the report.
14. The simulation/test specimen size and design.

(i) Simulation/test results, including all the information required by Appendix D: Test Data Sheets (Required Information)~~Appendix D: Test Data Sheets (Required Information)???~~.

(j) For test, date of last complete hot box calibration and last calibration check.

(k) For test, statement of experimental uncertainty associated with tests and data reduction when available.

(l) Any additional comments or data deemed important in the understanding or review of the report.

(m) Name and signature of individual accepting responsibility for the technical accuracy of a simulation/test report.

(n) Name and signature of individual conducting the simulation/test.

(o) A statement that the report may not be reproduced, except in full, without the approval of the laboratory.

(p) A statement that the report relates only to the fenestration products simulated/tested.

(q) For test, a drawing indicating the location of each specified thermocouple and the corresponding surface temperature.

(r) A statement indicating whether the product simulated/tested was a production line specimen, a prototype specimen, or as a test only option as identified by the manufacturer.

(s) All numerical values derived from the simulation/test of the product, except where otherwise indicated, shall be reported in the final report to two ~~significant digits~~decimal places in accordance with ASTM E29 procedures. (i.e. X.XX).

(t) Any non-standard simulation/test specimen size and non-standard simulation/test conditions used shall also be reported. If the simulation/test specimen size is non-standard (± 13 mm~~½" in~~) width and/or height of the Model size referenced in Table 1 of NFRC 100), then the text "non-standard size" shall be inserted immediately following the size everywhere the size is listed, both in the full report and in any summary. If the simulation/test conditions are non-standard, then the text "non-standard conditions" shall be inserted immediately following the name of the procedure, such as NFRC 100, everywhere the simulation/test procedure is listed, both in the full report and in any summary.

(u) The following statement shall be included in the test report directly after the above results are reported.

For U-factor, "This method does not include procedures to determine the heat flow due to either air movement through the specimen or solar radiation effects. As a consequence, the thermal transmittance results obtained do not reflect performances which may be expected from field installations due to not accounting for solar radiation, air leakage effects, and the thermal bridge effects that may occur due to the specific design and construction of the fenestration system opening. Therefore, it should be recognized that the thermal transmittance results obtained from this method are for standard conditions and should only be used for fenestration product comparisons and as input to thermal performance analyses which also include solar, air leakage and thermal bridge effects."[59]

(v) The criteria used to establish steady-state conditions and the test period duration.

(w) The information as required in Appendix D: Test Data Sheets (Required Information)~~Appendix D: Test Data Sheets (Required Information)~~.

(x) The information required in the applicable procedure (e.g. for U-factor, ASTM C1363, Section 12. Report; for SHGC, ASTM CXXXX, Section X. Report.or NFRC 201, Section ~~X~~??[60]. Report; for visible transmittance, ASTM E1175, Section ???[61]; for condensation, ???[62].)

~~4.6.2~~4.5.2 Units. Indices shall be reported in SI units. If both SI and I-P units are desired, indices shall be reported in SI (metric) units first, with I-P (inch-pound) units following in parentheses.[63]

(a) For U-factor, indices shall be reported to the nearest 0.01 $W/m^2 K$. (If I-P units are provided, U-factor shall be reported to the nearest 0.002 $Btu/ft^2 F$).

(b) For Solar Heat Gain Coefficient, indices shall be reported to the nearest 0.01 with a leading figure.

(c) For visible transmittance, indices shall be reported to the nearest 0.01 with a leading figure.

(d) For condensation, indices shall be reported to the nearest whole number[64].

Calculations shall be done with a minimum of one additional decimal place beyond that specified above for reporting.

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[59] Need corresponding statement for SHGC, visible transmittance, condensation.
[60] Dan, can you provide this section reference?
[61] Do we have a section reference?
[62] Do we have a section reference?
[63] Need to discuss units for: inputs into simulation/tests, for measurements for simulation/tests, and for reporting of results and ratings for simulation/tests. For example, is it allowed to make measurements and inputs in I-P units, calculate results in I-P units and then convert final answer to SI units?
[64] Check for consistency with final index.

5. SIMULATION

5.1 General. Simulation shall comply with the requirements of

(a) 5.1 General, and

(b) 5.2 U-factor (where simulation is being done for U-factor),

(c) 5.3 Solar Heat Gain Coefficient (where simulation is being done for SHGC),

(d) 5.4 Visible Transmittance (where simulation is being done for visible transmittance), and

(e) 5.5 Condensation (where simulation is being done for condensation).

Simulations shall be performed using computer programs that comply with the ISO 15099 (ASHRAE SPC142) calculation procedure, except where noted.

