9. SAMPLE PROBLEMS

9.1. Overview

There are four sample problems:

These sample problems may contain boundary conditions, frame cavity conditions and modeling techniques that do not conform to the NFRC modeling rules. If this is the case, the NFRC modeling rules always take precedence over what is shown in these example problems. Also, the results shown in these examples may not correspond exactly to results obtained with the WINDOW and THERM programs.

9.2 Problem 1: Vinyl Fixed

For this fixed vinyl window product, calculate the U-factor, SHGC, VT, and CR values.

9.2.1. Description

Window Type	Fixed picture window
Frame Material	PVC frame; the same geometry can be used for the head, sill and jambs. The wall thickness is 3.175 mm (0.125").
Glazing System	Double glazing, 19.05 mm (0.750") overall I.G. thickness. The outboard lite is double-strength clear glass (3.277 mm (0.129") thick), the inboard lite is double-strength clear glass with a PPG Sungate100 low-E coating on surface three, and the glazing cavity (12.5 mm (0.492")) is air filled.
Spacer type	Intercept Spacer with PIB primary seal and hot-melt butyl secondary seal
Glazing Tape	Foam rubber tape, 3.175 mm (0.125") thick
Dividers	Aluminum grille pattern, painted white, between the glass. The grille pattern for the window is three by four.
Cross Sections	See Section 9.2.7 for drawings of this product.

9.2.2. Glazing Matrix

The window is offered by the manufacturer both with and without dividers. The drawings indicate that there is less than 3.0 mm (0.118") between the glass and the divider, dividers, so the glazing matrix must include both a case with and without the dividers.

9.2.3. Center-of-glazing Modeling (WINDOW)

Model the glazing system in WINDOW with double strength glass, a 12.5 mm (0.492″) air space, air filled, and Sungate100 Low-e.

The figure below shows the WINDOW **Glazing System Library** for this glazing system.

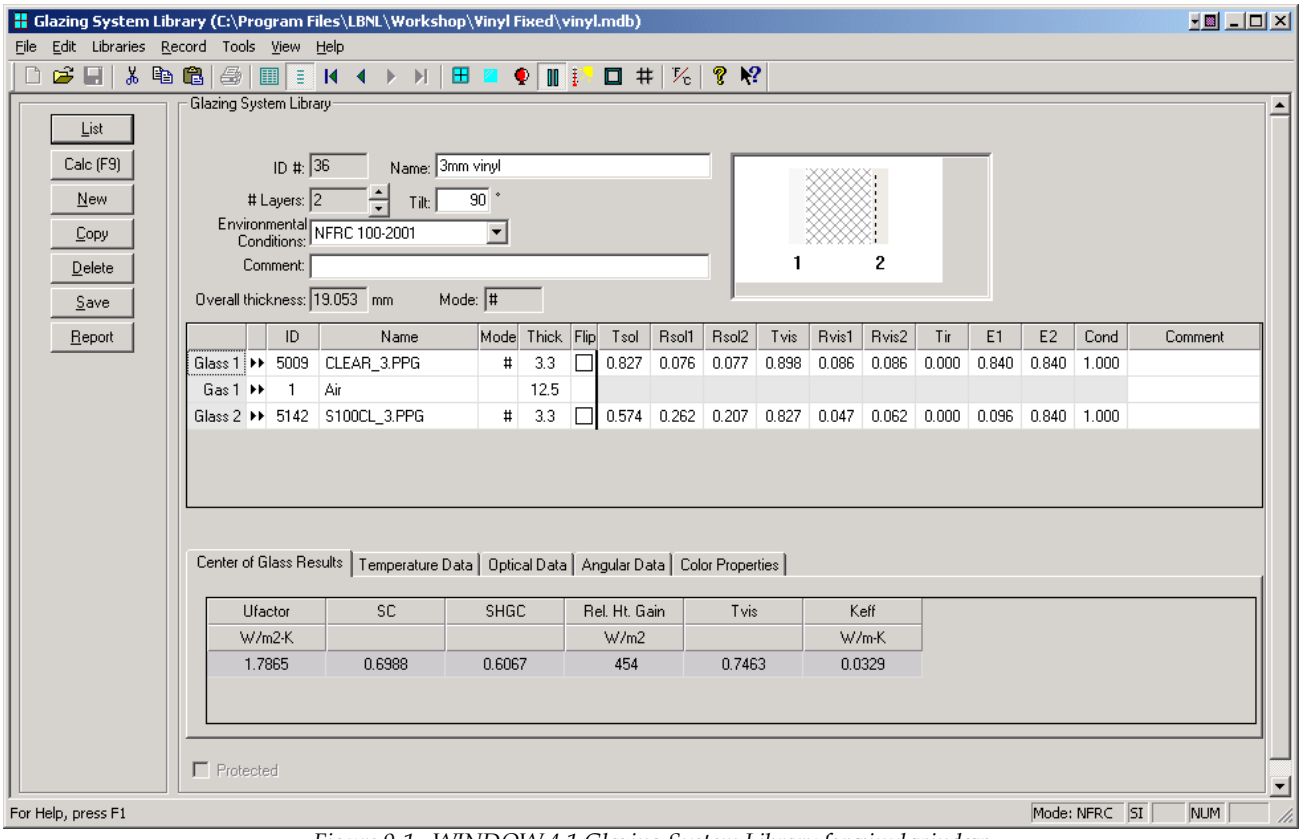


Figure 9-1. WINDOW 4.1 Glazing System Library for vinyl window

The results for the center-of-glazing U-factor are shown in the following table:

Table 9-1. Center-of-glazing U-factor results from WINDOW

		Center-of-glazing U-factor	
	Glazing Options (0.75" overall thickness)	**W/m^2-°C**	**(Btu/hr-ft^2-°F)**
1	Clear (3 mm), Air, Low-e (3mm)	1.7865	0.314

This glazing system will be used in THERM to calculate the edge-of-glazing and frame U-factors, and also in WINDOW to calculate the overall product U-factor.

9.2.4. Edge-of-glazing and Frame Modeling (THERM) for U-factor

Although this is a fixed window, and the head, sill and jamb have the same geometry, it is necessary to create a different cross section for each component type, because of the ISO 15099 modeling assumptions for gravity vectors as well as for Condensation Resistance modeling. The cross sections for each component will be the same, but the orientation of the glazing system and the properties will be different for each.

Table 9-3 shows the files that are on the CD for this example.

Table 9-2. Files associated with the vinyl window example

Cross Section	DXF Filename	THERM file
Sill (model with CR on)	Vinylp.dxf	Vinyl-Sill.thm
Head (model with CR on)	Vinylp.dxf	Vinyl-Head.thm
Jamb (model with CR *off*)	Vinylp.dxf	Vinyl-Jamb.thm
Divider (model as vertical divider with CR *off*)		Vinyl-Div.thm

Table 9-4 shows the resulting U-factors the vinyl frame and the divider cross sections.

Table 9-3. THERM results for vinyl window cross sections

	Frame U-factor		Edge U-factor	
Cross Section	**(W/m^2-°C)**	**($Btu/hr-ft^2$-°F)**	**(W/m^2-°C)**	**($Btu/hr-ft^2$-°F)**
Sill	1.6147	0.2821	2.0806	0.3663
Head	1.6024	0.2822	2.0828	0.3668
Jamb	1.7250	0.3038	2.0708	0.3647
Divider	2.7018	0.4758	2.0076	0.3535

Figures 9-2 and 9-3 show the THERM cross sections and U-factor results for this window.

Sill

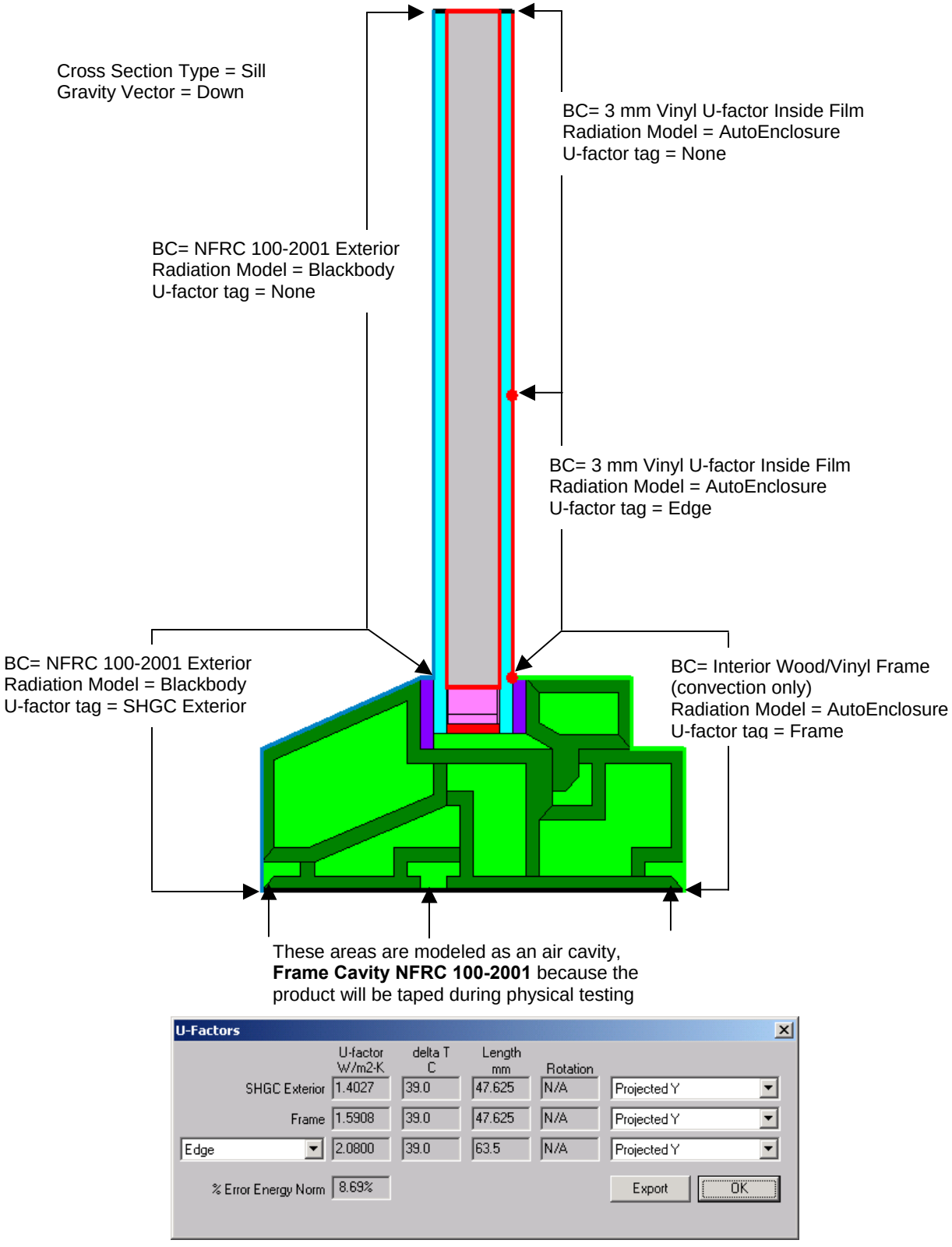


Figure 9-2. THERM cross section and U-factor for the vinyl fixed window sill.

