



National Fenestration Rating Council Incorporated

NFRC 100A-2010

Procedure for
Determining Fenestration Attachment Product U-factors

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FOREWORD

The National Fenestration Rating Council, Incorporated (NFRC) develops and operates a uniform rating system for energy and energy-related performance of fenestration and fenestration attachment products. The Rating System determines the U-factor, Solar Heat Gain Coefficient (SHGC), and Visible Transmittance (VT) of a product, which are mandatory ratings for labeling NFRC-certified products, and are mandatory ratings for inclusion on label certificates, and are supplemented by procedures for voluntary ratings of products for Air Leakage (AL) and Condensation Resistance. Together these rating procedures, as set forth in documents published by NFRC, are known as the NFRC Rating System.

The NFRC Rating System employs computer simulation and physical testing by NFRC-accredited laboratories to establish energy and related performance ratings for fenestration and fenestration attachment product types. The NFRC Rating System is reinforced by a certification program under which NFRC-licensed responsible parties claiming NFRC product certification shall label and certify fenestration and fenestration attachment products to indicate those energy and related performance ratings, provided the ratings are authorized for certification by an NFRC-licensed Certification and Inspection Agency (IA).

The requirements of the rating, certification, and labeling programs (Certification Programs) are set forth in the most recent versions of the following as amended, updated, or interpreted from time to time:

- NFRC 700 Product Certification Program (PCP)
- NFRC 705 Component Modeling Approach (CMA) Product Certification Program (CMA-PCP)

and through the Certification Programs and the most recent versions of its companion programs as amended, updated, or interpreted from time to time:

- The laboratory accreditation program (Accreditation Program), as set forth in the NFRC 701 Laboratory Accreditation Program (LAP)
- The IA licensing program (IA Program), as set forth in NFRC 702 Certification Agency Program (CAP)
- The CMA Approved Calculation Entity (ACE) licensing program (ACE Program) as set forth in the NFRC 708 Calculation Entity Approval Program (CEAP)

NFRC intends to ensure the integrity and uniformity of NFRC ratings, certification, and labeling by ensuring that responsible parties, testing and simulation laboratories, and IAs

adhere to strict NFRC requirements.

In order to participate in the Certification Programs, a Manufacturer/Responsible Party shall rate a product whose energy and energy-related performance characteristics are to be certified in accordance with mandatory NFRC rating procedures. At present, a Manufacturer/Responsible Party may elect to rate products for U-factor, SHGC, VT, AL, condensation resistance, or any other procedure adopted by NFRC, and to include those ratings on the NFRC temporary label affixed to its products or on the NFRC Label Certificate. U-factor, SHGC and VT, AL, and condensation resistance rating reports shall be obtained from a laboratory that has been accredited by NFRC in accordance with the requirements of the NFRC 701.

The rating shall then be reviewed by an IA that has been licensed by NFRC in accordance with the requirements of the NFRC 702. NFRC-licensed IAs review label format and content, conduct in-plant inspections for quality assurance in accordance with the requirements of the NFRC 702, and issue a product Certification Authorization Report (CAR) and may approve for issuance an NFRC Label Certificate for site-built or CMA products and attachment products. The IA is also responsible for the investigation of potential violations (prohibited activities) as set forth in the NFRC 707 Compliance and Monitoring Program (CAMP).

Products that are labeled with the NFRC Temporary and Permanent Label, or products that are listed on an NFRC Label Certificate in accordance with NFRC requirements, are considered to be NFRC-certified. NFRC maintains a Certified Products Directory (CPD), listing product lines and individual products selected by the Manufacturer/Responsible Party for which certification authorization has been granted.

NFRC manages the Rating System and regulates the PCP, LAP, and CAP in accordance with the NFRC 700 (PCP), the NFRC 701 (LAP), the NFRC 702 (CAP), the NFRC 705 (CMA-PCP), and the NFRC 708 (CEAP) procedures, and conducts compliance activities under all these programs as well as the NFRC 707 (CAMP). NFRC continues to develop the Rating System and each of the programs.

NFRC owns all rights in and to each of the NFRC 700, NFRC 701, NFRC 702, NFRC 705, NFRC 707, NFRC 708 and each procedure, which is a component of the Rating System, as well as each of its registration marks, trade names, and other intellectual property.

The structure of the NFRC programs and relationships among participants are shown in Figure 1, Figure 2, and Figure 3. For additional information on the roles of the IAs and laboratories and operation of the IA Program and Accreditation Program, see the NFRC 700 (PCP), NFRC 701 (LAP), and NFRC 702 (CAP) respectively.

Figure 1

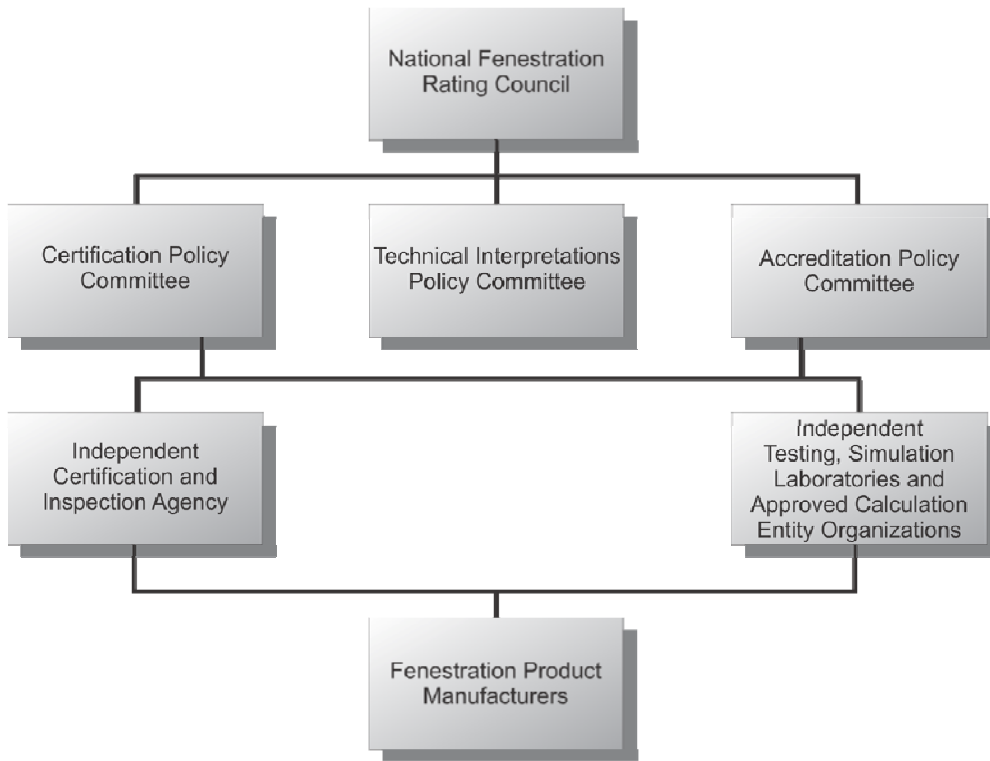


Figure 2

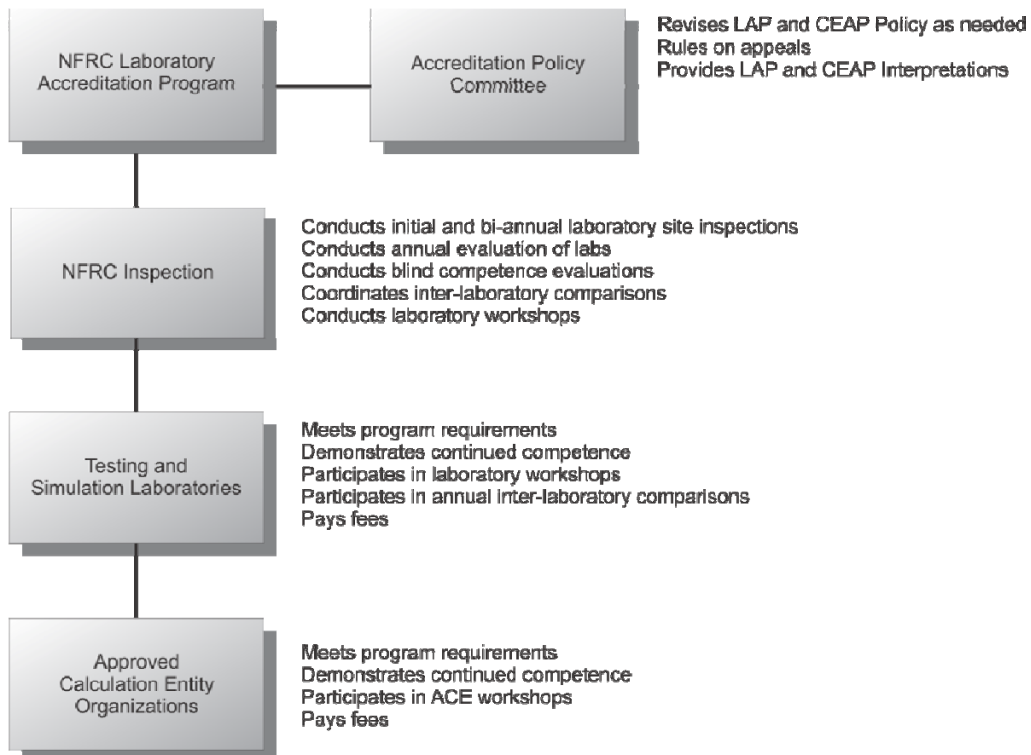
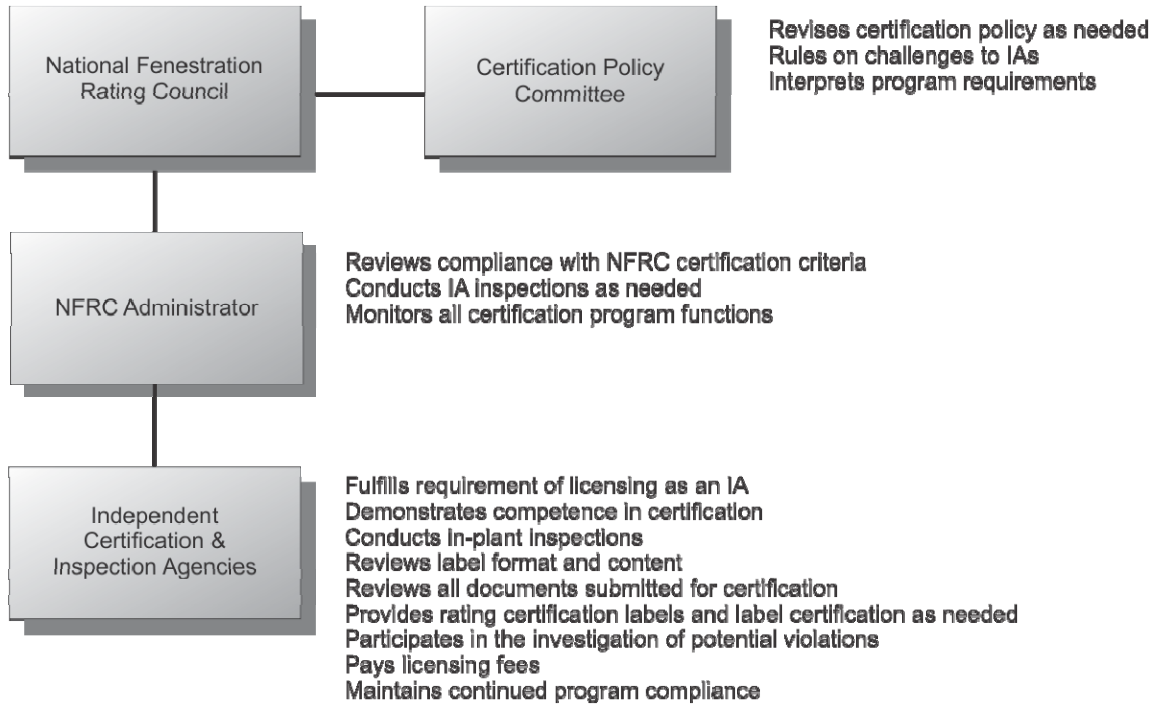