5.2 U-factor.

5.2.1 General Equation. The total product U-factor shall be determined using computed U-factors for the center-of-glazing area, edge-of-glazing area, frame area, divider area, and divider-edge area obtained by methods defined in ISO 15099, and the following equation:

$$U_t = \left(\frac{\Sigma(U_c \times A_c) + \Sigma(U_e \times A_e) + \Sigma(U_f \times A_f) + \Sigma(U_d \times A_d) + \Sigma(U_{de} \times A_{de})}{A_{pf}} \right)$$

where
U_t = U-factor of the total product, W/(m^2•K)
U_c = center-of-glazing U-factor, W/(m^2•K)
U_d = divider U-factor, W/(m^2•K)
U_{de} = divider-edge U-factor, W/(m^2•K)
U_e = edge-of-glazing U-factor, W/(m^2•K)
U_f = frame U-factor, W/(m^2•K)
A_c = center-of-glazing area, m^2
A_d = divider area, m^2
A_{de} = divider-edge area, m^2
A_e = edge-of-glazing area, m^2
A_f = frame area, m^2
A_{pf} = projected fenestration area, m^2

5.2.2 Environmental Conditions.

5.2.2.1 Temperatures. The temperature conditions used in the simulations shall be: exterior air and sky temperatures of -18 C, and an interior temperature of 21 C.

5.2.2.2 Surface Conductances. Surface conductance values used in the simulations shall be in accordance with ISO 15099. For purposes of this standard, the outdoor side heat surface conductance for convection shall be 24 W/m^2K (which corresponds to a wind speed of approximately 5.0 m/s).

5.2.2.3 Radiation. Radiation heat transfer shall be simulated in accordance with ISO 15099. ISO 15099 has two methods for handling detailed radiation heat transfer on interior surfaces of projecting products. Per ISO 15099 either of these methods is acceptable.

5.2.2.4 Solar Radiation. The incident solar radiation used in the simulations shall be 0 W/m^2.

5.2.3 Computations.

5.2.3.1 Center-of-Glazing. Center-of-glazing U-factor shall be computed using procedures in compliance with ISO 15099.

EXCEPTION: For products where the center-of-~~glass~~glazing component can not be simulated, the center-of-~~glass~~glazing component only (without any frame) shall be tested in accordance with:

(a) homogeneous materials
ASTM C 177[65]
ASTM C 518

(b) non-homogeneous materials
~~ASTM C 177?~~[66]
~~ASTM C 518?~~
ASTM C 1199

~~… and t~~These results shall ~~then~~ be used in the simulation.[67]

5.2.3.2 Edge-of-Glazing, Frame, Divider, and Divider-Edge. Using a computer program capable of modeling two-dimensional heat transfer, and procedures in compliance with ISO 15099, the following shall be computed:

(a) the edge-of-glazing U-factor;

(b) the frame U-factor;

(c) the divider U-factor; and

(d) the divider-edge U-factor.

5.3 Solar Heat Gain Coefficient (SHGC)

5.3.1 General Equation.[68] The total product SHGC shall be determined using computed SHGCs for the glazing area and for the frame and divider area obtained

$$SHGC_t = \left(\frac{\sum(SHGC_g \times A_g) + \sum(SHGC_f \times A_f) + \sum(SHGC_d \times A_d) + \sum(SHGC_{de} \times A_{de})}{A_{pf}} \right)$$

[65] Working Group IV to provide correct references.
[66] Working Group IV to provide correct references.
[67] For U-factor, how should we reference the center-of-glass test procedures? Should those specific test procedures be referenced in the simulation section (as they are only allowed for use as part of the simulation process)?

by methods defined in ISO 15099 and using the following equation[69],[70]:

where
$SHGC_t$ = solar heat gain coefficient of the total product, dimensionless
$SHGC_c$ = solar heat gain coefficient of the center-of-glazing, dimensionless
$SHGC_e$ = solar heat gain coefficient of the edge-of-glazing, dimensionless
$SHGC_f$ = solar heat gain coefficient of the frame, dimensionless
$SHGC_d$ = solar heat gain coefficient of the divider, dimensionless
$SHGC_{de}$ = solar heat gain coefficient of the divider-edge, dimensionless
A_c = center-of-glazing area, m^2
A_e = edge-of-glazing glass area, m^2
A_f = frame area, m^2
A_d = divider area, m^2
A_{de} = divider-edge area, m^2
A_{pf} = projected fenestration area, m^2

5.3.2 Environmental Conditions.

5.3.2.1 Temperatures. The temperature conditions used in the simulations shall be: outdoor air and sky temperatures of 32 C, and an indoor temperature of 24 C.