Jamb

Modeling Assumptions:

- Cross Section Type = Jamb
- Gravity Vector = Into the Screen
- Jambs are modeled without the Condensation Resistance Model

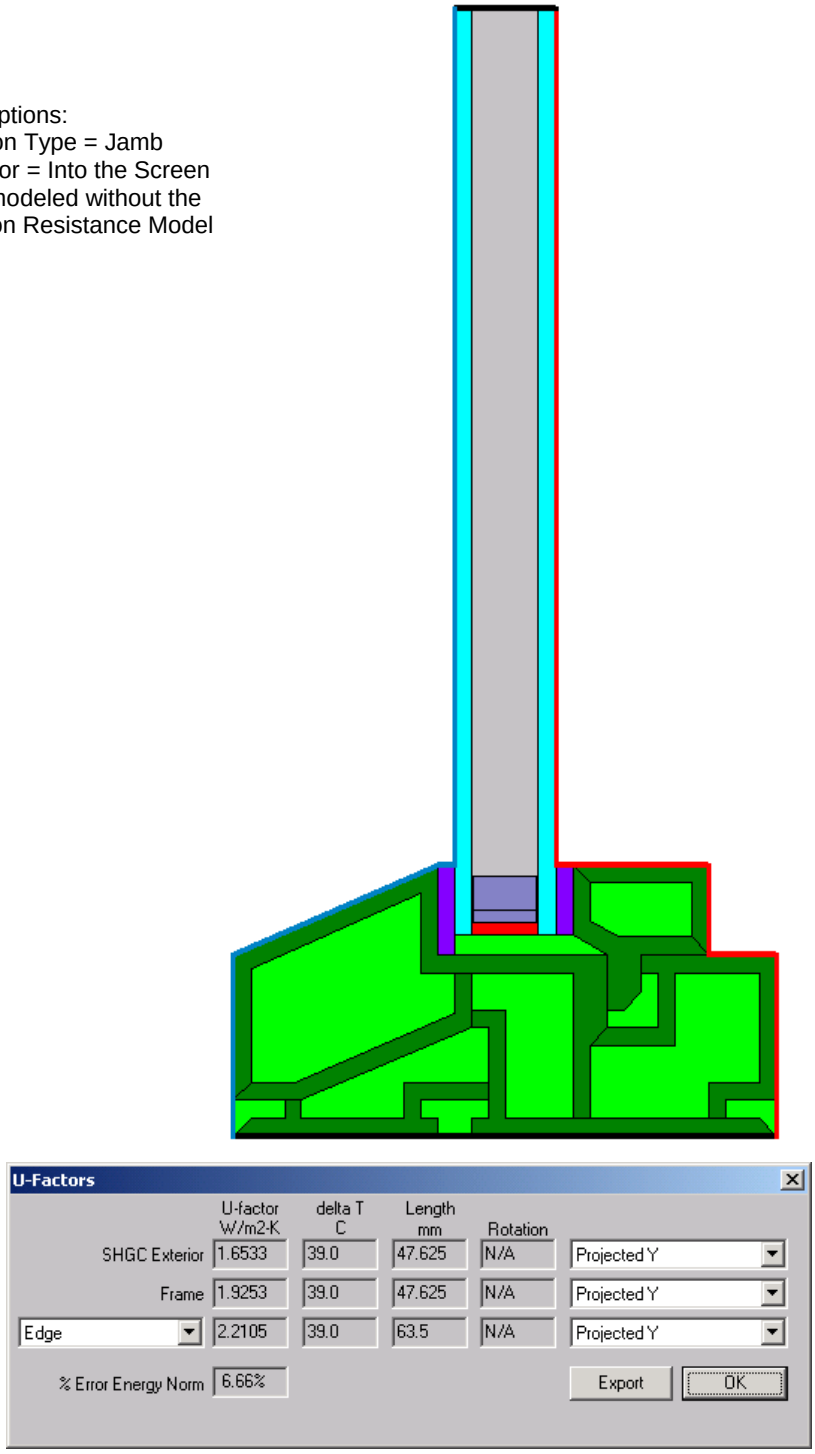


Figure 9-3. THERM cross section and U-factor for the vinyl fixed window jamb

Head

Modeling Assumptions:

- Cross Section Type = Head
- Gravity Vector = Down

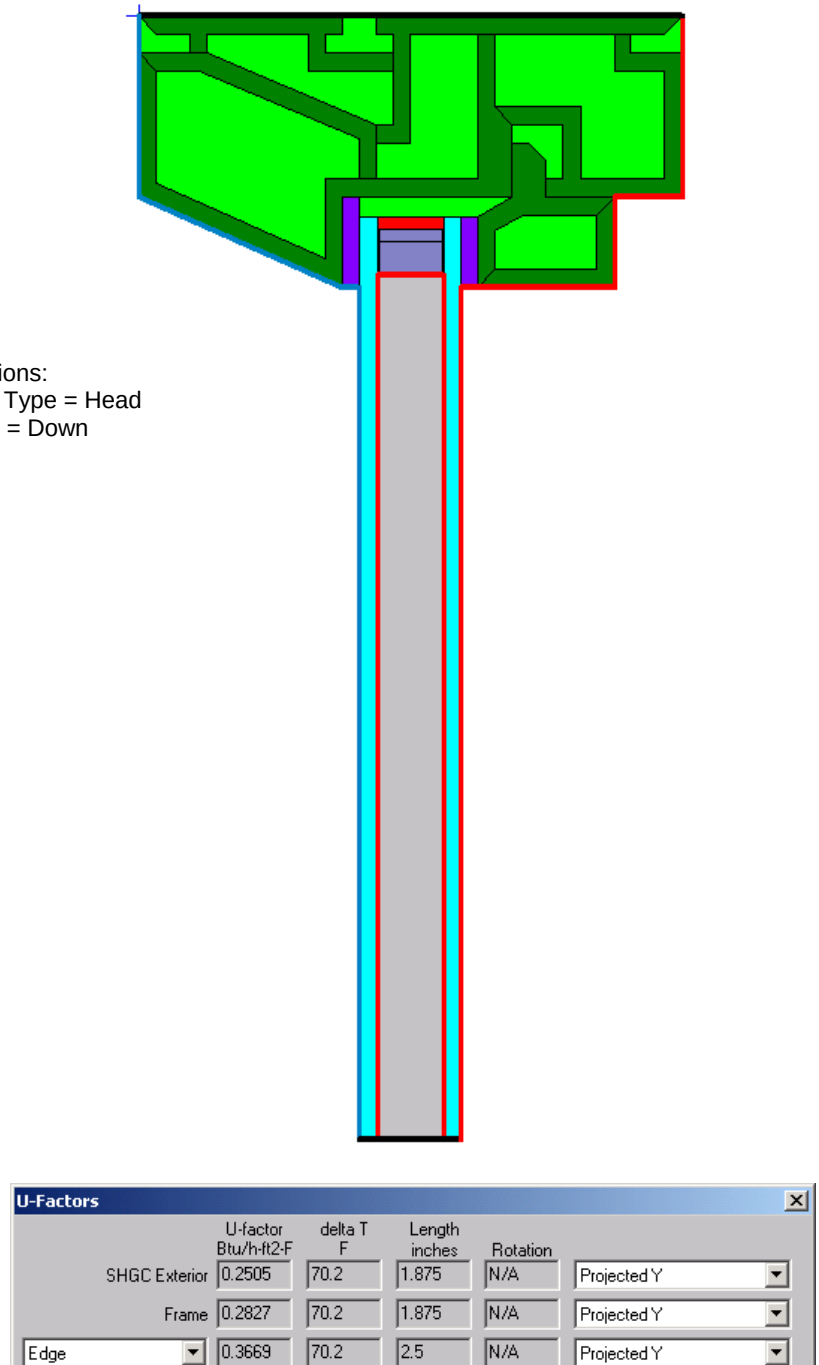


Figure 9-4. THERM cross section and U-factor for the vinyl fixed window head.

Divider

- Cross Section Type = Vertical Divider
- (model both vertical and horizontal dividers as Vertical)
- Do not use the CR model with a Vertical Divider cross section.
- Gravity Vector = Into the Screen
- It is not necessary to apply the SHGC Exterior U-factor tag in this case because the interior projected frame dimension and the exterior wetted length are the same (but it should be added for consistency).