Figure 3



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

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DISCLAIMER

NFRC certification is the authorized act of a Manufacturer/Responsible Party in: (a) labeling a fenestration or related attachment product with an NFRC Permanent Label and NFRC Temporary Label, or (b) generating a site built or CMA label certificate, either of which bears one or more energy-related performance ratings reported by NFRC-accredited simulation and testing laboratories and authorized for certification by an NFRC-licensed IA. Each of these participants acts independently to report, authorize certification, and certify the energy-related ratings of fenestration and related attachment products.

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1. PURPOSE

To specify a method for determination of U-factor for all fenestration attachment products that are co-planar to the fenestration products, excluding products covered in NFRC 100 Section 5.7 and Applied Films.

2. SCOPE

This standard applies to all co-planar fenestration attachment products, both interior and exterior as described in Section 1, "Purpose."

2.1 Fenestration Attachment Product Lines

A fenestration attachment product line is a series of products with distinct structural configuration as listed and shown in Table 5.1. Only the product lines stated in Table 5.1 are covered for this technical procedure. Location (such as exterior and interior) and orientation (such as vertical or horizontal) to the fenestration product constitute separate product lines. The following changes are the only allowable changes within a product line:

- A. Orientation of slats, pleats, shutters, louvers, operating hardware, and mounting hardware such as vertical or horizontal;
- B. Width or thickness of slats, pleats, louvers, and shutters;
- C. Operating hardware, hardware enclosures, and mounting hardware and enclosures;
- D. Material composition such as wood, polymer, fabric, or metal;
- E. Opacity and openness of material such as opaque to translucent or perforated;
- F. Emissivity of the attachment material (shading or glazing, for example); and
- G. The number of cells or compartments to trap air.

2.2 Fenestration Attachment Individual Products

An individual fenestration attachment product is a variation of a specific product line as defined in Table 5-1. The following are the variables of a product line, which are changed to build an individual fenestration attachment product. Each individual fenestration attachment product based on manipulation of the following product line variables shall be simulated or tested in accordance with Section 4.1.

The fenestration attachment product line variables are as follows:

2.2.1 Cellular Type Attachment

An individual cellular type attachment product is characterized by one or more of the following applicable variables.

- Cell size based on 6mm (0.25 in) intervals +/- 3 mm (0.19 in). Please refer to Figure 6.5 for an illustration on cell size determination
- Cell structure – differentiated by cell count through the depth
 - Single Cell
 - Cell within a cell
 - Full cell within a cell
 - Split cell within a cell
 - Two cells through depth
 - Three cells through depth
- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Edge Seals (such as but not limited to Track type seal)

2.2.2 Slat or Louver Type Attachment

An individual slat or louver type attachment product is characterized by one or more of the following applicable variables. Slat/Louver size is based on 6 mm (0.25 in) intervals (as shown in Figure 6-6).

- Slat/Louver thickness is based on 0.25 mm (0.01 in) intervals (as shown in Figure 6-6)
- Louver profile: flat, curved, or complex
- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.3 Sheer Type Attachment

An individual sheer type attachment product is characterized by one or more of the following applicable variables.

- Integrated Slat/Louver size is based on 6 mm (0.25 in) intervals (as shown in Figure 6-7)
- Type of material, such as but not limited to: Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.4 Shutter Type Attachment

An individual shutter type attachment product is characterized by one or more of the following applicable variables.

- Slat/Louver size is based on 6 mm (0.25 in) intervals (as shown in Figure 6-8)
- Slat/Louver thickness is based on 0.25 mm (0.01 in) intervals measured at the thickest point (as shown in Figure 6-6)
- Shutter frame dimensions (as shown in Figure 6-8)
- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.5 Pleated Type Attachment

An individual pleated type attachment product is characterized by one or more of the following applicable variables.

- Pleat size is based on 6 mm (0.25 in) intervals, as shown in Figure 6-9
- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)

- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.6 Roller Type Attachment

An individual roller type attachment product is characterized by one or more of the applicable variables.

- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.7 Roman Shade Type Attachment

An individual Roman type attachment product is characterized by one or more of the following applicable variables.

- Segment spacing is based on 6 mm (0.25 in) intervals (as shown in Figure 6-10)
- Segment loop overlap size is based on 3 mm (0.19 in) intervals (as shown in Figure 6-10)
- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film.
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.8 Drape Type Attachment

An individual drape type attachment product is characterized by one or more of the following applicable variables.

- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)

- Any type of glazing with any type of fenestration attachment product (reference NFRC 100 sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.9 Flat Panel Attachment – Non-Glazed

An individual flat panel type attachment product is characterized by one or more of the following applicable variables.

- Number of materials layers
- Type of material, such as but not limited to Metal, Wood, Fabric, and/or Film
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

2.2.10 Flat Panel Attachment – Glazed

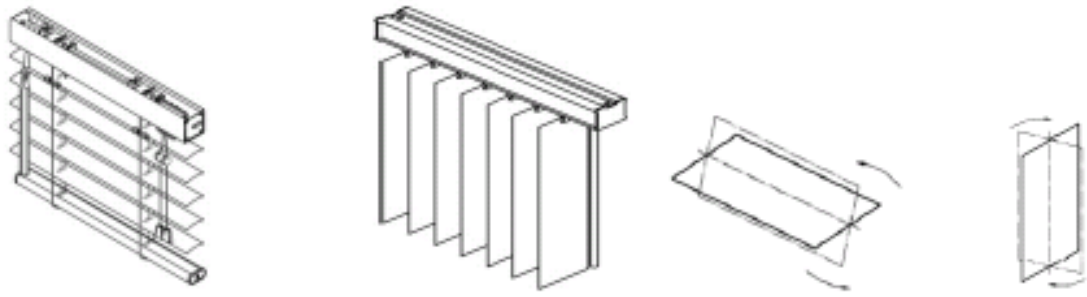
An individual glazed attachment product is characterized by one or more of the following applicable variables.

- Type of glazing materials, such as but not limited to glass and polymers
- Type of coatings on glazings, such as but not limited to films and low-e coatings
- Number of glazing layers
- Glazing thickness
- Dividers
- Configuration (Fixed, Single, Double Hung, or other)
- Any type of frame with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.5)
- Any type of glazing with any type of fenestration attachment product (reference NFRC 100, Sections 4.2.1, 4.2.2, 4.2.4.1, 4.2.4.3, 4.2.4.4)
- Any fenestration attachment product that incorporates Attachment Edge Seals (such as but not limited to Track type seal)

3. DEFINITIONS

Refer to NFRC 600 document for a definition on each of the attachment products. Following are some of the important terms referred in this document.

Articulating Fenestration Attachment Products: Fenestration Attachment Products that can deploy/retract as well as articulate. (Several examples are shown below; these examples are not all inclusive.)



Blind: A fenestration attachment product that has louvers in either a horizontal or vertical orientation which can be articulated to open or closed to manage light transmission.

Cellular shades: A fenestration attachment product that has a cellular structure. This attachment can be horizontal or vertical.

Attachment Edge Seal: Any device purposely constructed to reduce the air flow between the fenestration attachment product and the fenestration product casement.

Fenestration Attachment: A device (such as, but not limited to, shades, films, or blinds) designed to be physically attached to, incorporated with or covering a fenestration product.

Exterior Attachments: Fenestration attachment products located on the outside of the building envelope.

Interior Attachments: Fenestration attachment products located on the inside of the building envelope.

Fixed Fenestration Attachment Product: A fenestration attachment product designed to be non-operable.

Insulative flat panels: A fenestration attachment product made from any combination of material with a rigid flat panel frame.

Opaque (adj.): Not allowing visible light to pass through.

Roller shades, Solar shades, Roller Shutters: A fenestration attachment product that can be retracted and rolled onto the shaft.

Shade: A fenestration attachment product with horizontal panels that has one of several styles including, but not limited to: flat roman (figure 1), hobbled, and soft fold, and can be made with or without backing. (See non articulating fenestration attachment product for image)

Sheer shade: A fenestration attachment product made from a woven/knit material with or without soft or semi-rigid louvers. This product can have following construction: a) A

single layer of sheer material without louvers; b) A single layer of sheer material with louvers on the back; c) Two parallel layers of sheer material with a horizontal vane in between the two layers of fabric. This product can be horizontal or vertical.

Shutter: A fenestration attachment product that is rigid and usually consisting of a frame of vertical stiles and horizontal rails (top, center and bottom). Set within this frame can be louvers (both operable and inoperable) and/or solid panels that can be mounted within a frame.

Single layer Pleated shade: A fenestration attachment products made from a single layer of pleated flexible material.