5.3.2.2 Surface Conductances. Surface conductance values used in the simulations shall be in accordance with ISO 15099. For purposes of this standard, the outdoor side heat surface conductance for convection shall be 12 W/m^2K (which corresponds to a wind speed of approximately 2.5 m/s).

5.3.2.3 Radiation. Radiation heat transfer shall be simulated in accordance with ISO 15099. ISO 15099 has two methods for handling detailed radiation heat transfer on interior surfaces of projecting products. Per ISO 15099 either of these methods is acceptable.

5.3.2.4 Solar Radiation. The incident solar radiation used in the simulations shall be 783 W/m^2.

5.3.3 Computations.

5.3.3.1 Center-of-Glazing. The center-of-glazing SHGC shall be computed using procedures in compliance with ISO 15099.

EXCEPTION: For products where the center-of-glass component can not be simulated, the center-of-~~glass~~glazing component only (without any frame) shall be tested in accordance with

~~(a) Homogeneous (~~NFRC 201~~?)~~[71].

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[68] Limits on screens and other applied devices moved to Chapter 4.
[69] Equation is viewable in Page Layout view. Jeff, can you send me this equation in a format (as you did for the U-factor equation) that can be viewed without going to Page Layout.
[70] Projecting products still need to be addressed.
[71] Working Group V to provide correct references.

~~(b) non-homogeneous… and t~~These results shall ~~then~~ be used in the simulation.[72]

5.3.3.2 Edge-of-Glazing and Divider-Edge. The edge-of-glazing and divider-edge SHGC shall be equal to the center-of-glazing SHGC.

5.3.3.3 Frame and Divider. The frame and divider SHGC shall be computed using a procedures in compliance with ISO 15099. ISO 15099 has two methods for handling solar heat gain on the frame and divider. Per ISO 15099 either of these methods is acceptable.

A frame and divider absorptance of 0.3 shall be used for all products except glazed wall and sloped glazing systems. Glazed wall and sloped glazing systems shall use a frame and divider absorptance of 0.5.

5.3.3.4 Matrix. Determine the total fenestration product SHGC values for center-of-glazing SHGC values of 0.0 and 1.0. Total fenestration product SHGC values should be determined for all applicable cases. Where grouping is done for dividers in accordance with Section 4.2.2.4: calculate for the cases with no dividers, and all the cases identified in Section 4.2.2.4.

For any known center-of-glazing SHGC, the total fenestration product SHGC is to be calculated using the following equation:

$$SHGC_w = SHGC_0 + SHGC_{cg} * \left(SHGC_1 - SHGC_0\right)$$

where:

$SHGC_0$ = the total fenestration product SHGC for the center-of glass SHGC of 0.0 and

$SHGC_1$ = the total fenestration product SHGC for the center-of-glazing SHGC of 1.0.

Calculations with $SHGC_c$, $SHGC_0$, and $SHGC_1$ values shall be done with a minimum of one additional decimal place beyond that specified for reporting in Section 4.5.2~~4.6.2~~. The final SHGC value shall be reported in accordance with Section 4.5.2~~4.6.2~~.

5.4 Visible Transmittance (VT)

5.4.1 General Equation.[73] The total product VT shall be determined using computed VTs for the glazing area and for the frame and divider area obtained by methods defined in ISO 15099 and using the following equation[74]:

[72] For SHGC, how should we reference the center-of glass test procedures? Should those specific test procedures be referenced in the simulation section (as they are only allowed for use as part of the simulation process)?

[73] Limits on screens and other applied devices moved to Chapter 4.

[74] Equation is viewable in Page Layout view. Jeff, can you send me this equation in a format (as you did for the U-factor equation) that can be viewed without going to Page Layout.

$$VT_{t=} = \left(\frac{VT_c \times A_c + VT_e \times A_e + VT_f \times A_f + VT_d \times A_d + VT_{de} \times A_{de}}{A_{pf}} \right)$$

where
VT_t = visible transmittance of the total product, dimensionless
VT_c = visible transmittance of the center-of-glazing, dimensionless
VT_e = visible transmittance of the edge-of-glazing, dimensionless
VT_f = visible transmittance of the frame, dimensionless
VT_d = visible transmittance of the divider, dimensionless
VT_{de} = visible transmittance of the divider-edge, dimensionless
A_c = center-of-glazing area, m^2
A_e = edge-of-glazing area, m^2
A_f = frame area, m^2
A_d = divider area, m^2
A_{de} = divider-edge area, m^2
A_{pf} = projected fenestration area, m^2

5.4.2 Environmental Conditions. The environmental conditions used in the simulations for visible transmittance shall be the same as those used for SHGC calculations in Section 5.3.2.