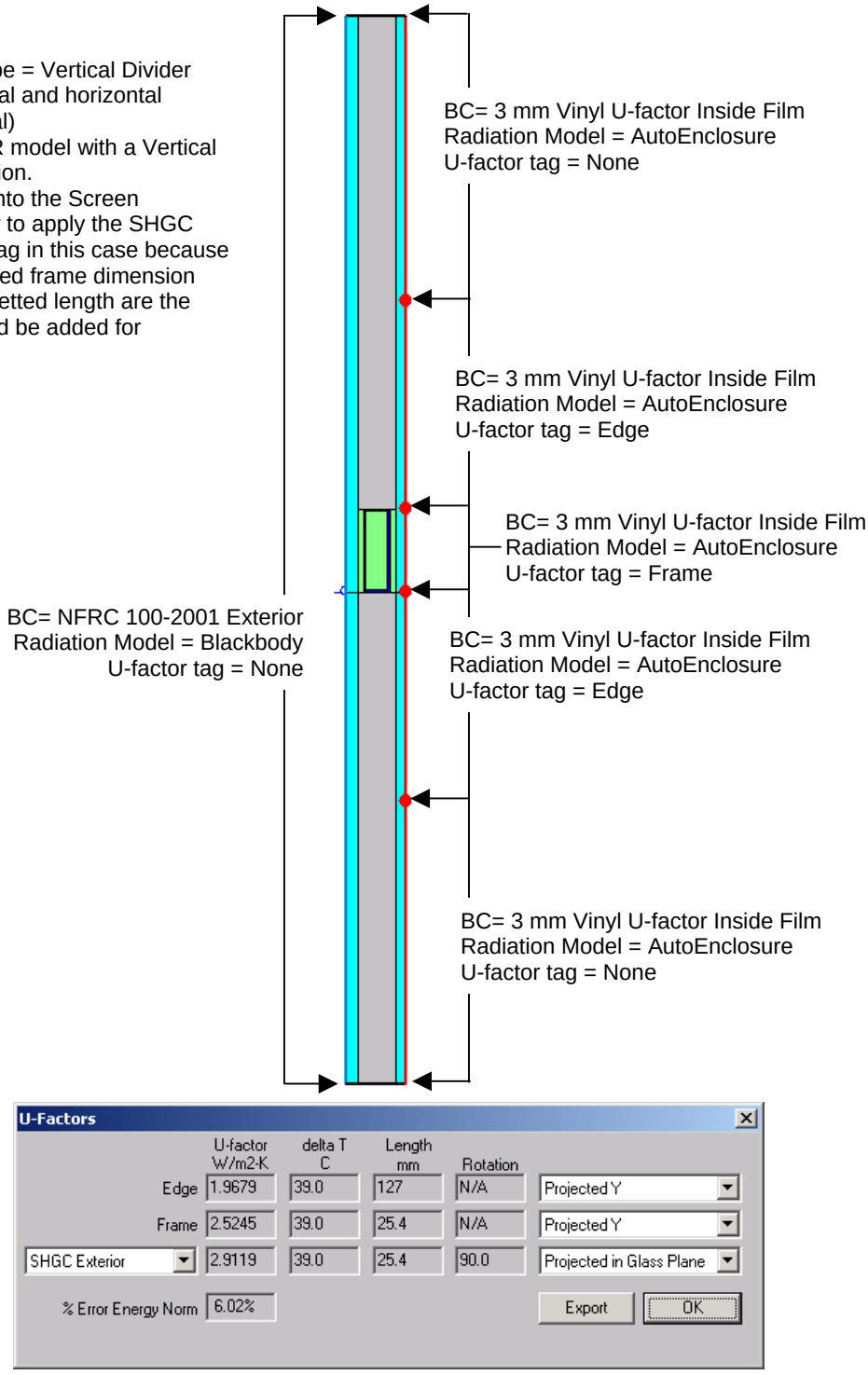


Figure 9-5. THERM cross section and U-factor for the vinyl fixed window divider.

9.2.5. Total Product U-Factor

In WINDOW, import the THERM cross sections into the Frame Library.

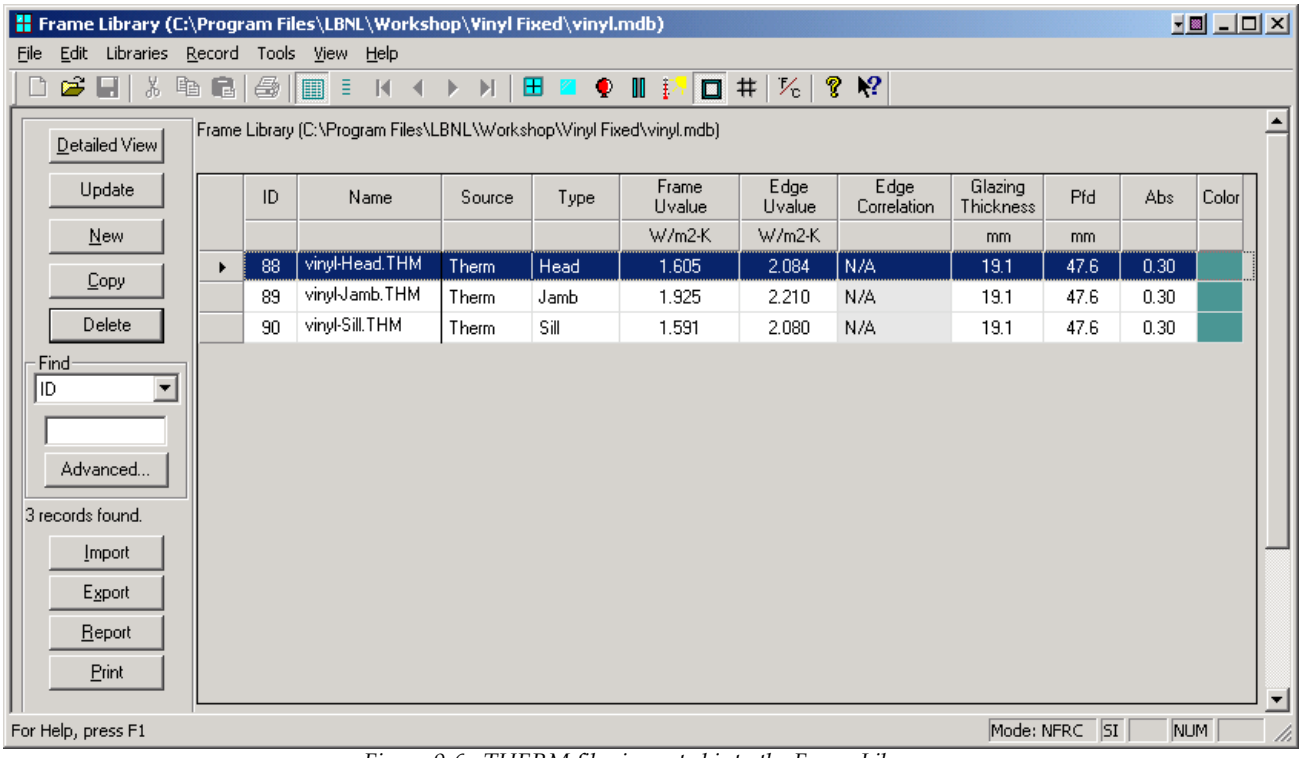


Figure 9-6. THERM files imported into the Frame Library.

In the WINDOW Window Library, two records are created for the U-factor calculation, one without dividers and one with the manufacturer supplied dividers, as shown in the figure below.

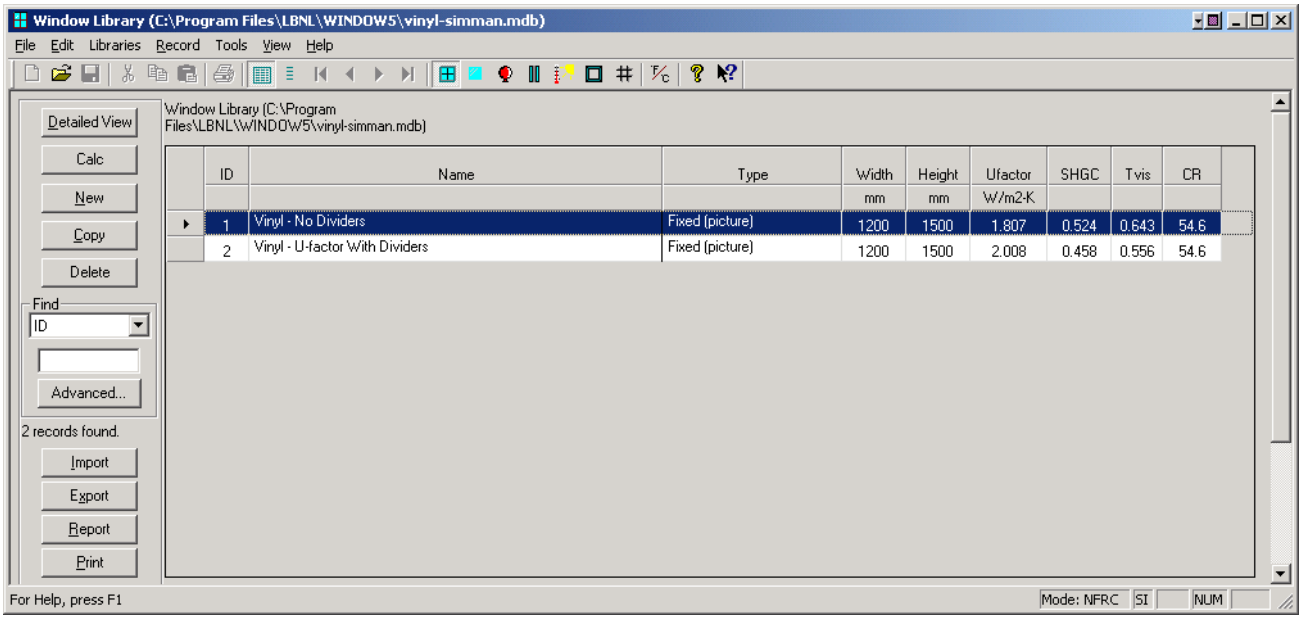


Figure 9-7. Window Library records for the product with and without dividers for the U-factor calculation.