4. GENERAL

4.1 Compliance

Fenestration attachment product ratings shall be determined by following the procedure outlined in Section 4.2. This section presents and references methods for determining specific attachment product heat transfer properties or quantities used in the determination of these properties.

4.2 Product Line Simulation and Testing

The total fenestration attachment product U-factor shall be determined by simulation where a validated simulation exists and performed with fenestration attachment product in both the fully open and fully closed positions using all Fenestration Attachments Reference Windows (defined in Table 5-2) or Fenestration Attachments Reference Skylights (defined in Table 5-3).

Each product line will be validated utilizing a representative fenestration attachment product tested according to Section 4.2.3 utilizing the double glazed clear version of the Fenestration Attachments Reference Window (defined in Table 5-2) and/or Fenestration Attachments Reference Skylight (defined in Table 5-3). The simulation and tested U-factors must validate according to Section 4.2.4.

4.2.1 Fenestration Attachment Products Standard Simulation and Test Installation Instructions

This section presents procedures for installing fenestration attachment product on a reference window.

- All Fenestration Attachment Products shall utilize the following installation instructions, except where product design prevents usage
 - In the case where product design prevents usage the manufacturer's recommended installation shall be followed and modified to follow the instructions below as closely as possible

- Skylight Fenestration Attachment Products shall be installed according to manufacturer's installation instructions using the instructions given below if applicable

4.2.1.1 Fenestration Attachment Products Standard Simulation and Test Installation Instructions

- A. The fenestration attachment product shall be evaluated in conjunction with all Fenestration Attachments Reference Windows (defined in Table 5-2) or Fenestration Attachments Reference Skylights (defined in Table 5-3);
- B. Installed "inside" the window/skylight recess (reveal, day lighting region) which shall be based on the Fenestration Attachments Reference Windows/Skylights sizes,
 - i. Oriented in the maximum thickness configuration (typically fully open) the plane of the attachment nearest to the glazing shall be 25 mm (1 in) from the center of glazing interior surface;
 - ii. The fenestration attachment product to edge of frame allowance shall be the result of manufacturer's standard deductions based on applicable Fenestration Attachments Reference Windows or Fenestration Attachments Reference Skylights construction;
- C. Installed "outside" the window/skylight frame which is based on the Fenestration Attachments Reference Windows/Skylights sizes,
 - i. Edge of attachment shall overhang the frame by 50 mm (2.0 in) +/- 6 mm (0.25 in) except as addressed in Section 4.2.1.1.D;
- D. Product shall be simulated as installed:
 - i. Products shall be installed according to manufacturer's installation instructions utilizing the specific dimension given above in 4.2.1.1.A-C,
 - ii. These dimensions may be adjusted if the construction and manufacturer-recommended installation instructions preclude their use. If the dimensions listed in A-C are not used, the actual dimensions shall be recorded; and
- E. The fenestration attachment product shall be evaluated in both the fully open and fully closed positions.

[Note: Utilize the "as installed" position for non-operating/fixed in place devices.]

4.2.1.2 Installation Requirements for Testing and Simulation Exterior Fenestration Attachment Products

- A. The fenestration attachment product shall be evaluated in conjunction with all the Fenestration Attachments Reference Windows in Table 5-2 or all of the Fenestration Attachments Reference Skylights in Table 5-3;
- B. Exterior attachments can be installed “inside” the window recesses or “outside” the window frame,
 - i. For attachments installed “inside”:
 - (a) The fenestration attachment product to edge of frame allowance shall be assumed to be a result of manufacturer’s standard deductions based on applicable Fenestration Attachments Reference Windows or Fenestration Attachments Reference Skylights construction,
 - ii. For attachments installed “outside”:
 - (a) The minimum attachment overlap beyond the edge of frame is 37 mm + 6 mm (1.5 in + 0.25 in);
- C. Oriented in the maximum thickness configuration (typically fully open) the plane of the attachment nearest to the glazing shall be located from 50 mm +/- 6 mm (2 in +/- 0.25 in) from center of glazing exterior surface;
- D. Attachment shall be simulated as installed.
 - i. Products shall be installed according to manufacturer’s installation instructions utilizing the specific dimension given above in A-C,
 - ii. These dimensions may be adjusted if the construction and manufacturer-recommended installation instructions preclude their use. If the dimensions listed in A-C are not used, the actual dimensions utilized will be recorded;
- E. The fenestration attachment product shall be evaluated in both the fully open and fully closed positions; and

[Note: Utilize the “as installed” position for non operating/fixed in place devices.]
- F. The open space between attachment and window frame shall be between 0 mm (0 in) (no air space) and 50 mm (2 in).

4.2.2 Calculation of Total Fenestration Attachment Products Rating

All ratings will be derived utilizing the Fenestration Attachment Product Reference Windows/Skylights (listed in Tabled 5-2 and 5-3). The Fenestration Attachment Product Reference Windows/Skylights shall be constructed as indicated in Section 6.

Fenestration Attachment Product Reference Window/Skylight U-factors are determined utilizing the applicable Fenestration Attachment Product Reference product only during simulation and testing. Total Fenestration Attachment Product Reference Window/Skylight U-factor is determined utilizing the applicable Fenestration Attachment Product Reference Window/Skylight with the attachment installed during simulation and testing.

4.2.3 Testing

If the fenestration attachment product cannot be simulated then testing shall be conducted as detailed in NFRC 102 and the following sections:

4.2.3.1 Fenestration Attachment Product Reference Window/Skylight Test Procedure

Testing shall be conducted as detailed in NFRC 102 to determine the Fenestration Attachment Product Reference Window/Skylight U-factors.

- The reference window U-factor will be verified utilizing NFRC 102 each time a reference window is installed and each time it is removed
- An inspection log for each window will be maintained onsite detailing:
 - Construction date of window and who built it
 - The date of U-factor verification and the value
 - The general condition of the window
 - Seals intact
 - Glass intact
 - Frame intact – no dents, cracks, warping, or tears
- All reference windows will be stored
 - In a dry area (70% RH or less), shielded from direct sunlight
 - Relative temperature between 50° F and 100° F
 - In such a manner as to minimize damage to framing and glass.

4.2.3.2 Total Fenestration Attachment Products Test Procedure

Testing shall be conducted as detailed in NFRC 102 with the following additional items added:

Fenestration Attachment Products shall be installed as indicated in Section 4.1. The system shall be tested with the product in both the fully open and the fully closed positions or “as installed” position for non-operating/fixed in place devices.

4.2.4 Validation

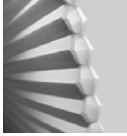
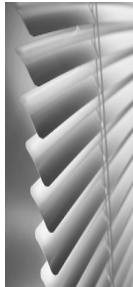


Simulated and tested U-factors for a given total fenestration attachment product shall be considered equivalent if the agreement between the two numbers is within the ranges in Table 4-1.



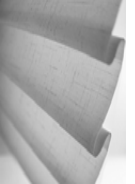
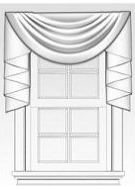

Table 4-1 -- Equivalence


Simulated U-factor	Accepted Difference Between Tested and Simulated U-factor
1.7 W/m ² K (0.3 Btu/h·ft ² ·°F) or less	0.17 W/m ² K (0.03 Btu/h·ft ² ·°F) or less
Greater than 1.7 W/m ² K (0.3 Btu/h·ft ² ·°F)	10% of Simulated U-factor

5. TABLES

5.1 Fenestration Attachment Product Lines

Product Line	Product Description	Picture / Sketch	Vane Rotation or lateral movement to increase or decrease transmitted daylight
Cellular Type	An attachment made from fabric or laminated film or any combination of material, which has cellular construction. Cellular structure is defined as two or more layers joined at the pleats to form compartments or cells that trap air. Cellular construction can be single cell, multiple cell or cell-in-cell.		No
Slat, Louver or Panel Type Vanes	An attachment made from aluminum or wood or synthetic wood or fabric or any combination of material which has horizontal or vertical vanes Horizontal - one vane above or next to another and suspended by strips of cloth called tapes or by cords (other suspension options are possible). The vane width can be from 0.5" to 20". The vane can be overlapping or non-overlapping. Vertical – one vane next to another oriented vertically The vane width can be from 0.5" to 20". The vane can be overlapping or non-overlapping.		Yes
Sheer Type	An attachment made from sheer fabric and with or without soft or semi-rigid louvers. The attachment can have following construction: a) A single layer of sheer fabric without louvers; b) A single layer sheer fabric with louvers on the back; c) Two parallel layers of sheer fabric with horizontal vane in between the two layers of fabric.		Yes
Shutter Type	An attachment made predominantly from wood, synthetic wood or any combination of material, which is solid, stable and usually consisting of a frame of vertical stiles and horizontal rails (top, center and bottom). Set within this frame can be louvers (either operable or fixed), solid panels, fabric, glass and most any other item that can be mounted within a frame.		Yes

Product Line	Product Description	Picture / Sketch	Vane Rotation or lateral movement to increase or decrease transmitted daylight
Pleated Type	An attachment made from a single layer of pleated fabric or any suitable flexible material. This attachment can be horizontal or vertical.		No
Roller Type	An attachment made from fabric or any suitable material which can be retracted and rolled on a shaft.		No
Roman Shade Type	An attachment made from fabric or any combination of material which has horizontal loops at regular intervals. This attachment can be made with or without non-folded backing.		No
Drape Type	An attachment made from fabric or any material in drape form or in flat sheet form. The drape is usually hung from rail or from a rod with hooks.		No
Flat Panel Non Glazed	An attachment made from fabric or any combination of material with a rigid flat panel frame.		No

Product Line	Product Description	Picture / Sketch	Vane Rotation or lateral movement to increase or decrease transmitted daylight
Flat Panel Glazed	An attachment made with glazing and incorporated into a frame.		This system may incorporate a movable glazing system