5.4.3 Computations.

5.4.3.1 Center-of-Glazing. The center-of-glazing VT shall be computed using procedures in compliance with ISO 15099.

EXCEPTION: For products where the center-of-~~glass~~glazing component can not be simulated, the center-of-~~glass~~glazing shall be tested in accordance with ASTM E 1175 "Standard Test Method for Determining Solar Photopic Reflectance, Transmittance, and Absorptance of Materials Using a Large Diameter Integrating Sphere". ~~… and t~~These results shall ~~then~~ be used in the simulation.[75]

5.4.3.2 Edge-of-Glazing and Divider-Edge. The edge-of-glazing and divider-edge SHGC shall be equal to the center-of-glazing SHGC.

5.4.3.3 Frame and Divider. Opaque frame and opaque divider VT[76] are equal to 0.00. Non-opaque frame and divider VT shall be determined in accordance with Section 5.4.3.1, Exception.

5.4.3.4 Matrix. Determine the total fenestration product VT values for center-of-glazing VT values of 0.0 and 1.0. Total fenestration product SHGC values should be determined for all applicable cases. Where grouping is done for dividers in

[75] For visible transmittance, how should we reference the center-of glass test procedures? Should those specific test procedures be referenced in the simulation section (as they are only allowed for use as part of the simulation process)?
[76] Jeff, there was also a reference to "FT". What is that? Was that a typo?

accordance with Section 4.2.2.4: calculate for the cases with no dividers, and all the cases identified in Section 4.2.2.4.

For any known center-of-glazing VT, the total fenestration product VT is to be calculated using the following equation:

$$VT_w = VT_0 + VT_c * (VT_1 - VT_0)$$

where:

VT_0 = the total fenestration product VT for the center-of glass VT of 0.0 and
VT_1 = the total fenestration product VT for the center-of-glazing VT of 1.0.

Calculations with VT_c, VT_0, and VT_1 values shall be done with a minimum of one additional decimal place beyond that specified for reporting in Section 4.5.2~~4.6.2~~. The final SHGC value shall be reported in accordance with Section 4.5.2~~4.6.2~~.

5.5 Condensation

****** Work on the condensation simulation procedure is on going and is not available at this time. ******

~~**EXCEPTION:** For products where the center-of-glass component can not be simulated, the center-of-glass shall be tested in accordance with … and these results shall then be used in the simulation.~~[77]

[77] For condensation, is a center-of-glass test procedure needed? If so, how should we reference the center-of glass test procedures? Should those specific test procedures be referenced in the simulation section (as they are only allowed for use as part of the simulation process)?

6. TESTING

6.1 **General.** Testing shall comply with the requirements of

(a) 6.1 General, and

(b) 6.2 U-factor (where testing is being done for U-factor),

(c) 6.3 Solar Heat Gain Coefficient (where testing is being done for SHGC),

(d) 6.4 Visible Transmittance (where testing is being done for visible transmittance), and

(e) 6.5 Condensation (where testing is being done for condensation).

6.2 U-factor. The total fenestration product U-factor shall be determined in accordance with the following:

(a) ASTM C 1199 *Standard Test Method for Measuring the Steady State Thermal Transmittance of Fenestration Systems Using Hot Box Methods*, and

(b) ASTM E 1423 *Practice for Determining the Steady-State Thermal Transmittance of Fenestration Systems*.

6.3 Solar Heat Gain Coefficient (SHGC). The total fenestration product SHGC shall be determined in accordance with the following NFRC 201 *Standard Test Method for Measuring the Solar Heat Gain Coefficient of Fenestration Systems Using Calorimetry Hot Box Methods.*

6.4 Visible Transmittance (VT).[78]

6.5 Condensation. The condensation resistance index shall be determined using the procedures in 6.2, tested concurrently when testing for U-factor, and under the same environmental test conditions.[79]

[78] What procedure should be used? Working Group V to make recommendation.
[79] The 18 October 2000 conference call said to use the same procedure as for U-factor. Is this complete and complete? Do we need anything else here?