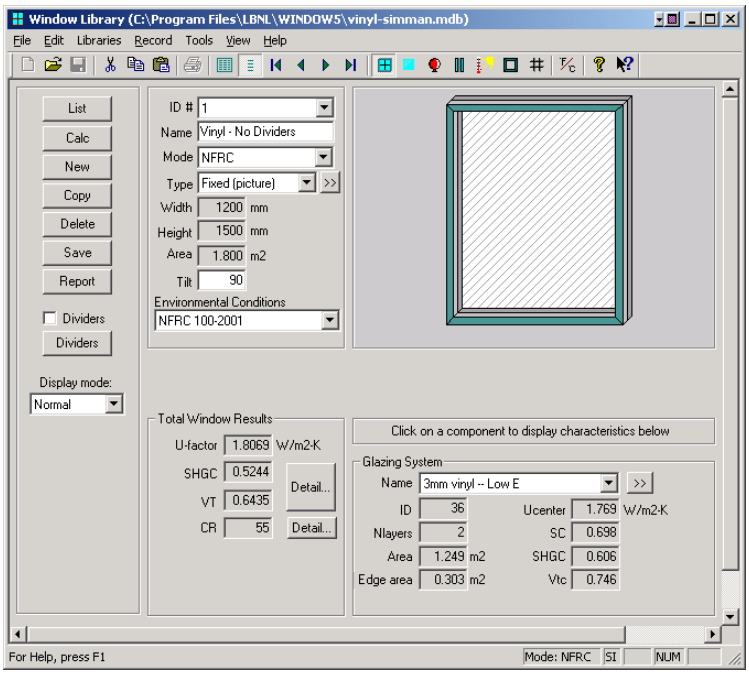


Figure 9-8. WINDOW total product U-factor calculation without dividers

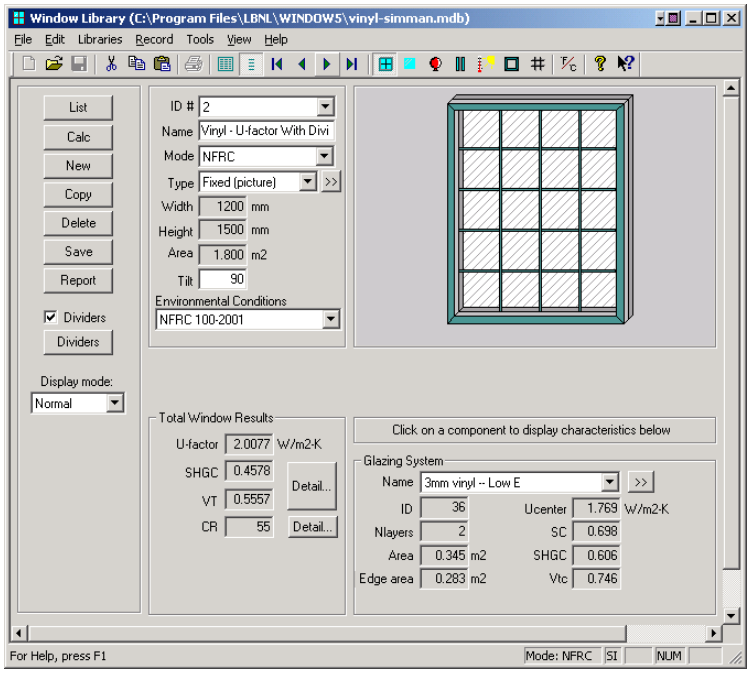


Figure 9-9. WINDOW total product U-factor calculation with dividers

The following table shows the overall product U-factor, from WINDOW, with and without dividers.

Table 9-4. Total Product U-factors

Glazing Options (19.0 mm overall thickness)		Total Product U-factor	
		(W/m^2-°C)	($Btu/hr-ft^2$-°F)
1	Clear, Air, Low-e, Without dividers	1.8069	0.3182
2	Clear, Air, Low-e, With dividers	2.0077	0.3536

9.2.6. Individual Product SHGC and VT using SHGC 0 & 1 and VT 0 & 1

The methodology for determining the Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) for products is outlined in *NFRC 200* using values of $SHGC_0$, $SHGC_1$, VT_0, VT_1. These values are calculated in WINDOW for the best glazing option modeled with the highest frame and edge U-factor frame, as outlined in *NFRC 200*, Section 6.1.1 (a). The values calculated from that one case are then used to calculate the SHGC for any other glazing options using Equations 3 and 4 in *NFRC 200* -- do not use the $SHGC_0$, $SHGC_1$, VT_0, VT_1 from WINDOW5 for every glazing option, just for the best glazing option.

WINDOW5 automatically calculates the the $SHGC_0$, $SHGC_1$, VT_0, VT_1 values for any product in the Window Library, for the three cases outlined in *NFRC 200*:

- No Dividers
- Dividers < 25.4 mm
- Dividers ≥ 25.4 mm

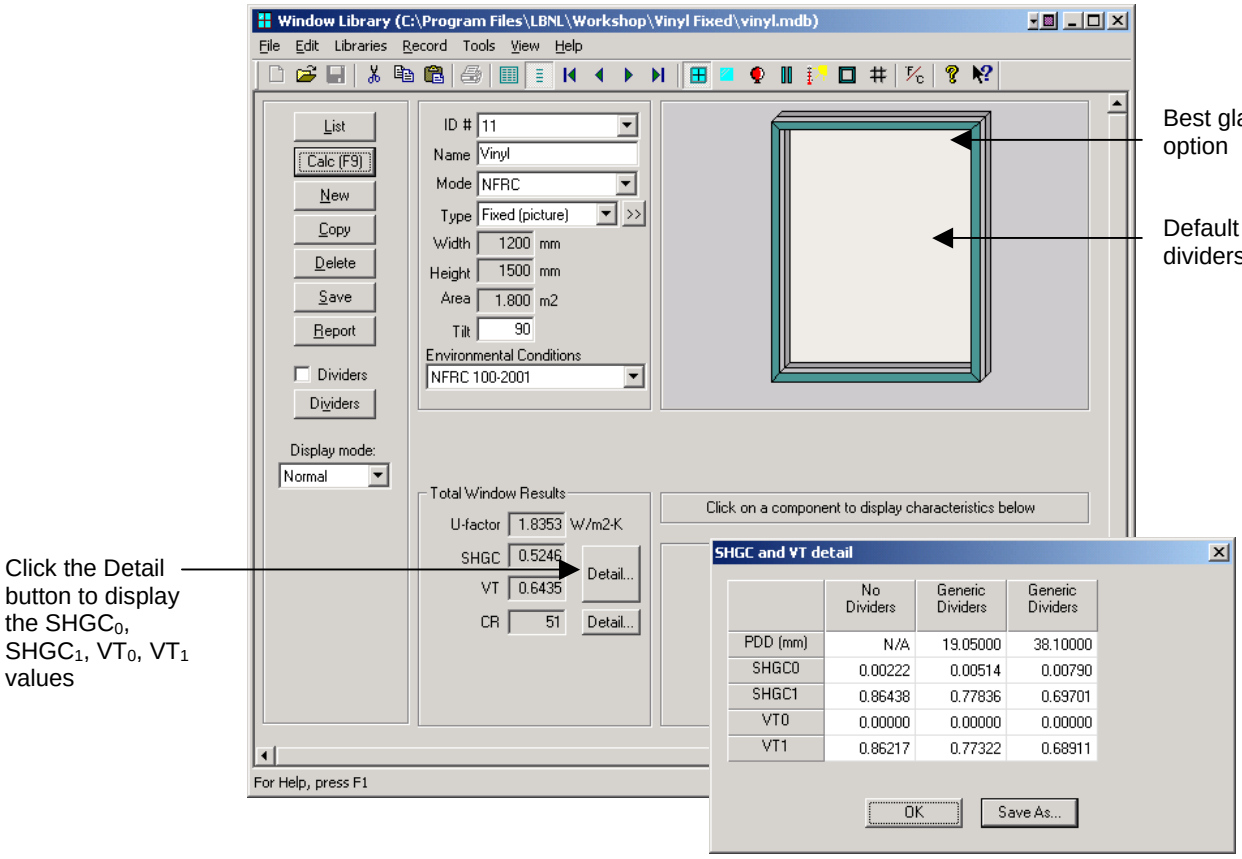


Table 9-5. $SHGC_0$, $SHGC_1$ VT_0, VT_1 for the three cases with the best glazing option for this product line, Clear, Air, Low-E.

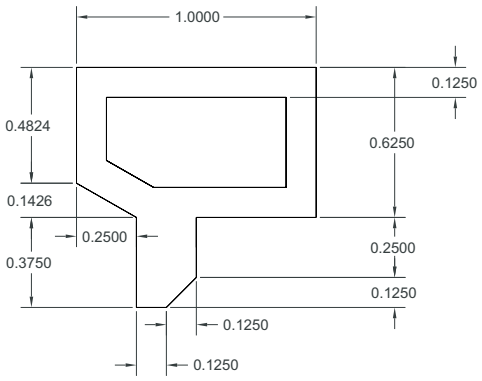
	No Dividers	Dividers ≤ 25.4 mm (1.0 inches)	Dividers > 25.4 mm (1.5 inches)
$SHGC_0$	0.00222	0.00514	0.00790
$SHGC_1$	0.86438	0.77836	0.69701
VT_0	0.000	0.000	0.000
VT_1	0.86217	0.77320	0.68911

Figure 9-10. Window Library record for $SHGC_0$, $SHGC_1$, VT_0, VT_1 calculation.

9.2.7. Drawings Vinyl Fixed Window

The following pages contain detailed drawings for this window.