5.2 Fenestration Attachment Products Reference Windows/Skylights

5.2.1 Table of Fenestration Attachment Products Reference Windows/Skylights

Table 5-2 – Fenestration Attachment Products Reference Windows

Reference Glazing System	Frame Type	Size	U-factor	SHGC	VT
		<i>mm x mm (in x in)</i>	<i>W/(m²·°C) (Btu/(hr·Ft²·°F))</i>		
3mm (1/8in) clear	Fixed Metal	1200 x 1500 (47 x 59)	6.973 (1.228)	0.730	0.720
3mm (1/8in) clear + 6mm (1/4in) air + 3mm (1/8in) clear	Fixed Metal	1200 x 1500 (47 x 59)	4.804 (0.846)	0.650	0.652
3mm (1/8in) clear + 13mm (1/2in) air + 3mm (1/8in) high solar low-e	Fixed Non metal	1200 x 1500 (47 x 59)	2.055 (0.362)	0.602	0.632
3mm (1/8in) mid solar low-e + 13mm (1/2in) air + 3mm (1/8in) clear	Fixed Non metal	1200 x 1500 (47 x 59)	1.811 (0.319)	0.357	0.598
3mm (1/8in) low solar low-e + 13mm (1/2in) air + 3mm (1/8in) clear	Fixed Non metal	1200 x 1500 (47 x 59)	1.786 (0.314)	0.211	0.407

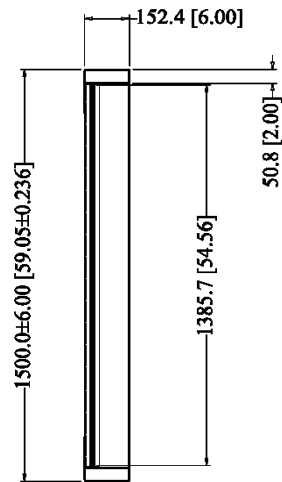
Table 5-3 – Fenestration Attachment Products Reference Skylights

Reference Glazing System	Frame Type	Size	U-factor	SHGC	VT
		<i>mm x mm (in x in)</i>	<i>W/(m²·°C) (Btu/(hr·Ft²·°F))</i>		
6mm (1/4in) clear	Metal	1200 x 1200 (46.5 x 46.5)	8.949 (1.576)	0.818	0.883
3mm (1/8in) clear + 6mm (1/4 in) air + 3mm (1/8in) clear	Metal	1200 x 1200 (46.5 x 46.5)	5.713 (1.006)	0.761	0.814
3mm (1/8in) clear + 13mm (1/2in) air + 3mm (1/8in) high solar low-e	Non-Metal	1200 x 1200 (46.5 x 46.5)	3.476 (0.612)	0.681	0.724
3mm (1/8in) mid solar low-e + 13mm (1/2in) air + 3mm (1/8in) clear	Non-Metal	1200 x 1200 (46.5 x 46.5)	3.266 (0.575)	0.399	0.685
3mm (1/8in) low solar low-e + 13mm (1/2in) air + 3mm (1/8in) clear	Non-Metal	1200 x 1200 (46.5 x 46.5)	3.242 (0.571)	0.234	0.467

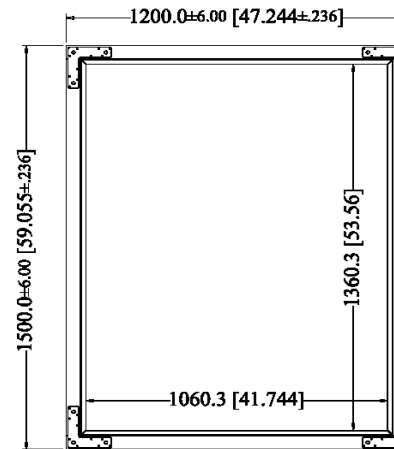
6. FIGURES

Figure 6-1 – Metal Frame Single Pane Metal Framed Reference Window

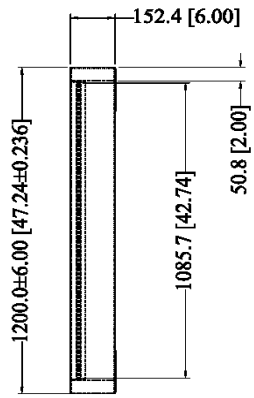
Metric as primary units unless note (I-P Units in Brackets)



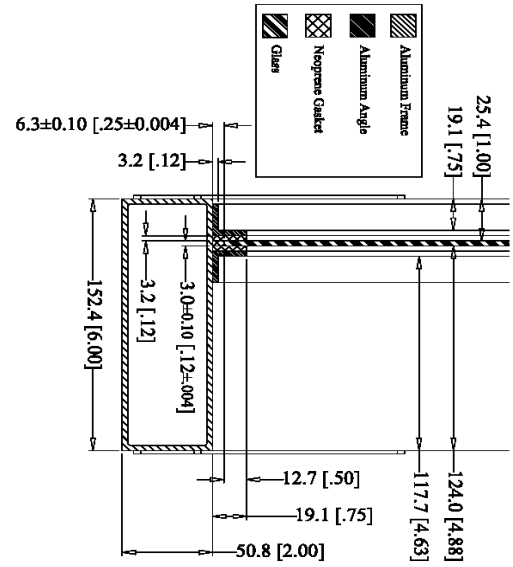
Metal Frame **Single Pane** – SIDE view



Metal Frame **Single Pane** – FRONT View



Metal Frame **Single Pane** – TOP view



Metal Frame **Single Pane** – TOP detail

Table 6-1 – Bill of Materials for Metal Frame Single Pane Reference Window

Quantity #	Component Description (Width x Depth x Wall Thickness)	Component Length Inch	Total Length Inch
2	Aluminum Rectangular Tube (2 in x 6 in x 0.125 in)	55.055	
2	Aluminum Rectangular Tube (2 in x 6 in x 0.125 in)	47.244	204.598
4	Aluminum 90° Angle (3/4 in x 3/4 in x 0.125 in)	55.055	
4	Aluminum 90° Angle (3/4 in x 3/4 in x 0.125 in)	43.244	393.197
4	Neoprene Foam Rubber, High Density (1/8 in x 3/4 in)	55.055	
4	Neoprene Foam Rubber, High Density (1/8 in x 3/4 in)	43.244	393.197
2	Neoprene Foam Rubber, High Density (1/4 in x 1/4 in)	55.055	
2	Neoprene Foam Rubber, High Density (1/4 in x 1/4 in)	43.244	196.598
8	6 in x 6 in x 1.5 in L Strap		
92	Stainless Steel Pan Head or Bevel Head Metal Screws (#8 x 5/8 in); 4 in Spacing		
72	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 9 per L-Strap		
1	Clear Glass (54.56 in x 42.74 in x 1/8 in)		Table 6-2a

Table 6-2a – Clear 3mm Glass for Single and Double Pane Reference Window

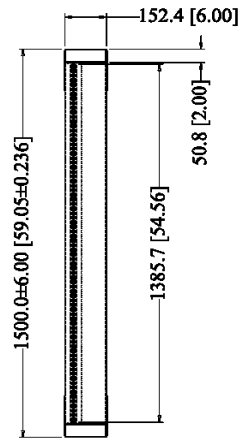
ID	Name	Product Name	Manufacturer	Source	Mode	Thickness <i>mm</i>	Tsol	Tvis	emis1	emis2
102	CLEAR_3.DAT	Generic Clear Glass	Generic	IGDB v11.4	#	3.048	0.834	0.899	0.84	0.84
412	Clear Float Glass 3.vto	Clear Float Glass	Vitro	IGDB v14.1	#	3.004	0.838	0.896	0.84	0.84
887	CLR_3.AFG	Float Glass	AFG Industries	IGDB v11.4	#	3.124	0.859	0.904	0.84	0.84
1222	FL3.amg	Indoflot Clear 3.0	Asahimas	IGDB v15.1	#	2.880	0.840	0.898	0.84	0.84
2001	Clr-3.CIG	Float Glass - 3mm	Cardinal Glass Industries	IGDB v16.4	#	2.970	0.848	0.904	0.84	0.84
3011	Clear_33.GRD	Float Glass	Guardian	IGDB v15.4	#	3.277	0.848	0.902	0.84	0.84
3013	Clear_30.GRD	Float Glass	Guardian	IGDB v15.4	#	2.972	0.854	0.903	0.84	0.84
4200	clear_03.gvb	PLANIBEL	GLAVERBEL S.A.	IGDB v12.4	#	2.900	0.862	0.903	0.84	0.84
5009	CLEAR_3.PPG	Clear Glass	PPG Industries	IGDB v11.4	#	3.277	0.827	0.898	0.84	0.84
9801	CLEAR3.LOF	Optifloat™ Clear	Pilkington North America	IGDB v11.4	#	2.997	0.837	0.899	0.84	0.84
Minimum						2.880	0.827	0.896	0.840	0.840
Maximum						3.277	0.862	0.904	0.840	0.840
Average						3.045	0.845	0.901	0.840	0.840
Maximum Difference from Average						0.232	0.018	0.005	0.000	0.000

Table 6-2b – Clear 6mm Glass for Single and Double Pane Reference Window

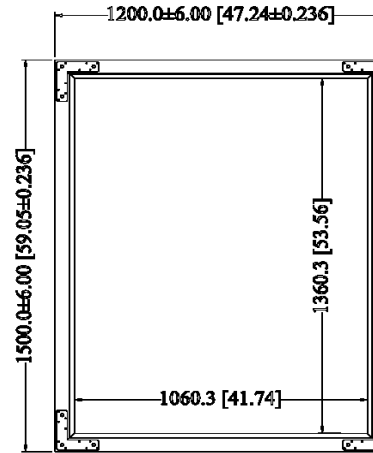
ID	Name	ProductName	Manufacturer	Source	Mode	Thickness <i>mm</i>	Tsol	Tvis	emis1	emis2
103	CLEAR_6.DAT	Generic Clear Glass	Generic	IGDB v11.4	#	5.715	0.771	0.884	0.84	0.84
415	Clear Float Glass 6.vto	Clear Float Glass	Vitro	IGDB v14.1	#	5.775	0.772	0.878	0.84	0.84
890	CLR_6.AFG	Float Glass	AFG Industries	IGDB v11.4	#	5.715	0.801	0.883	0.84	0.84
1225	FL6.amg	Indoflot Clear 6.0	Asahimas	IGDB v15.1	#	5.870	0.759	0.882	0.84	0.84
2004	Clr-6.CIG	Float Glass - 6mm	Cardinal Glass Industries	IGDB v16.4	#	5.660	0.788	0.889	0.84	0.84
3016	Clear_60.GRD	Float Glass	Guardian	IGDB v15.4	#	5.613	0.804	0.892	0.84	0.84
4203	clear_06.gvb	PLANIBEL	GLAVERBEL S.A.	IGDB v12.4	#	5.850	0.809	0.888	0.84	0.84
4214	cl33_1.gvb	STRATOBEL CLEAR 33.1	GLAVERBEL S.A.	IGDB v12.4	#	6.180	0.778	0.885	0.84	0.84
5012	CLEAR_6.PPG	Clear Glass	PPG Industries	IGDB v11.4	#	5.664	0.771	0.886	0.84	0.84
7199	ip_fl_6.ipe	Float 6 mm	INTERPANE GLAS INDUSTRIE AG	IGDB v17.0	#	6.000	0.790	0.887	0.837	0.837
9804	CLEAR6.LOF	Optifloat™ Clear	Pilkington North America	IGDB v11.4	#	5.664	0.774	0.883	0.84	0.84
9819	Clear6m.LOF	Optifloat™ Clear	Pilkington North America	IGDB v13.9	#	5.918	0.783	0.885	0.84	0.84
Minimum						5.613	0.759	0.878	0.837	0.837
Maximum						6.180	0.809	0.892	0.840	0.840
Average						5.802	0.783	0.885	0.840	0.840
Maximum Difference from Average						0.378	0.026	0.007	0.003	0.003