APPENDICES

Appendix A~~A~~: Approximate I-P Conversions for Information Purposes Only

The units used throughout the document are SI (metric) units. All measurements are to be done in SI units. Compliance is to be determined based on SI units. The following are approximate I-P conversions for the SI units used in this procedure. **These conversions are for information only. They are NOT acceptable for determining compliance with this procedure.**

Approximate I-P Conversions for Information Purposes Only

	Exact SI Unit	Approximate I-P Conversion
Section 2		
Product size	610 mm	24 in.
Product size	700 mm	27 in.
Section 4		
Physically measured parameters	1 mm	1/32 in.
Glass thickness range	2.0 mm	5/64 in.
Glass thickness range	3.0 mm	1/8 in.
Glass thickness range	4.5 mm	11/64 in.
Glass thickness range	6.0 mm	15/64 in.
Glass thickness range	6.5 mm	1/4 in.
Glazing deflection	3 mm	1/8 in.
Glazing deflection	6 mm	1/4 in.
Gap width	13 mm	1/2 in.
Non-standard size width and/or height	13 mm	1/2 in.
Divider size	20 mm	3/4 in.
Divider size	25 mm	1 in.
Divider size	40 mm	1-3/4 in.
Outdoor air ventilator assembly	50 mm	2 in.

Divider pattern	200 mm	8 in.
Product size	300 mm	12 in.
Product size	600 mm	24 in.
Product size	700 mm	27 in.
Product size	1000 mm	39 in.
Product size	1180 mm	46-1/2 in.
Product size	1200 mm	47 in.
Product size	1500 mm	59 in.
Product size	2000 mm	79 in.
Product size	3000 mm	118 in.
Default door frames	1.4 mm	0.055 in.
Default door frames	1.6 mm	0.065 in.
Default door frames	3 mm	1/8 in.
Default door frames	116 mm	4-9/16 in.
Default door frames	121 mm	4-3/4 in.
Default door frames	146 mm	5-3/4 in.
Physical measurement accuracy	1 mm	1/32 in.
U-factor	0.01 W/m^2 K	0.002 Btu/ft^2 F
Section 5		
Outdoor side heat surface conductance for convection	12 $W/m^2 \cdot K$	2.11 $Btu/h \cdot ft^2 \cdot ^oF$
Outdoor side heat surface conductance for convection	24 $W/m^2 \cdot K$	4.23 $Btu/h \cdot ft^2 \cdot ^oF$
Incident solar radiation	783 W/m^2	248 $Btu/h \cdot ft^2$
Temperature	24 C	75 ºF
Temperature	32 C	90 ºF
Wind speed	2.5 m/s	5.6 mph
Wind speed	5.0 m/s	11.2 mph

Appendix B~~B~~: Material Conductivities[80]

Name	Material Type	Conductivity (Btu/h-ft-oF)	Emissivity	Frame Btu-in/h-ft^2-F	Program Btu/h-ft-F	W/m-K
Aluminum Alloys	Solid	92.448	0.2	1109.36	92.447	159.993
ABS/ASA (Cycolac/Geloy)				0.91	0.076	0.131
Asphalt/ Tar				5.13	0.428	0.740
Brick:Concrete (2400 kg/m3)				15.95	1.329	2.300
Brick:Fired Clay (2400 kg/m3)				9.71	0.809	1.400
Built-Up Roofing				1.18	0.098	0.170
Butyl Rubber		0.138	0.9	1.66	0.138	0.239
Cardboard Honeycomb				1.11	0.093	0.160
Cellular Glass				0.35	0.029	0.050
Cellulose				0.28	0.023	0.040
Cellulosic Fibre				0.28	0.023	0.040
Cement: Lime, Mortar & Stucco				7.63	0.636	1.100
Cement Plaster: Sand Aggregate				4.85	0.404	0.699
Compressed bat insulation						
Concrete: 480 kg/m3, Extra-Low Density Agg.				1.11	0.093	0.160
Concrete: 1600 kg/m3, Low Density Agg.				5.2	0.433	0.750
Concrete: 2400 kg/m3, High Density Agg.				15.95	1.329	2.300
Crushed Stone				11.79	0.983	1.700
Fiberglass (PE Resin)		0.173	0.9	2.08	0.173	0.300
Fiberglass (reinforced nylon)				1.6	0.133	0.231
Foam Rubber		0.017	0.9	0.21	0.018	0.030
Foam Weatherstripping		0.017	0.9	0.21	0.018	0.030
Glass (plate or float)		0.577	0.84	6.93	0.578	0.999
Glass Fibre (Rigid) Roof Insulation				0.33	0.028	0.048
Glass Fibre (Semi-Rigid) Sheathing				0.24	0.020	0.035
Glass Fibre (Spray Applied)				0.27	0.023	0.039
Gypsum Board				1.11	0.093	0.160
Gypsum Plaster: Low Density Aggregate				1.59	0.133	0.229
Gypsum Plaster: Sand Aggregate				5.69	0.474	0.821
Gypsum Sheathing				1.11	0.093	0.160
Hardboard: Medium Density (800 kg/m3)				0.76	0.063	0.110
Hardwood Flooring				1.11	0.093	0.160

[80] Dragan to provide updated table.