Head, Sill and Jamb



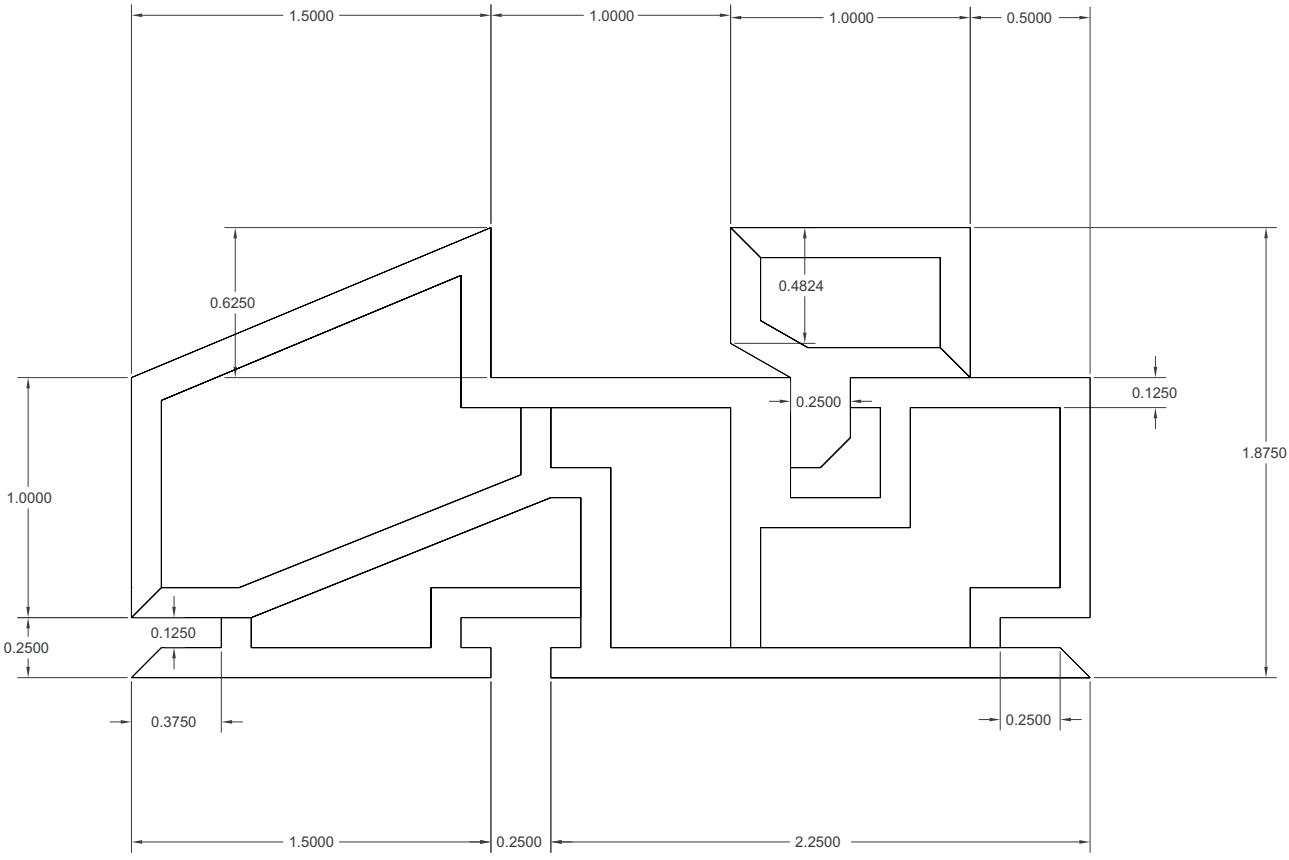


Figure 9-11. Dimensioned drawing for vinyl fixed window.

Spacer

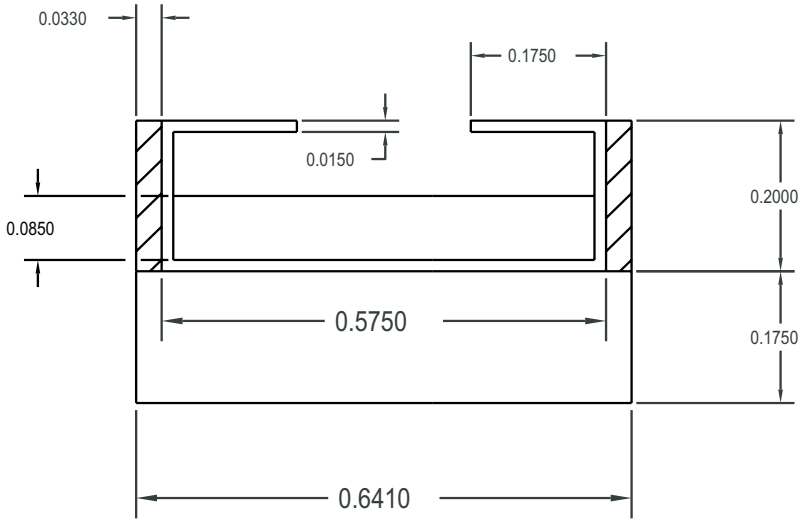
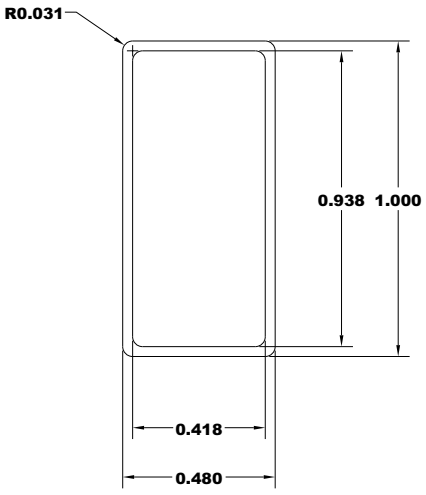


Figure 9-12. Dimensioned drawing for spacer.

Divider

00080-A **Page 21**

Divider type A



Aluminum
Metal
white

Figure 9-13. Dimensioned drawing for divider.

9.3 Problem 2: Aluminum Horizontal Slider Window

For this example problem, there are 4 glazing options. Calculate the total product U-factor, SHGC, VT and the specialty products table.

9.3.1. Description

Window Type	Horizontal Slider
Frame Material	Aluminum painted white. Thermal breaks as indicated in the drawing assembly. The manufacturer indicated that the de-bridge width is 0.250" for all the cross sections. Thermal break material is poured in place polyurethane.
Overall Size	Width = 1500mm; Height = 600mm
Spacer type	See drawings in Section 9.3.7.
Weather Strip	See drawings in Section 9.3.7.
Cross Sections	Section 9.3.7 contains the drawings for this example.
Dividers	Aluminum painted white. See drawing for dimensions. Manufacturer provides standard 12" on center or less horizontal and vertical grid pattern for his products. Based on the drawings and the glazing cavity thickness, the dividers do not need to be modeled because the gap between the divider and the glass is greater than 3.0 mm (0.118”).
Glazing system	The manufacturer uses the following glass type options depending on the market availability and price factor. The manufacturer uses clear and Low-e coated glass from the same manufacturer.

All clear glass having nominal thickness of 3mm, 4mm, 5mm, and 6mm from PPG or CIG.

Low-e coated clear glass having emissivity range from 0.100-0.096. Thicknesses are nominal 3mm, 4mm, 5mm and 6mm from PPG (SUNGATE 100, clear glass) or CIG (LoE SUN45 coating, clear glass)

9.3.2. Glazing Matrix

The following table shows the glazing matrix that is to be simulated for this window. **However, for this example, only glazing option 1 (the 3 mm case) will be modeled** using CIG glass.

Table 9-6. Matrix of Glazing Options for Problem 2

	Glazing Options (1.0" overall thickness)	Grid Option	Manufacturer
*** 1**	**Clear (3 mm), Argon (95%), Low-e (3 mm)**	**Grids do not need to be modeled (see note above in divider description)**	**CIG, PPG**
2	Clear (3 mm), Argon (95%), Clear (3 mm)	**Grids do not need to be modeled (see note above in divider description)**	CIG, PPG

9.3.3. Center-of-glazing Modeling (WINDOW)

In WINDOW, create the glazing systems needed for the Glazing Matrix in Section 9.3.2. An example of one of the four glazing systems is shown in the figure below.

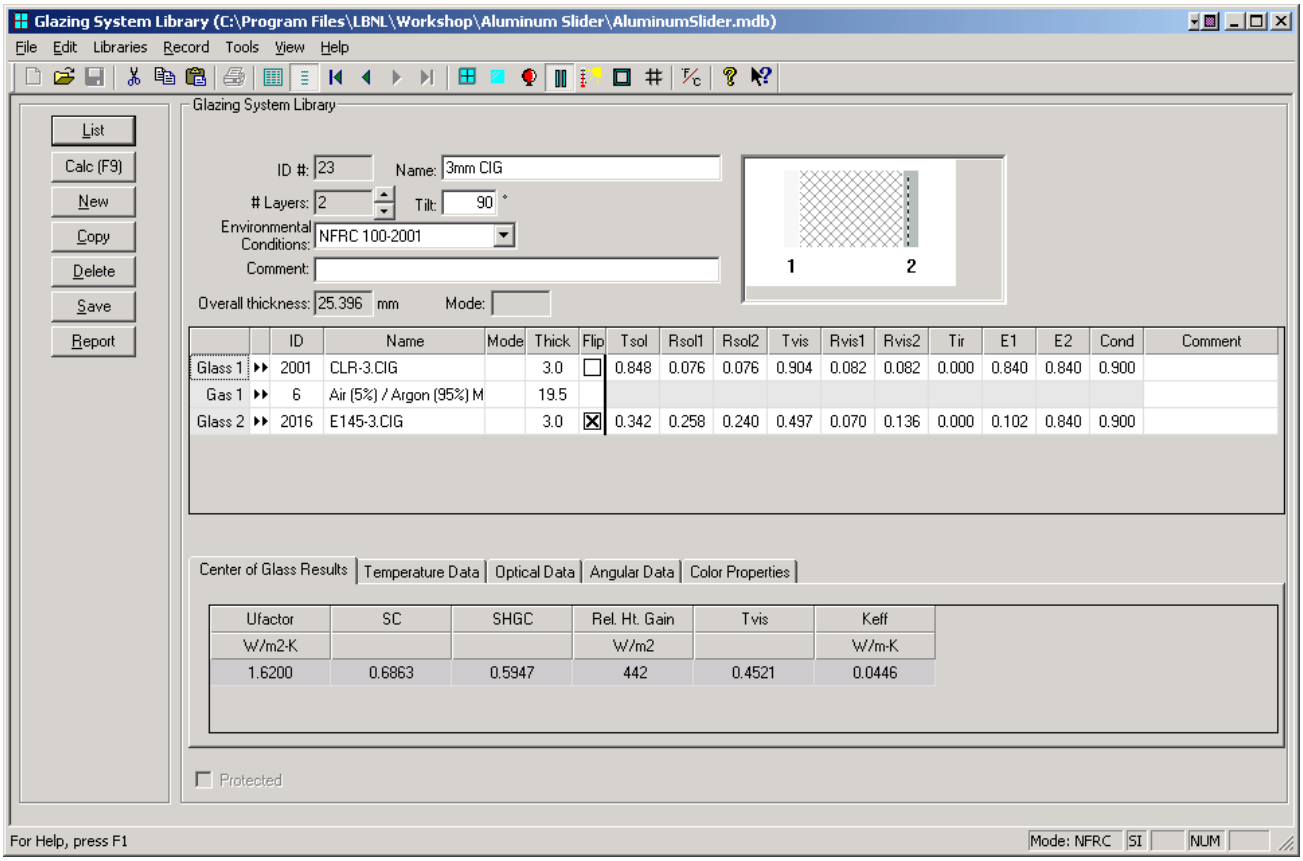


Figure 9-14. WINDOW 4.1 Glazing System Library for the Glazing Options

The results for the center-of-glazing U-factor are shown in the following table:

Table 9-7. Center-of-glazing U-factor Results for the Matrix of Glazing Options

		Center-of-glazing U-factor	
	Glazing Options (25.396 mm overall thickness)	**W/m^2-°C**	**(Btu/hr-ft^2-°F)**
1	Clear (3 mm), Argon (95%), Low-e (3mm)	1.6200	0.2853

These glazing systems will be used in THERM to calculate the frame and edge-of-glazing U-factors, and also in WINDOW to calculate the overall product U-factor.