Figure 6-2 -- Metal Frame Double Pane Reference Window

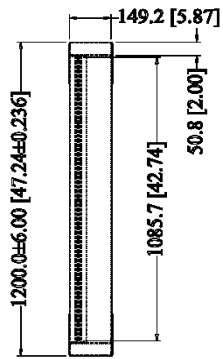
Metric as primary units unless noted (I-P Units in brackets)



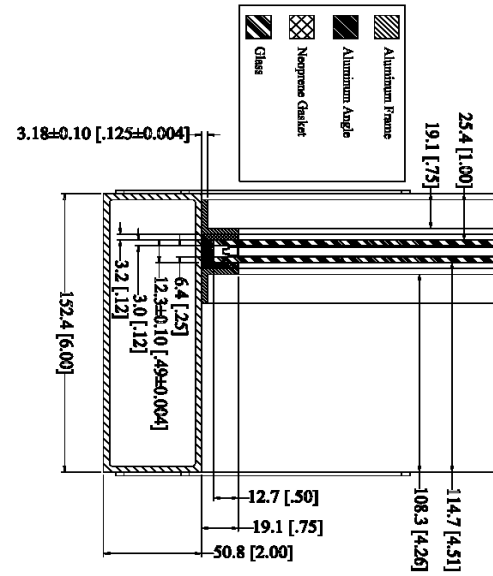
Metal Frame **Double Pane** – SIDE view



Metal Frame **Double Pane** – FRONT View



Metal Frame **Double Pane** – TOP view



Metal Frame **Double Pane** – TOP detail

Table 6-3 – Bill of Materials for Metal Frame Double Pane Reference Window

Quantity #	Component Description <i>(Width x Depth x Wall Thickness)</i>	Component Length <i>Inch</i>	Total Length <i>Inch</i>
2	Aluminum Rectangular Tube (2 in x 6 in x 0.125 in)	55.055	
2	Aluminum Rectangular Tube (2 in x 6 in x 0.125 in)	47.244	204.598
4	Aluminum 90° Angle (3/4 in x 3/4 in x 0.125 in)	55.055	
4	Aluminum 90° Angle (3/4 in x 3/4 in x 0.125 in)	43.244	393.197
4	Neoprene Foam Rubber, High Density (1/8 in x 3/4 in)	55.055	
4	Neoprene Foam Rubber, High Density (1/8 in x 3/4 in)	43.244	393.197
2	Neoprene Foam Rubber, High Density (1/4 in x 1 in)	55.055	
2	Neoprene Foam Rubber, High Density (1/4 in x 1 in)	43.244	196.598
8	6 in x 6 in x 1.5 in L Strap		
92	Stainless Steel Pan Head or Bevel Head Metal Screws (#8 x 5/8 in); 4 in Spacing		
72	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 9 per L-Strap		
2	Aluminum Spacer Desiccant, and Sealant System (1/2 in x 1/4 in)	54.555	Figure 6-2-a
2	Aluminum Spacer Desiccant, and Sealant System (1/2 in x 1/4 in)	42.744	194.598
2	Clear Glass (54.56 in x 42.74 in x 1/8 in)		Table 6.2a

Figure 6-2-a – Spacer and Sealant System for Double Pane Reference Window

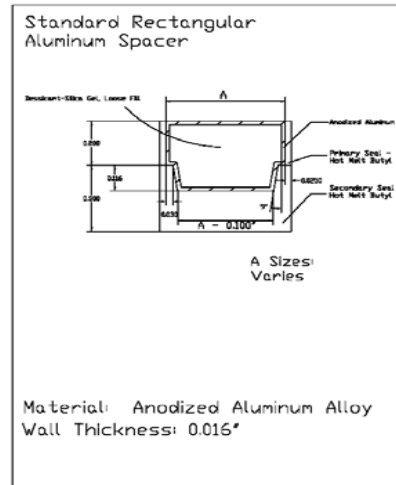
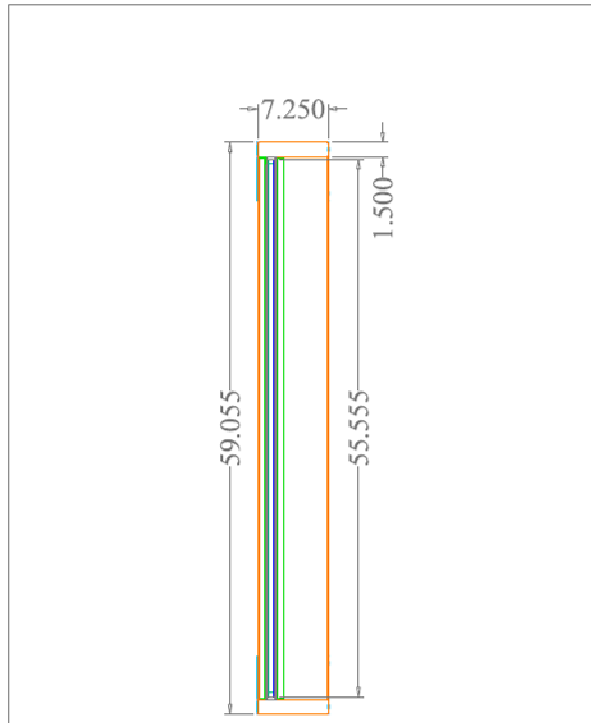
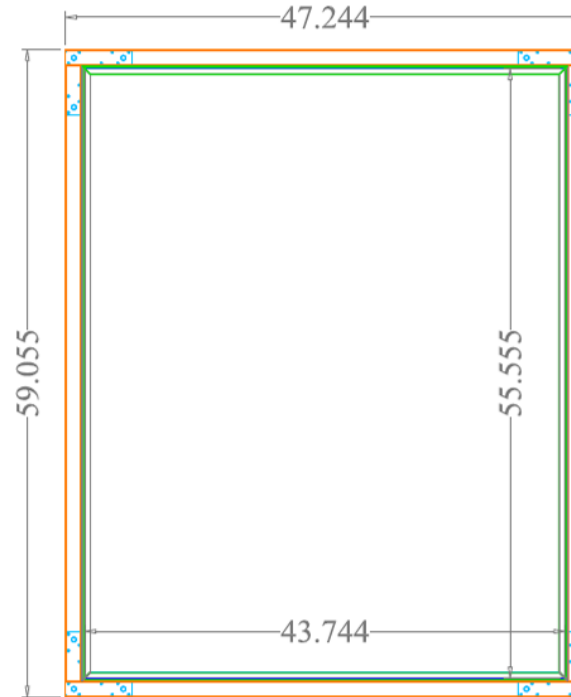


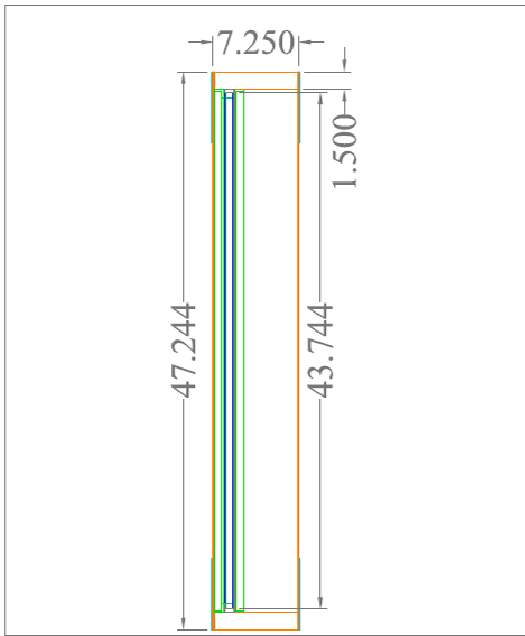
Figure 6-3 – Non Metal Frame Double Pane Reference Window



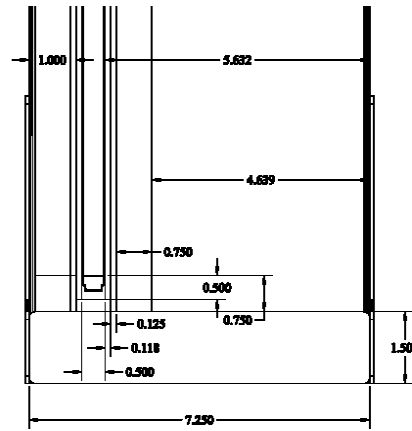
Non-Metal Frame **Double Pane** – SIDE view



Non-Metal Frame **Double Pane** – FRONT View



Non- Metal Frame **Double Pane** – TOP view



Non-Metal Frame **Double Pane** – TOP detail

Table 6-4 – Bill of Materials for Non-Metal Frame Double Pane Reference Windows

Quantity #	Component Description (Width x Depth x Wall Thickness)	Component Length Inch	Total Length Inch
2	Douglas Fir (Nominal 2 in x 8 in)	56.055	
2	Douglas Fir (Nominal 2 in x 8 in)	47.244	206.598
4	Aluminum 90° Angle (3/4 in x 3/4 in x 0.125 in)	56.055	
4	Aluminum 90° Angle (3/4 in x 3/4 in x 0.125 in)	44.244	401.197
4	Neoprene Foam Rubber, High Density (1/8 in x 3/4 in)	56.055	
4	Neoprene Foam Rubber, High Density (1/8 in x 3/4 in)	44.244	401.197
2	Neoprene Foam Rubber, High Density (1/4 in x 1 in)	56.055	
2	Neoprene Foam Rubber, High Density (1/4 in x 1 in)	44.244	200.598
8	6 in x 6 in x 1.5 in L Strap		
96	Stainless Steel Pan Head or Bevel Head Metal Screws (#8 x 5/8 in); 4 in Spacing		
72	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 9 per L-Strap		
2	Aluminum Spacer Desiccant, and Sealant System (1/2 in x 1/2 in)	55.555	Figure 6-2a
2	Aluminum Spacer Desiccant, and Sealant System (1/2 in x 1/2 in)	43.744	198.598
2	Clear Glass (55.56 in x 43.74 in x 1/8 in)		Table 6.2a
1	Clear Glass + High Solar Gain Lo-E on Surface 3 (54.56 in x 42.74 in x 1/4 in)		
1	Clear Glass + Low Solar Gain Lo-E on Surface 2 (55.56 in x 43.74 in x 1/8 in)		