Insul. Fibreboard (Ceiling Tile, Lay-in Panel)			0.42	0.035	0.061
Insul. Fibreboard (Roof Board)			0.38	0.032	0.055
Insul. Fibreboard (Sheathing, Building Board)			0.42	0.035	0.061
Interior Finish (plank, tile) Board			0.35	0.029	0.050
Mineral Fibre-Loose Fill (Rock, Slag, Glass)			0.35	0.029	0.050
Mineral Fibre-Low Density (Rock. Slag, Glass)			0.29	0.024	0.042
Mineral Fibre-Med. Density (Rock. Slag, Glass)			0.27	0.023	0.039
Mineral Fibre-High Density (Rock, Slag, Glass)			0.25	0.021	0.036
Mohair (Poly)	0.08	0.9	0.97	0.081	0.140
Sweep					
Neoprene	0.109	0.9	1.32	0.110	0.190
Nylon	0.144	0.9	1.73	0.144	0.250
Particle Board			0.76	0.063	0.110
Particle Board: Low Density (590 kg/m3)			0.69	0.058	0.100
Particle Board:Medium Density (800 kg/m3)			0.97	0.081	0.140
Particle Board: High Density (1000 kg/m3)			1.18	0.098	0.170
Particle Board: Underlayment			0.76	0.063	0.110
Perlite			0.37	0.031	0.053
Plywood- Interior			0.83	0.069	0.120
Finish					
Plywood			0.76	0.063	0.110
(Softwood)					
PMMA (Plexiglass, Lucite)	0.115	0.9	1.39	0.116	0.200
Polycarbonate	0.109	0.9		0.000	0.000
(Lexan)					
Polyethylene (high density)	0.3	0.9	3.61	0.301	0.521
Polyethylene (low density)	0.19	0.9		0.000	0.000
Polyisobutylene	0.138	0.9	1.66	0.138	0.239
(PIB)					
Polyisocyanurate/Polyurethane-Faced Sheathing			0.14	0.012	0.020
Polyisocyanurate/Polyurethane-Initial			0.12	0.010	0.017
Polyisocyanurate/Polyurethane-Unfaced Board			0.17	0.014	0.025
Polystyrene			0.26	0.022	0.037
Polystyrene- Expanded Type 1			0.26	0.022	0.037
Polystyrene- Expanded Type 2&3			0.24	0.020	0.035
Polystyrene- Extruded Type 2,3&4			0.2	0.017	0.029
Polysulphide	0.109	0.9	1.32	0.110	0.190
Polyurethane Foam Insulation (Spray Applied)			0.17	0.014	0.025
Polyurethane, HCFC blown- Initial			0.12	0.010	0.017
Polyurethane, HCFC blown- 5 yr. Aged			0.15	0.013	0.022
PVC/Vinyl (Rigid)	0.098	0.9	1.18	0.098	0.170
Silica Gel	0.017	0.9	0.21	0.018	0.030
(desiccant)					
Silicone	0.208	0.9	2.5	0.208	0.361
Silicone Foam	0.098	0.9	1.18	0.098	0.170
Slate			9.71	0.809	1.400

Steel - ANSI 1040 Mild	27.734	0.2	332.81	27.734	47.998
Steel - ANSI 304 Stainless	8.262	0.2	99.15	8.263	14.299
Steel-Galvanized Sheet (0.14% carbon)			429.88	35.823	61.998
Stone: Calcitic, Dolomite, Granite, Limestone			15.95	1.329	2.300
Stone: Quartzitic, Sandstone			23.57	1.964	3.399
Terrazzo			12.48	1.040	1.800
Tile- Ceramic			13.17	1.098	1.899
Tile- Cork			0.49	0.041	0.071
Tile- Linoleum, Vinyl, Rubber			1.18	0.098	0.170
Urethane (liquid)	0.179	0.9	2.15	0.179	0.310
Vermiculite			0.46	0.038	0.066
Vinyl cladding			1.18	0.098	0.170
Vinyl (flexible)	0.069	0.9	0.83	0.069	0.120
Waferboard			0.63	0.053	0.091
Wood	0.06	0.9		0.000	0.000
Wood (Cedar or Redwood)	0.063	0.9	0.76	0.063	0.110
Wood (hardwood: maple)	0.092	0.9	1.11	0.093	0.160
Wood (Pine, Spruce, Fir)	0.08	0.9	0.97	0.081	0.140
Wood (Studs: White Pine, Fir, Spruce)			0.83	0.069	0.120
Wood Subfloor			0.76	0.063	0.110