9.3.4. Edge-of-glazing and Frame Modeling (THERM)

There are seven cross-sections that must be modeled for this product, listed in Table 9-10. The THERM files listed in this table can be found on the CD.

Table 9-8. Cross sections to be modeled with their associated dxf and THERM files

Cross Section	DXF Filename	THERM file for 3 mm
Sill Vent	530vtsl.dxf	sv_01.thm
Sill Fixed	530fxsl.dxf	sf_01.thm
Jamb Vent	530vtjb.dxf	jv_01.thm
Jamb Fixed	530fxjb.dxf	jf_01.thm
Head Vent	530vthd.dxf	hv_01.thm
Head Fixed	530fxhd.dxf	hf_01.thm
Meeting Rail	530mtrl.dxf	mr_01.thm
Spacer	Cig30.dxf	Spacer-3mm.thm

In addition to the DXF files provided on CD, detailed drawings of these cross sections are in Section 9.3.7 of this manual.

Make a THERM file for each of the cross sections using the following steps:

- Use the DXF files as an underlay for each file. The files were not created in a manner that THERM can autoconvert, but the underlay can be used to trace the cross sections. (See Chapter 5, "Drawing Cross-Section Geometry" in the *THERM User's Manual).*
- As the polygons for each cross section are being drawn, assign the correct material properties to them. (See Chapter 5, "Drawing Cross-Section Geometry" in the *THERM User's Manual*.)
- Insert the glazing system created in WINDOW 5. (See Section 5.9, "Inserting a Glazing System" in the *THERM User's Manual*.) Notice that the spacer is open to the glazing cavity, so use the technique discussed in Section 8.7.3, "Modifying Glazing Cavities (imported from WINDOW) for Open Spacers."
- Assign the boundary conditions to the entire cross section. (See Chapter 6, "Defining Boundary Conditions" in the *THERM User's Manual*.)
- Calculate the U-factor and CR temperatures for the cross section. (See Chapter 7, "Calculating Results" in the *THERM User's Manual*.)

- Table 9-11 shows the resulting U-factors from each cross section for the 3 mm glazing case. Note the result for the Grid case, which will be imported into the WINDOW **Divider Library.**

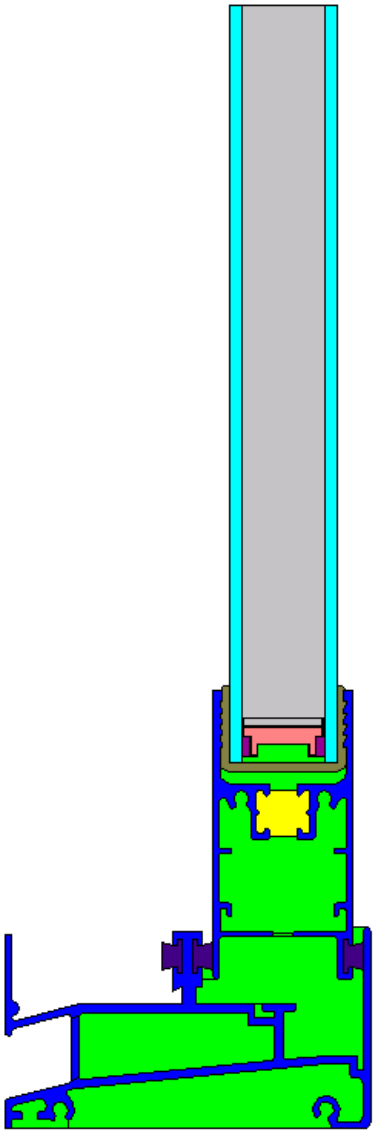
Table 9-9. Frame and Edge THERM U-factor Results for Glazing Option 1: 3 mm

	Frame U-factor		Edge U-factor	
Cross Section	**(W/m^2-^{o}C)**	**(Btu/hr-ft^2-^{o}F)**	**(W/m^2-^{o}C)**	**(Btu/hr-ft^2-^{o}F)**
Sill Vent	5.696	1.003	2.097	0.369
Sill Fixed	8.411	1.481	2.011	0.354
Jamb Vent	4.916	0.866	2.071	0.365
Jamb Fixed	7.546	1.329	2.036	0.359
Head Vent	5.315	0.936	2.031	0.358
Head Fixed	6.848	1.206	2.053	0.362
Meeting Rail	4.862	0.856	2.110	0.372

- Table 9-12 shows the resulting U-factors from each cross-section for the 6 mm glazing case.

The figures on the following pages show THERM files and U-factor results screens for each of the cross-sections with the 3 mm glazing system.

Sill Vent Cross Section
(sv_01.thm)



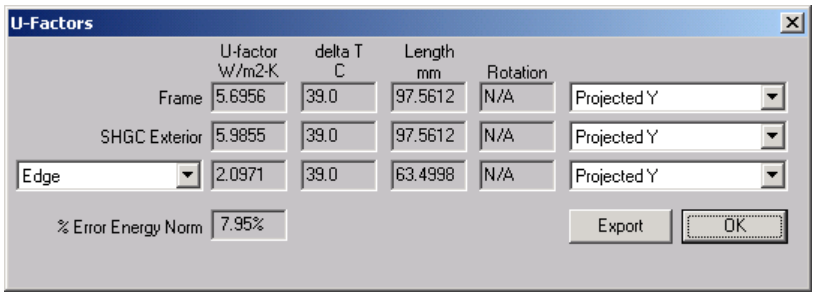


Figure 9-15. THERM file and U-factors for Sill Vent Cross Section.

Sill Fixed Cross Section
(sf_01.thm)

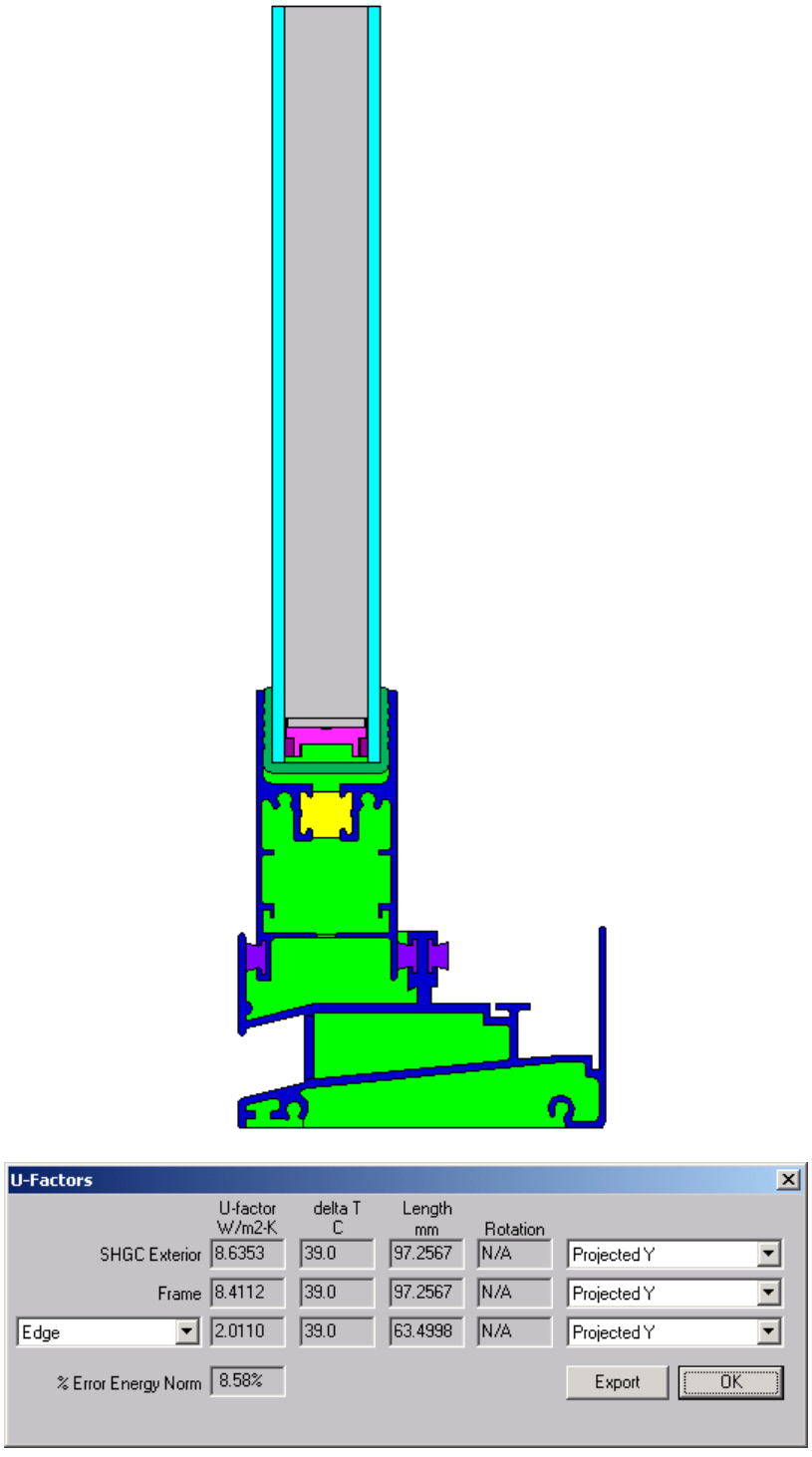


Figure 9-16. THERM file and U-factors for Sill Fixed Cross Section.