Figure 6-4 – Illustration of Different Cell Structure of Cellular Type Attachments

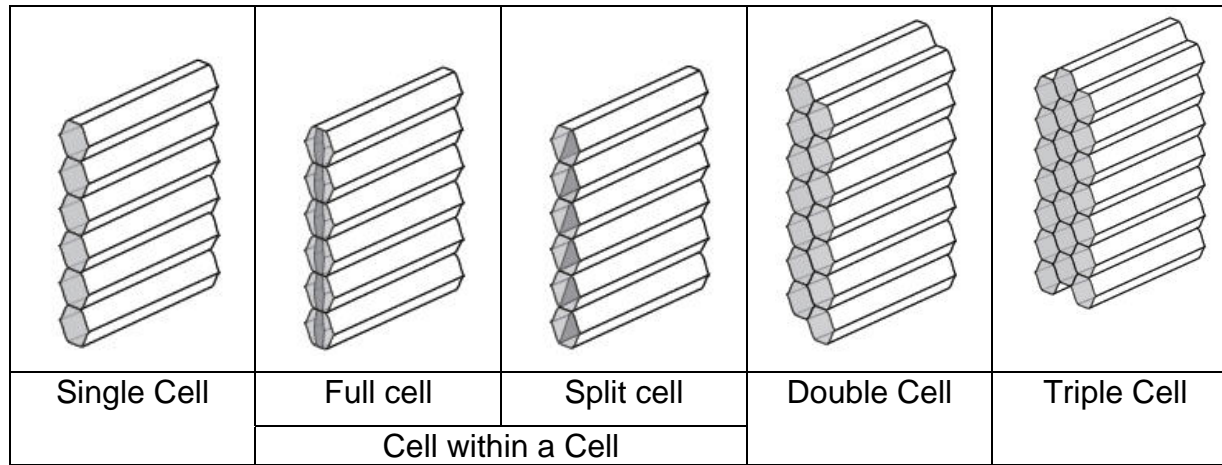


Figure 6-5 – Cellular Type Attachment Cell Size Measurement Illustration

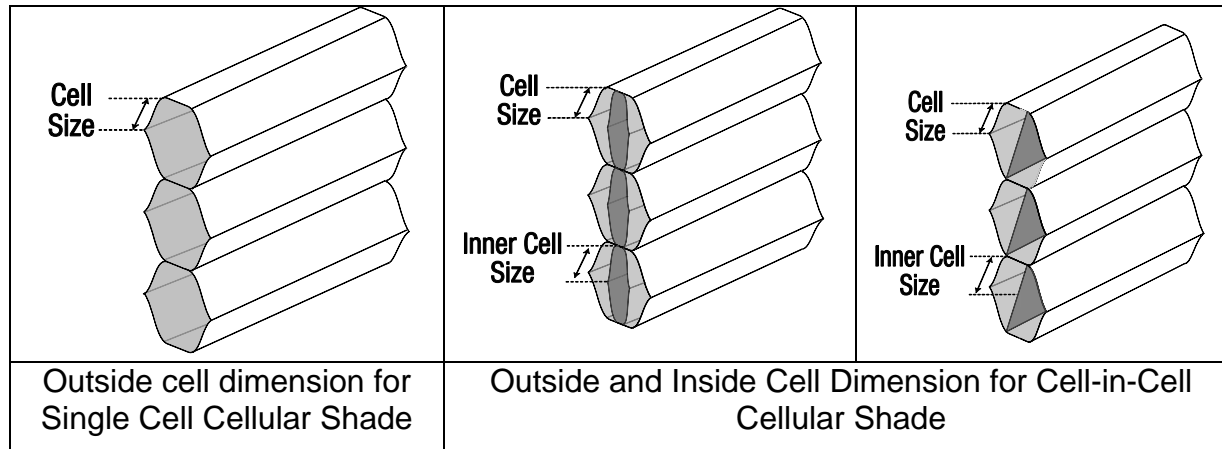


Figure 6-6 – Slat/Louver Type Attachment Dimension Measurement Illustration

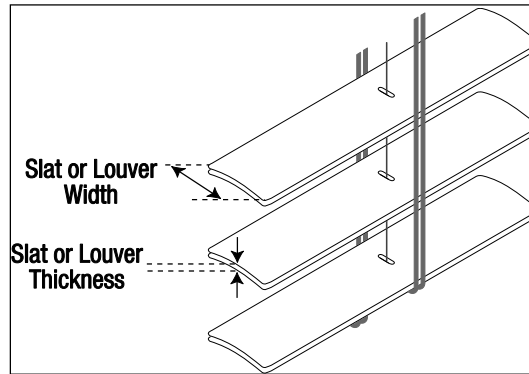


Figure 6-7 – Sheer Type Attachment Dimension Measurement Illustration

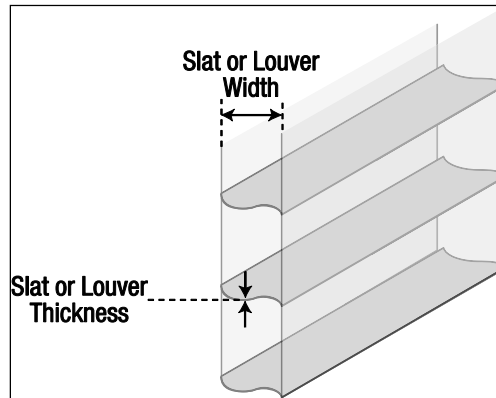


Figure 6-8 – Shutter Type Attachment Dimension Measurement Illustration

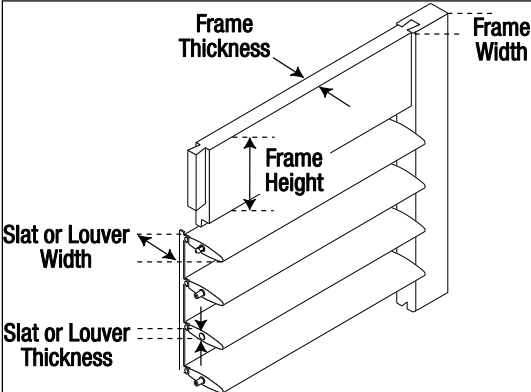


Figure 6-9 – Pleated Type Attachment Dimension Measurement Illustration

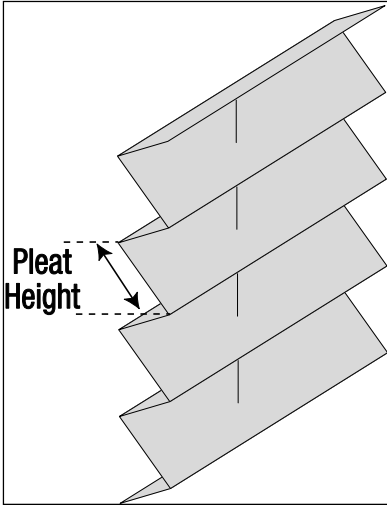


Figure 6-10 – Roman Shade Type Attachment Dimension Measurement Illustration

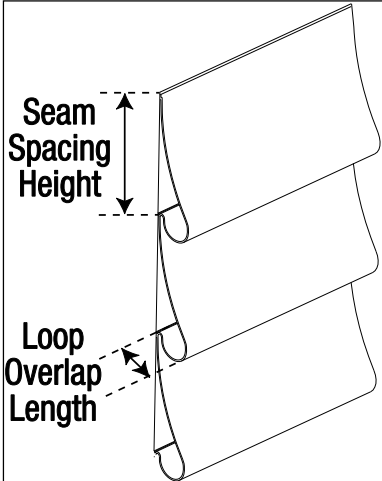


Table 6-5a – Bill of Materials for Single Glazed Metal Frame Reference Skylights

Quantity #	Component Description <i>(Width x Depth x Well Thickness)</i>	Component Length <i>Inch</i>	Total Length <i>Inch</i>	Source	Part Number	Web Page
Metal Frame						
4	Aluminum Rectangular Tube (2 in x 4 in x 0.125 in)	47.244	188.976	McMaster-Carr	88935K69	www.mcmaster.com
4	Aluminum 90° Angle (2 in x 2 in x 0.125 in)	47.494	189.976	McMaster-Carr	88805K63	www.mcmaster.com
8	Neoprene Foam Rubber, High Density (1/8 in x 2 in)	47.244	377.953	McMaster-Carr	8694K69	www.mcmaster.com
4	Neoprene Foam Rubber, High Density (1/4 in x 1/4 in)	27.244	188.976	McMaster-Carr	8647K83	www.mcmaster.com
4	Simpson Strong-Tie (6 in x 6 in x 1/5 in L-Strap)			Simpson	66L	www.strongtie.com
4	Simpson A-Angle (5 7/8 in x 5 7/8 in x 1.5 in 90° Angle)			Simpson	A66	www.strongtie.com
48	Stainless Steel Pan Head or Bevel Head Metal Screws (#8 x 5/8 in); 4 in Spacing			McMaster-Carr	92470A196	www.mcmaster.com
36	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 9 per L-Strap			McMaster-Carr	92470A121	www.mcmaster.com
16	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 4 per 90° Angle			McMaster-Carr	92470A121	www.mcmaster.com
Single Clear Glazing						
1	Clear Glass (46.74 in x 46.74 in x .236 in)			See Glass Library		