Appendix C~~C~~: Glazing Deflection

Variations in the pressure in the space between the sheets of ~~glass~~glazing in sealed glazing units may cause deflections in the ~~glass~~glazing. In extreme cold weather cases, the ~~glass~~glazing surfaces may bow and come into contact with each other at their centerpoints. This change in the enclosed space dimensions can significantly effect the thermal conductance, C_S, and the thermal transmittance, U_S, of the test specimen. Factors which can cause a pressure unbalance between the glazing unit enclosed air space and the surrounding environment are:

(1) Differences in the barometric pressure due to a difference in the elevations of the fenestration system manufacturing facility and the testing facility.
(2) Changes in barometric pressure at the testing facility due to local weather variations.
(3) Changes in the mean temperature of the glazing unit enclosed airspace during testing.

Recognizing that ~~glass~~glazing deflection can cause a change in the thermal conductance, C, and the thermal transmittance, U, an estimation of the gap spacing between the ~~glass~~glazing sheets is required immediately before and after the test. The initial gap thickness can be estimated by either measuring the overall glazing thickness at the center or measuring the deflection profile of each ~~glass~~glazing plate and then subtracting the thickness of the individual plates. Gap thickness during the test can be estimated from the initial thickness measurements minus the change in ~~glass~~glazing deflections which occur during the test. The glazing deflection measurements shall be performed on both sides of the fenestration system and must be included in the test report. The glazing deflection measurements should be performed:

(1) After the fenestration system has been delivered to the testing laboratory and has come to equilibrium in the laboratory.
(2) Just before the test commences, and
(3) Immediately after the test is completed and the test specimen enclosed air space mean temperature is close to that which existed during the test.

Appendix D~~D~~: Test Data Sheets (Required Information)

~~** Convert to SI? **~~

Measured Test Data

Heat Flows

1. Total measured input into metering box (Q_{total}) _____~~Btu/hr~~W
2. Surround Panel Heat Flow (Q_{sp}) _____~~Btu/hr~~W
3. Metering Box Wall Heat Flow (Q_{mb}) _____~~Btu/hr~~W
4. Flanking Loss Heat Flow (Q_{fl}) _____~~Btu/hr~~W
5. Net Specimen Heat Loss (Q_s) _____~~Btu/hr~~W

Areas

1. Test Specimen Projected Area (A_s) _____~~Ft~~m^2
2. Test Specimen Interior Surface Area (A_{int}) _____~~Ft~~m^2
3. Test Specimen Exterior Surface Area (A_{ext}) _____~~Ft~~m^2
4. Metering Box Opening Area (A_{mb}) _____~~Ft~~m^2
5. Metering Box Interior Baffle Area (A_{b1}) _____~~Ft~~m^2
6. Metering Box Exterior Baffle Area (A_{b2}) _____~~Ft~~m^2
7. Surround Panel Interior Exposed Area (A_{sp}) _____~~Ft~~m^2

Test Conditions

1. Average Metering Room Ambient Temperature _____~~F~~C
2. Average Weather Side Ambient Temperature _____~~F~~C
3. Average Guard/Environmental Ambient Temperature _____~~F~~C
4. Metering Room Average Relative Humidity _____%
5. Measured Exterior Wind Velocity _____~~mph~~m/s
6. Measured Static Pressure Difference Across Test Specimen _____~~psf~~
7. Surround Panel Thickness _____~~inches~~m

m

Surface Temperature Data

1. Specimen Area-weighted interior surface temperature (t_1) _____~~F~~C
2. Specimen Area-weighted exterior surface temperature (t_2) _____~~F~~C
3. Area-weighted interior frame surface temperature _____~~F~~C
4. Area-weighted exterior frame surface temperature _____~~F~~C
5. Area-weighted interior edge-of-~~glass~~glazing surface temperature _____~~F~~
6. Area-weighted exterior edge-of-~~glass~~glazing surface temperature _____~~F~~

7. Area-weighted interior center-of-~~glass~~glazing surface temperature _____ ~~F~~
8. Area-weighted exterior center-of-~~glass~~glazing surface temperature _____ ~~F~~