Jamb Vent Cross Section
(jv_01.thm)

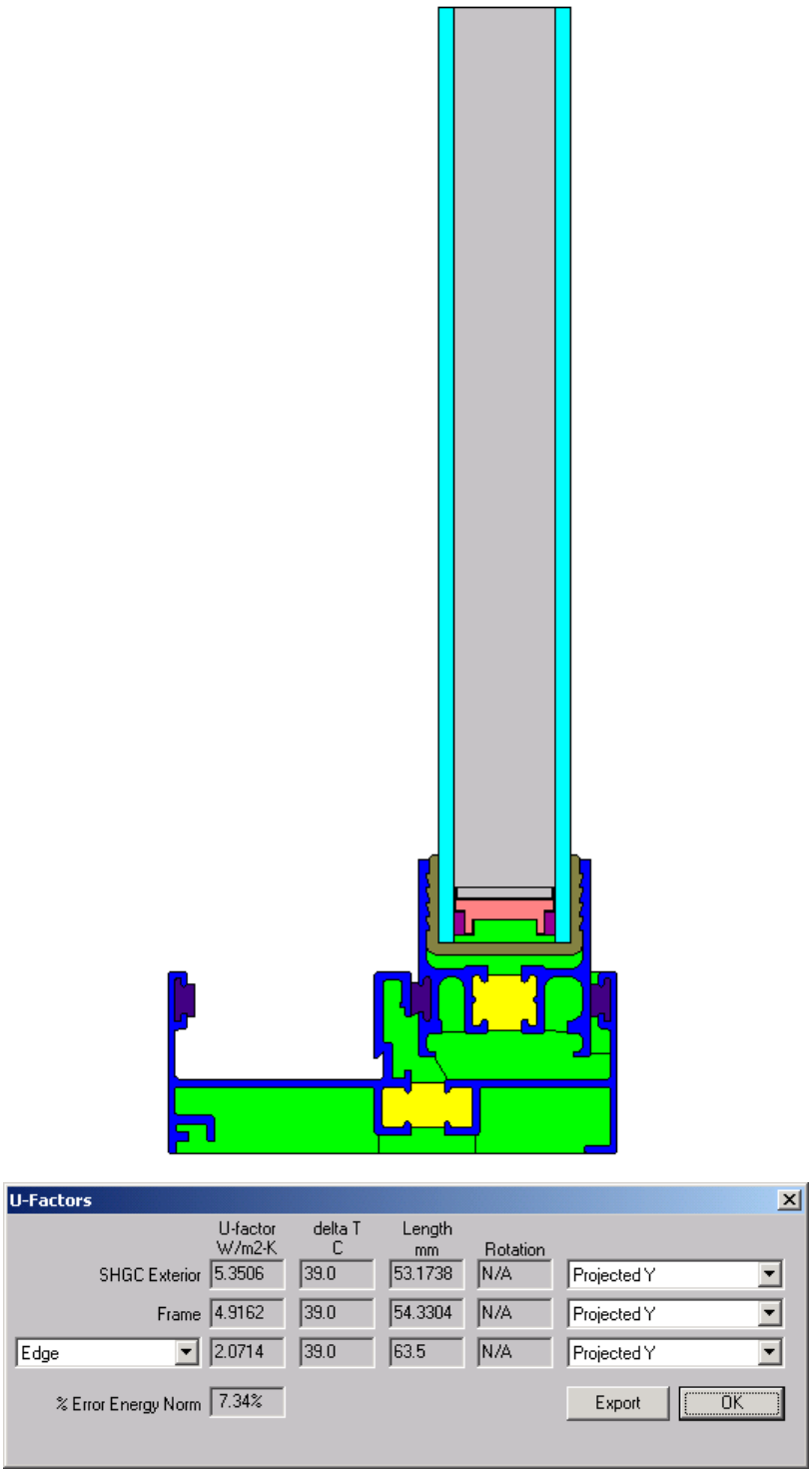


Figure 9-17. THERM file and U-factors for Jamb Vent Cross Section.

Jamb Fixed Cross Section
(jf_01.thm)

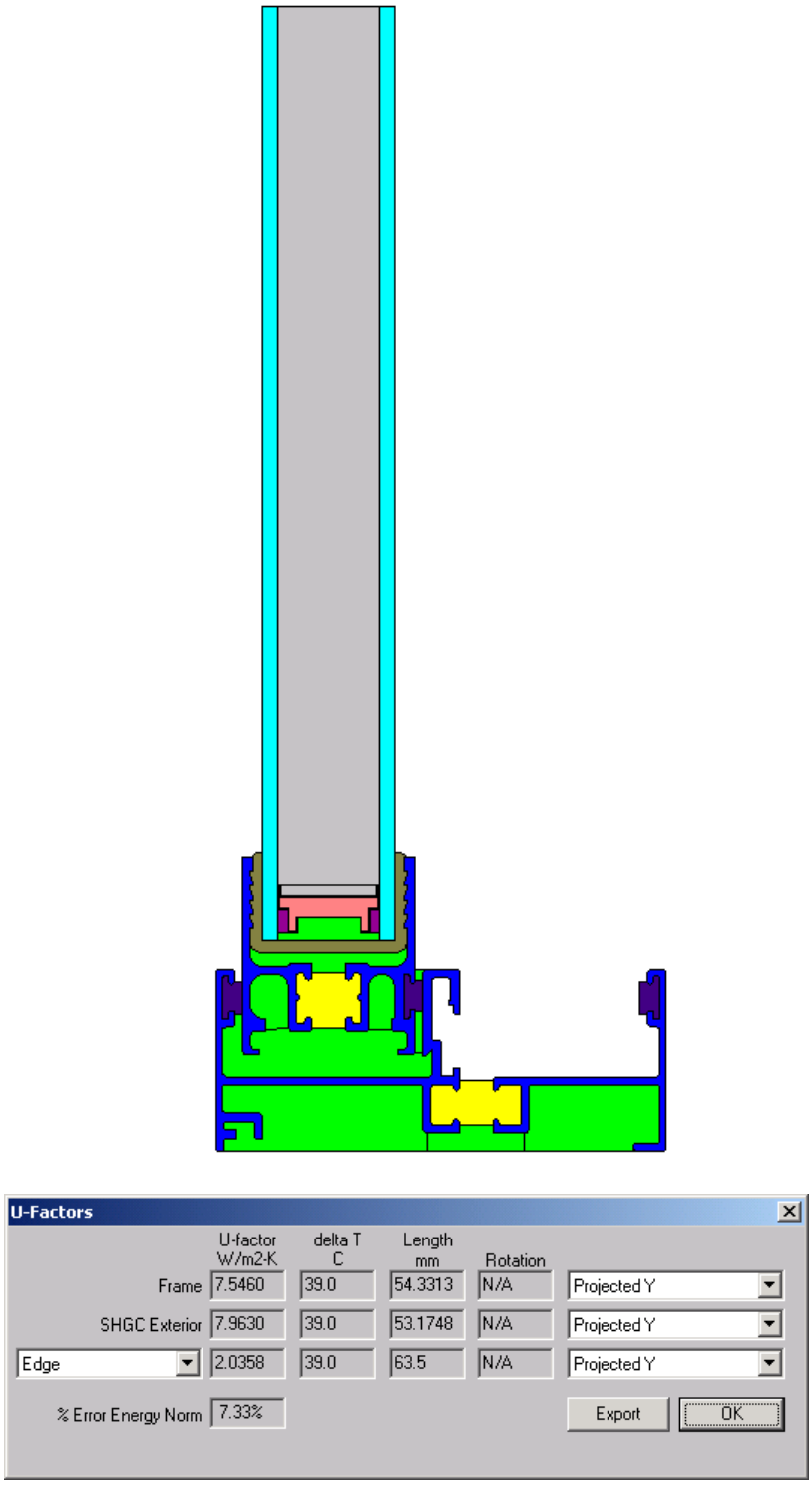


Figure 9-18. THERM file and U-factors for Jamb Fixed Cross Section.

Head Vent Cross Section
(hv_01. thm)

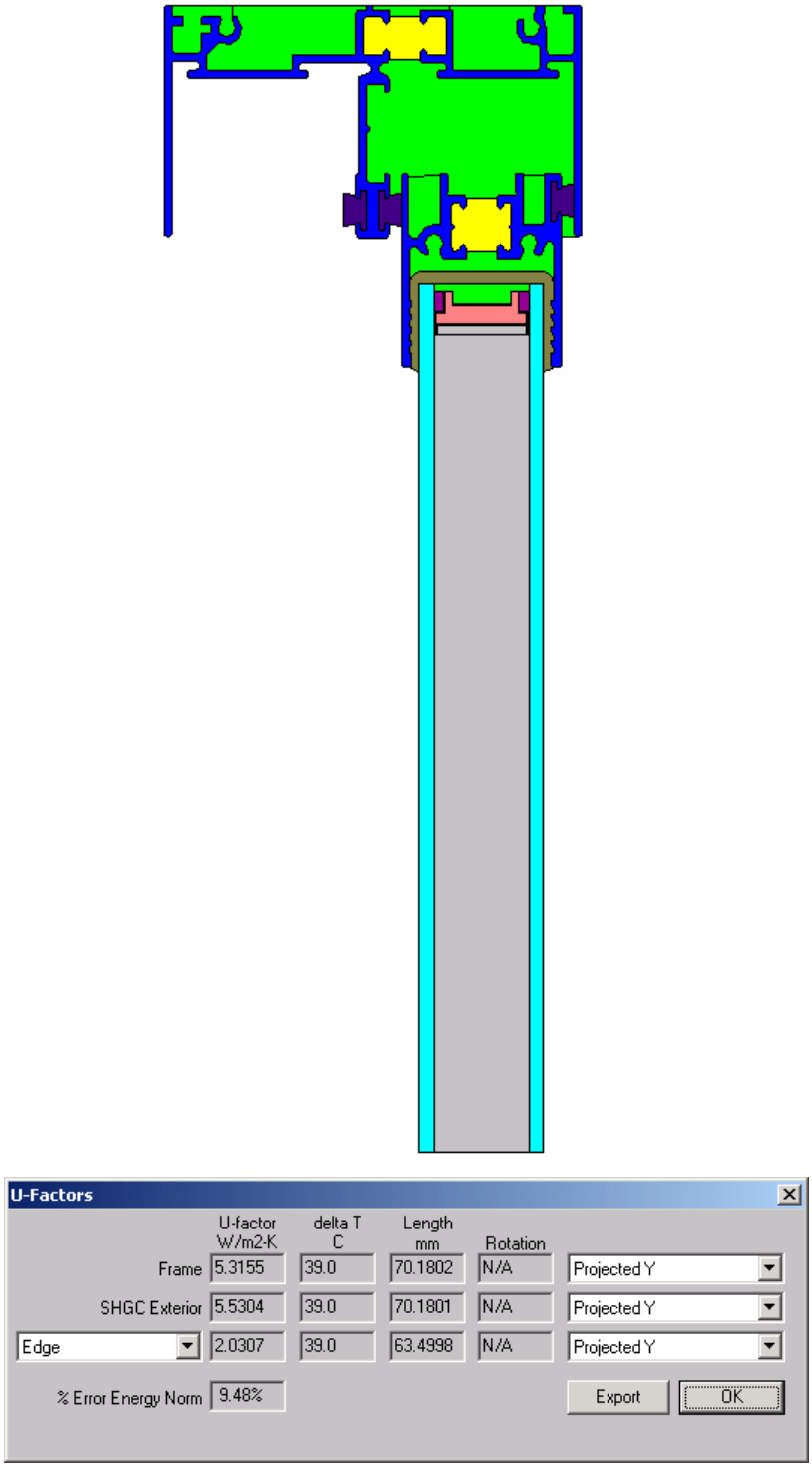
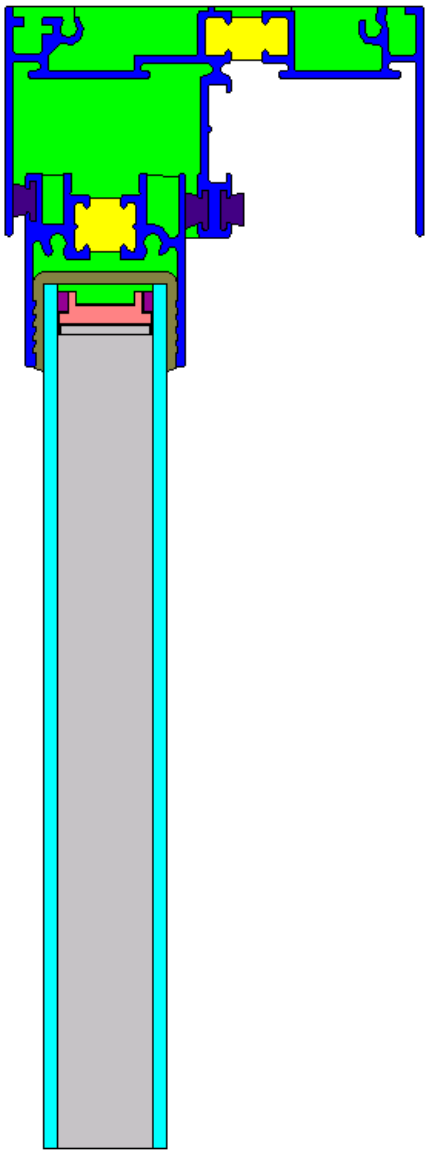