Table 6-5b – Reference Glazing for Single Glazed Metal Frame Reference Skylights

Used to calculate values in Reference Window Tables

ID	Name	Product Name	Manufacturer	Source	Mode	Color	Thickness <i>mm</i>	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	Emis1	Emis2	Cond
102	CLEAR_3.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		3.048	0.834	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1
412	Clear Float Glass 3.vto	Clear Float Glass	Vitro	IGDB v14.1	#		3.004	0.838	0.077	0.078	0.896	0.085	0.086	0	0.840	0.840	1
887	CLR_3.AFG	Float Glass	AFG Industries	IGDB v11.4	#		3.124	0.859	0.079	0.078	0.904	0.077	0.077	0	0.840	0.840	1
1222	FL3.amg	Indoflot Clear 3.0	Asahimas	IGDB v15.1	#		2.880	0.840	0.074	0.074	0.898	0.081	0.081	0	0.840	0.840	1
2001	Clr-3.CIG	Float Glass – 3mm	Cardinal Glass Industries	IGDB v16.4	#		2.970	0.848	0.076	0.076	0.904	0.082	0.082	0	0.840	0.840	1
3011	Clear_33.GRD	Float Glass	Guardian	IGDB v15.4	#		3.277	0.848	0.077	0.076	0.902	0.083	0.083	0	0.840	0.840	1
3013	Clear_30.GRD	Float Glass	Guardian	IGDB v15.4	#		2.972	0.854	0.077	0.077	0.903	0.083	0.083	0	0.840	0.840	1
4200	Clear_03.gvb	PLANIBEL	GLAVERBEL S.A.	IGDB v12.4	#		2.900	0.862	0.076	0.076	0.903	0.080	0.080	0	0.840	0.840	1
5009	CLEAR_3.PPG	Clear Glass	PPG Industries	IGDB v11.4	#		3.277	0.827	0.076	0.077	0.898	0.086	0.086	0	0.840	0.840	1
9801	CLEAR3.LOF	Optifloat™ Clear	Pilkington North America	IGDB v11.4	#		2.997	0.837	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1
Minimum							2.880	0.827	0.074	0.074	0.896	0.077	0.077	0	0.840	0.840	1
Maximum							3.277	0.862	0.079	0.078	0.904	0.086	0.086	0	0.840	0.840	1
Average							3.045	0.845	0.076	0.076	0.901	0.082	0.082	0	0.840	0.840	1
Maximum Difference from Average							0.232	0.018	0.003	0.002	0.005	0.005	0.005	0	0.000	0.000	0

Highlighted Row: Used to calculate value in Reference Window Tables

Table 6-6a – Bill of Materials Double Glazed Low Solar Low-e Wood Frame Reference Skylight

Quantity #	Component Description (Width x Depth x Wall Thickness)	Component Length Inch	Total Length Inch	Source	Part Number	Web Page
Metal Frame						
2	Douglas Fir (Nominal 2 in x 4 in)	47.244		Lowe's	50863	www.lowes.com
2	Douglas Fir (Nominal 2 in x 4 in)	44.244	140.732	Lowe's	50863	www.lowes.com
4	Aluminum 90° Angle (2 in x 2 in x 0.125 in)	47.494	189.976	McMaster-Carr	88805K63	www.mcmaster.com
8	Neoprene Foam Rubber, High Density (1/8 in x 2 in)	47.244	377.953	McMaster-Carr	8694K69	www.mcmaster.com
4	Neoprene Foam Rubber, High Density (1 1/2 in x 1 in)	47.244	188.976	McMaster-Carr	8694K98	www.mcmaster.com
4	Simpson Strong-Tie (6 in x 6 in x 1.5 in L-Strap)			Simpson	66L	www.strongtie.com
4	Simpson A-Angle (5 7/8 in x 5 7/8 in x 1.5 in 90° Angle)			Simpson	A66	www.strongtie.com
48	Stainless Steel Pan Head or Bevel Head Metal Screws (#8 x 5/8); 4 in spacing			McMaster-Carr	92470A196	www.mcmaster.com
36	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 9 per L-Strap			McMaster-Carr	92470A121	www.mcmaster.com
16	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 4 per 90° Angle			McMaster-Carr	92470A121	www.mcmaster.com
Double Low-e Glazing						
4	Aluminum Spacer Desiccant and Sealant System (1/2 in x 1/2 in)	44.244	176.976	See <i>Spacer Drawing</i>		
1	Clear Glass + Low Solar Gain Low-e on Surface 2 (44.24 in x 44.24 in x 0.118 in)			See <i>Low Solar Glass</i>		
1	Clear Glass (44.24 in x 44.24 in x 0.118 in)			See <i>Clear Glass</i>		

Table 6-6b – Reference Glazing for Double Glazed Low Solar Low-e Wood Frame Reference Skylight

ID	Name	Product Name	Manufacturer	Source	Mode	Color	Thickness mm	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	Emis1	Emis2	Cond	
972	Ti-AC23_3.AFG	Comfort Ti-AC23	AGC Glass Co. NA	IGDB v14.6	#		3.100	0.211	0.320	0.406	0.437	0.108	0.037	0	0.840	0.040	1	
976	Ti-AC23_Lami.AFG	Comfort Ti-AC23	AGC Glass Co. NA	IGDB v14.6	#		2.600	0.214	0.328	0.404	0.440	0.106	0.038	0	0.840	0.041	1	
5313	SB80_3.PPG	Solarban® 80 on clear	PPG Industries	IGDB v14.1	#		3.277	0.226	0.430	0.666	0.527	0.309	0.341	0	0.840	0.024	1	
5427	Solarban z75_3.PPG	Solarban® z75	PPG Industries	IGDB v15.2	#		3.277	0.233	0.367	0.559	0.587	0.066	0.051	0	0.841	0.018	1	
							Minimum	2.600	0.211	0.320	0.404	0.437	0.066	0.037	0	0.840	0.018	1
							Maximum	3.277	0.233	0.430	0.666	0.587	0.309	0.341	0	0.841	0.041	1
							Average	3.064	0.221	0.361	0.509	0.498	0.147	0.117	0	0.840	0.031	1
							Maximum Difference from Average	0.464	0.012	0.069	0.157	0.089	0.162	0.224	0	0.001	0.013	0

Highlighted Row: Used to calculate value in Reference Window Tables

ID	Name	Product Name	Manufacturer	Source	Mode	Color	Thickness mm	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	Emis1	Emis2	Cond	
102	CLEAR_3.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		3.048	0.834	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1	
412	Clear Float Glass 3.vto	Clear Float Glass	Vitro	IGDB v14.1	#		3.004	0.838	0.077	0.078	0.896	0.085	0.086	0	0.840	0.840	1	
887	CLR_3.AFG	Float Glass	AFG Industries	IGDB v11.4	#		3.124	0.859	0.079	0.078	0.904	0.077	0.077	0	0.840	0.840	1	
1222	FL3.amg	Indoflot Clear 3.0	Asahimas	IGDB v15.1	#		2.880	0.840	0.074	0.074	0.898	0.081	0.081	0	0.840	0.840	1	
2001	Clr-3.CIG	Float Glass – 3mm	Cardinal Glass Industries	IGDB v16.4	#		2.970	0.848	0.076	0.076	0.904	0.082	0.082	0	0.840	0.840	1	
3011	Clear_33.GRD	Float Glass	Guardian	IGDB v15.4	#		3.277	0.848	0.077	0.076	0.902	0.083	0.083	0	0.840	0.840	1	
3013	Clear_30.GRD	Float Glass	Guardian	IGDB v15.4	#		2.972	0.854	0.077	0.077	0.903	0.083	0.083	0	0.840	0.840	1	
4200	clear_03.gvb	PLANIBEL	GLAVERBEL S.A.	IGDB v12.4	#		2.900	0.862	0.076	0.076	0.903	0.080	0.080	0	0.840	0.840	1	
5009	CLEAR_3.PPG	Clear Glass	PPG Industries	IGDB v11.4	#		3.277	0.827	0.076	0.077	0.898	0.086	0.086	0	0.840	0.840	1	
9801	CLEAR3.LOF	Optifloat™ Clear	Pilkington North America	IGDB v11.4	#		2.997	0.837	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1	
							Minimum	2.880	0.827	0.074	0.074	0.896	0.077	0.077	0	0.840	0.840	1
							Maximum	3.277	0.862	0.079	0.078	0.904	0.086	0.086	0	0.840	0.840	1
							Average	3.045	0.845	0.076	0.076	0.901	0.082	0.082	0	0.840	0.840	1
							Maximum Difference from Average	0.232	0.018	0.003	0.002	0.005	0.005	0.005	0	0.000	0.000	0

Highlighted Row: Used to calculate value in Reference Window Tables

Table 6-7a – Bill of Materials Double Glazed Medium Solar Low-e Wood Frame Reference Skylights

Quantity #	Component Description (Width x Depth x Wall Thickness)	Component Length Inch	Total Length Inch	Source	Part Number	Web Page
Metal Frame						
2	Douglas Fir (Nominal 2 in x 4 in)	47.244		Lowe's	50863	www.lowes.com
2	Douglas Fir (Nominal 2 in x 4 in)	44.244	140.732	Lowe's	50863	www.lowes.com
4	Aluminum 90° Angle (2 in x 2 in x 0.125 in)	47.494	189.976	McMaster-Carr	88805K63	www.mcmaster.com
8	Neoprene Foam Rubber, High Density (1/8 in x 2 in)	47.244	377.953	McMaster-Carr	8694K69	www.mcmaster.com
4	Neoprene Foam Rubber, High Density (1 1/2 in x 1 in)	47.244	188.976	McMaster-Carr	8694K98	www.mcmaster.com
4	Simpson Strong-Tie (6 in x 6 in x 1.5 in L-Strap)			Simpson	66L	www.strongtie.com
4	Simpson A-Angle (5 7/8 in x 5 7/8 in x 1.5 in 90° Angle)			Simpson	A66	www.strongtie.com
48	Stainless Steel Pan Head or Bevel Head Metal Screws (#8 x 5/8); 4 in spacing			McMaster-Carr	92470A196	www.mcmaster.com
36	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 9 per L-Strap			McMaster-Carr	92470A121	www.mcmaster.com
16	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 4 per 90° Angle			McMaster-Carr	92470A121	www.mcmaster.com
Double Low-e Glazing						
4	Aluminum Spacer Desiccant and Sealant System (1/2 in x 1/2 in)	44.244	176.976	See <i>Spacer Drawing</i>		
1	Clear Glass + Low Solar Gain Low-e on Surface 2 (44.24 in x 44.24 in x 0.118 in)			See <i>Low Solar Glass</i>		
1	Clear Glass (44.24 in x 44.24 in x 0.118 in)			See <i>Clear Glass</i>		