Results

1. Thermal Transmittance of test specimen (U_S) _____ ~~B~~
2. Standardized Thermal Trans. of Test Specimen (U_{staw}) _____ ~~Btu/hr-ft^2-F~~W/m^2-C
3. Standardized Thermal Trans. of Test Specimen (U_{stcts}) _____ ~~Btu/hr-ft^2-F~~W/m^2-C

Calculated Test Data

Method A (Modified) Procedure

1. Room Side Surface Conductance (h_I) _____ ~~B~~
2. Weather Side Surface Conductance (h_{II}) _____ ~~B~~
3. Test Specimen Thermal Conductance (C_S) _____ ~~B~~
4. Standardized Thermal Transmittance (U_{st}) _____ ~~B~~
5. Standardized Room Side Surface Conductance (h_{stI}) _____ ~~Btu/hr-ft^2-F~~W/m^2-C
6. Standardized Weather Side Surface Conductance (h_{stII}) _____ ~~Btu/hr-ft^2-F~~W/m^2-C

Method B (Equivalent "CTS" Method)

1. Room Side Surface Conductance (h_I) _____ ~~B~~
2. Weather Side Surface Conductance (h_{II}) _____ ~~B~~

3. Test Specimen Thermal Conductance (C_s) _____~~B~~
4. Standardized Thermal Transmittance (U_{st}) _____~~B~~
5. Convection Coefficient (K) _____~~B~~
6. Radiative Test Specimen Heat Flow (Q_{r1}) _____~~Btu/hr~~W
7. Conductive Test Specimen Heat Flow(Q_{c1}) _____~~Btu/hr~~W
8. Equivalent Room Side Surface Temperature _____~~F~~C
9. Equivalent Weather Side Surface Temperature _____~~F~~C
10. Room Side Baffle Surface Temperature (T_{b1}) _____~~F~~C
11. Cold Side Baffle Surface Temperature (T_{b2}) _____~~F~~C
12. Standardized Room Side Surface Conductance (h_{stI}) _____~~B~~
13. Standardized Weather Side Surface Conductance (h_{stII}) _____~~B~~
14. Emittance of ~~Glass~~Glazing (e1) _____
15. Warm Side Baffle Emittance (eb1) _____

Note: List results for both methods!

Test Duration (must be completed in full)

1. The environmental systems were started at _____ hrs. on _____.
2. The test parameters were considered stable for two consecutive two hour test periods from _____ hrs., _____ to _____ hrs., _____.
3. The thermal performance test results were derived from _____, hrs., _____ to _____ hrs., _____.

Discuss the method used to determine U_{st} and explain why that method was chosen

_____
_____
_____

Surface Temperature and Area Information

Individual Temperature Measurements			***Area-weighted Measurements***			
_____*Individual Surface Temperatures*			*Assigned Areas per TC Location*		*Area-weighted Temperatures*	
Thermocouple #	*Interior* (~~F~~C)	*Exterior* (~~F~~C)	*Interior* (~~ft~~m^2)	*Exterior* (~~ft~~m^2)	*Interior* (~~F~~C)	*Exterior* (~~F~~C)
1	_____	_____		_____	_____	_____
2	_____	_____		_____	_____	_____

3	_____	_____	_____	_____	_____
4	_____	_____	_____	_____	_____
5	_____	_____	_____	_____	_____
6	_____	_____	_____	_____	_____
7	_____	_____	_____	_____	_____
8	_____	_____	_____	_____	_____
9	_____	_____	_____	_____	_____
10	_____	_____	_____	_____	_____
11	_____	_____	_____	_____	_____
12	_____	_____	_____	_____	_____
13	_____	_____	_____	_____	_____
14	_____	_____	_____	_____	_____
15	_____	_____	_____	_____	_____
16	_____	_____	_____	_____	_____
17	_____	_____	_____	_____	_____
18	_____	_____	_____	_____	_____
19	_____	_____	_____	_____	_____
20	_____	_____	_____	_____	_____
21	_____	_____	_____	_____	_____
22	_____	_____	_____	_____	_____
23	_____	_____	_____	_____	_____
24	_____	_____	_____	_____	_____
25	_____	_____	_____	_____	_____
26	_____	_____	_____	_____	_____
27	_____	_____	_____	_____	_____
28	_____	_____	_____	_____	_____
29	_____	_____	_____	_____	_____
30	_____	_____	_____	_____	_____

Average interior area-weighted surface temperature	_____	~~F~~C
Average exterior area-weighted surface temperature	_____	~~F~~C

Measured interior surface area	_____	~~ft~~m^2
Measured exterior surface area	_____	~~ft~~m^2