Table 6-7b – Reference Glazing for Double Glazed Medium Solar Low-e Wood Frame Reference Skylights

ID	Name	Product Name	Manufacturer	Source	Mode	Color	Thickness <i>mm</i>	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	Emis1	Emis2	Cond	
960	TiAC40_3.afg	Comfort IaAC40 on Clear	AGC Glass Co. NA	IGDB v11.4	#		3.023	0.412	0.422	0.335	0.779	0.037	0.045	0	0.041	0.840	1	
2011	LoE272-3.CIG	LoE ² 272 on 3 mm Clear	Cardinal Glass Industries	IGDB v16.4	#		2.970	0.429	0.325	0.418	0.793	0.056	0.043	0	0.840	0.042	1	
3213	LEPPIIC3.GRD	Performance Plus II on Clear	Guardian	IGDB v11.4	#		2.972	0.424	0.367	0.445	0.757	0.141	0.112	0	0.836	0.044	1	
5348	SB60-Starphire_3.PPG	Solarban [®] 60 on Starphire [®]	PPG Industries	IGDB v14.1	#		3.277	0.418	0.419	0.456	0.813	0.058	0.050	0	0.840	0.035	1	
							Minimum	2.970	0.412	0.325	0.335	0.757	0.037	0.043	0	0.041	0.035	1.00
							Maximum	3.277	0.429	0.422	0.456	0.813	0.141	0.112	0	0.840	0.840	1.00
							Average	3.061	0.421	0.383	0.414	0.786	0.073	0.063	0	0.639	0.240	1.00
							Maximum Difference from Average	0.217	0.009	0.058	0.079	0.029	0.068	0.050	0	0.598	0.600	0.00

Highlighted Row: Used to calculate value in Reference Window Tables

ID	Name	Product Name	Manufacturer	Source	Mode	Color	Thickness <i>mm</i>	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	Emis1	Emis2	Cond	
102	CLEAR_3.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		3.048	0.834	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1	
412	Clear Float Glass 3.vto	Clear Float Glass	Vitro	IGDB v14.1	#		3.004	0.838	0.077	0.078	0.896	0.085	0.086	0	0.840	0.840	1	
887	CLR_3.AFG	Float Glass	AFG Industries	IGDB v11.4	#		3.124	0.859	0.079	0.078	0.904	0.077	0.077	0	0.840	0.840	1	
1222	FL3.amg	Indoflot Clear 3.0	Asahimas	IGDB v15.1	#		2.880	0.840	0.074	0.074	0.898	0.081	0.081	0	0.840	0.840	1	
2001	Clr-3.CIG	Float Glass – 3mm	Cardinal Glass Industries	IGDB v16.4	#		2.970	0.848	0.076	0.076	0.904	0.082	0.082	0	0.840	0.840	1	
3011	Clear_33.GRD	Float Glass	Guardian	IGDB v15.4	#		3.277	0.848	0.077	0.076	0.902	0.083	0.083	0	0.840	0.840	1	
3013	Clear_30.GRD	Float Glass	Guardian	IGDB v15.4	#		2.972	0.854	0.077	0.077	0.903	0.083	0.083	0	0.840	0.840	1	
4200	Clear_03.qvb	PLANIBEL	GLAVERBEL S.A.	IGDB v12.4	#		2.900	0.862	0.076	0.076	0.903	0.080	0.080	0	0.840	0.840	1	
5009	CLEAR_3.PPG	Clear Glass	PPG Industries	IGDB v11.4	#		3.277	0.827	0.076	0.077	0.898	0.086	0.086	0	0.840	0.840	1	
9801	CLEAR3.LOF	Optifloat [™] Clear	Pilkington North America	IGDB v11.4	#		2.997	0.837	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1	
							Minimum	2.880	0.827	0.074	0.074	0.896	0.077	0.077	0	0.840	0.840	1
							Maximum	3.277	0.862	0.079	0.078	0.904	0.086	0.086	0	0.840	0.840	1
							Average	3.045	0.845	0.076	0.076	0.901	0.082	0.082	0	0.840	0.840	1
							Maximum Difference from Average	0.232	0.018	0.003	0.002	0.005	0.005	0.005	0	0.000	0.000	0

Highlighted Row: Used to calculate value in Reference Window Tables

Table 6-8a – Bill of Materials Double Glazed High Solar Low-e Non-Metal Frame Reference Skylights

Quantity #	Component Description (Width x Depth x Wall Thickness)	Component Length Inch	Total Length Inch	Source	Part Number	Web Page
Metal Frame						
2	Douglas Fir (Nominal 2 in x 4 in)	47.244		Lowe's	50863	www.lowes.com
2	Douglas Fir (Nominal 2 in x 4 in)	44.244	140.732	Lowe's	50863	www.lowes.com
4	Aluminum 90° Angle (2 in x 2 in x 0.125 in)	47.494	189.976	McMaster-Carr	88805K63	www.mcmaster.com
8	Neoprene Foam Rubber, High Density (1/8 in x 2 in)	47.244	377.953	McMaster-Carr	8694K69	www.mcmaster.com
4	Neoprene Foam Rubber, High Density (1 1/2 in x 1 in)	47.244	188.976	McMaster-Carr	8694K98	www.mcmaster.com
4	Simpson Strong-Tie (6 in x 6 in x 1.5 in L-Strap)			Simpson	66L	www.strongtie.com
4	Simpson A-Angle (5 7/8 in x 5 7/8 in x 1.5 in 90° Angle)			Simpson	A66	www.strongtie.com
48	Stainless Steel Pan Head or Bevel Head Metal Screws (#8 x 5/8); 4 in spacing			McMaster-Carr	92470A196	www.mcmaster.com
36	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in);9 per L-Strap			McMaster-Carr	92470A121	www.mcmaster.com
16	Stainless Steel Pan Head Metal Screws (#5 x 1/2 in); 4 per 90° Angle			McMaster-Carr	92470A121	www.mcmaster.com
Double Low-e Glazing						
4	Aluminum Spacer Desiccant and Sealant System (1/2 in x 1/2 in)	44.244	176.976	See <i>Spacer Drawing</i>		
1	Clear Glass + Low Solar Gain Low-e on Surface 2 (44.24 in x 44.24 in x 0.118 in)			See <i>Low Solar Glass</i>		
1	Clear Glass (44.24 in x 44.24 in x 0.118 in)			See <i>Clear Glass</i>		

Table 6-8b – Reference Glazing for Double Glazed High Solar Low-e Non-Metal Frame Reference Skylights

ID	Name	Product Name	Manufacturer	Source	Mode	Color	Thickness mm	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	Emis1	Emis2	Cond
907	CMFTE2_3.AFG	Comfort E ² on Clear	AGC Glass Co. NA	IGDB v11.4	#		3.099	0.695	0.115	0.101	0.830	0.096	0.087	0	0.204	0.840	1
2812	AM3SG500.ESP	Armour Glass lowE	Energy Saving Products of FL	IGDB v13.7	#		3.430	0.656	0.122	0.130	0.815	0.108	0.113	0	0.215	0.927	1
5242	S500CL_3.PPG	Sungate® 500 on Clear	PPG Industries	IGDB v11.4	#		3.277	0.705	0.126	0.108	0.833	0.113	0.109	0	0.215	0.840	1
Minimum							3.099	0.656	0.115	0.101	0.815	0.096	0.087	0	0.204	0.840	1.00
Maximum							3.430	0.705	0.126	0.130	0.833	0.113	0.113	0	0.215	0.927	1.00
Average							3.269	0.685	0.121	0.113	0.826	0.106	0.103	0	0.211	0.869	1.00
Maximum Difference from Average							0.170	0.029	0.006	0.017	0.011	0.010	0.016	0	0.007	0.058	0.00

Highlighted Row: Used to calculate value in Reference Window Tables

ID	Name	Product Name	Manufacturer	Source	Mode	Color	Thickness <i>mm</i>	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	Emis1	Emis2	Cond	
102	CLEAR_3.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		3.048	0.834	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1	
412	Clear Float Glass 3.vto	Clear Float Glass	Vitro	IGDB v14.1	#		3.004	0.838	0.077	0.078	0.896	0.085	0.086	0	0.840	0.840	1	
887	CLR_3.AFG	Float Glass	AFG Industries	IGDB v11.4	#		3.124	0.859	0.079	0.078	0.904	0.077	0.077	0	0.840	0.840	1	
1222	FL3.amg	Indoflot Clear 3.0	Asahimas	IGDB v15.1	#		2.880	0.840	0.074	0.074	0.898	0.081	0.081	0	0.840	0.840	1	
2001	Clr-3.CIG	Float Glass – 3mm	Cardinal Glass Industries	IGDB v16.4	#		2.970	0.848	0.076	0.076	0.904	0.082	0.082	0	0.840	0.840	1	
3011	Clear_33.GRD	Float Glass	Guardian	IGDB v15.4	#		3.277	0.848	0.077	0.076	0.902	0.083	0.083	0	0.840	0.840	1	
3013	Clear_30.GRD	Float Glass	Guardian	IGDB v15.4	#		2.972	0.854	0.077	0.077	0.903	0.083	0.083	0	0.840	0.840	1	
4200	Clear_03.gvb	PLANIBEL	GLAVERBEL S.A.	IGDB v12.4	#		2.900	0.862	0.076	0.076	0.903	0.080	0.080	0	0.840	0.840	1	
5009	CLEAR_3.PPG	Clear Glass	PPG Industries	IGDB v11.4	#		3.277	0.827	0.076	0.077	0.898	0.086	0.086	0	0.840	0.840	1	
9801	CLEAR3.LOF	Optifloat™ Clear	Pilkington North America	IGDB v11.4	#		2.997	0.837	0.075	0.075	0.899	0.083	0.083	0	0.840	0.840	1	
							Minimum	2.880	0.827	0.074	0.074	0.896	0.077	0.077	0	0.840	0.840	1
							Maximum	3.277	0.862	0.079	0.078	0.904	0.086	0.086	0	0.840	0.840	1
							Average	3.045	0.845	0.076	0.076	0.901	0.082	0.082	0	0.840	0.840	1
							Maximum Difference from Average	0.232	0.018	0.003	0.002	0.005	0.005	0.005	0	0.000	0.000	0

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