Figure 9-19. THERM file and U-factors for Head Vent Cross Section.

Head Fixed Cross Section
(hf_01.thm)



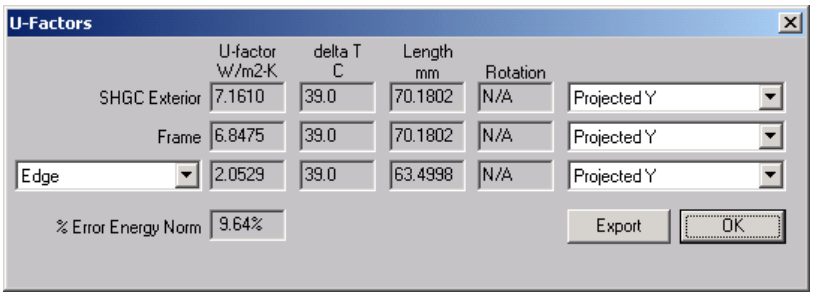


Figure 9-20. THERM file and U-factors for Head Fixed Cross Section.

Meeting Rail Cross Section
(mr_01. thm)

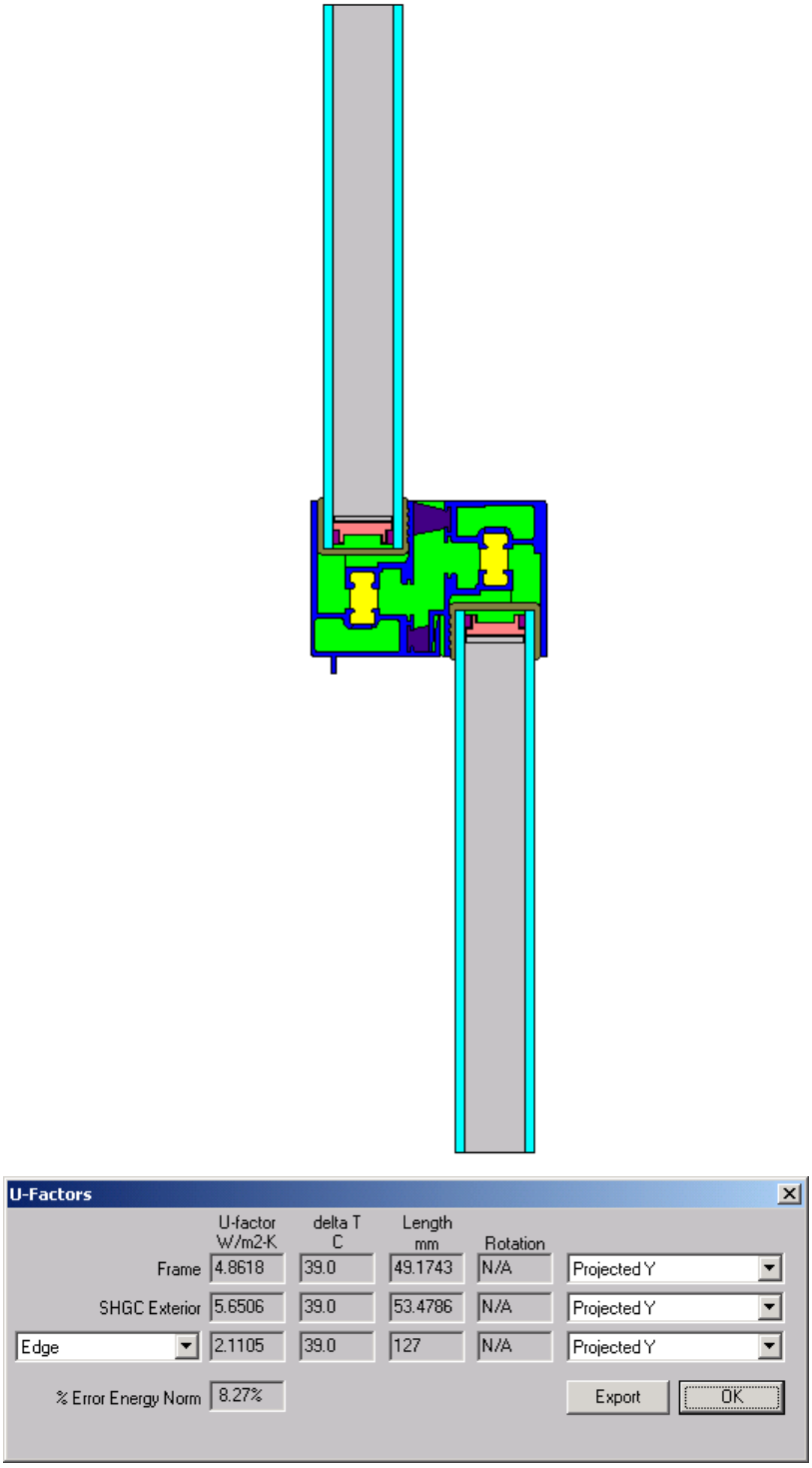


Figure 9-21. THERM file and U-factors for Meeting Rail Cross Section.

9.3.5. Total Product U-Factor

In WINDOW, import the THERM cross sections into the **Frame Library**.

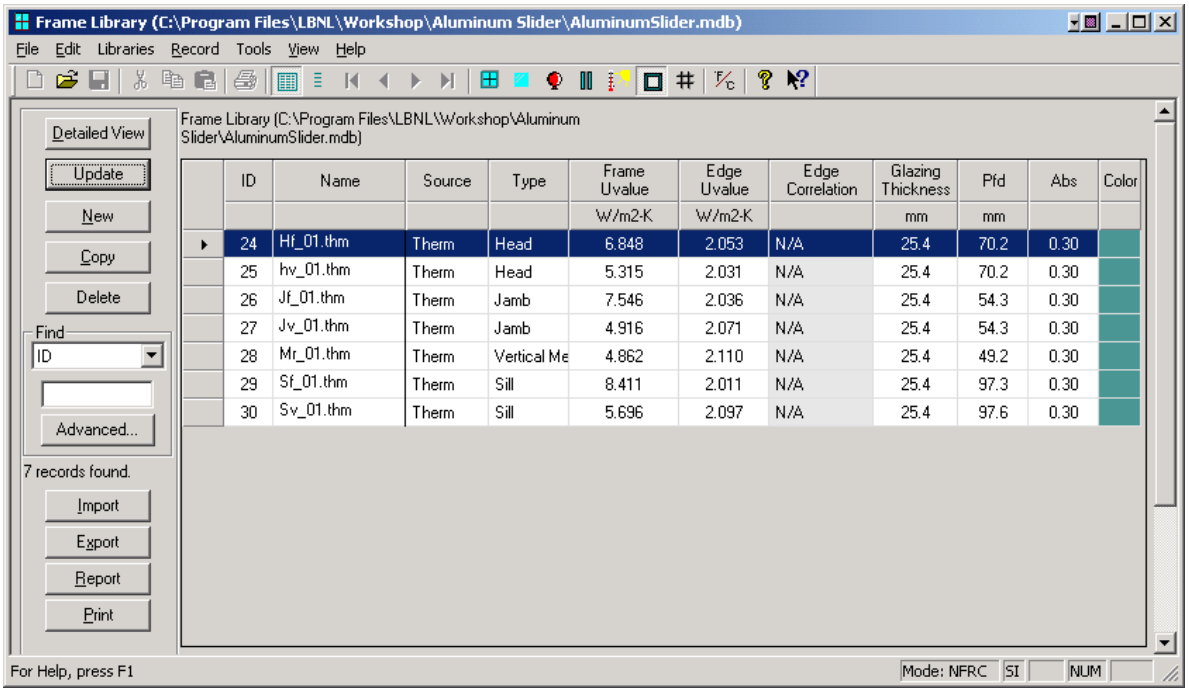


Figure 9-22. THERM files imported into the Frame Library.

In the WINDOW Window Library, create a record using the THERM files imported into the Frame Library, and the glazing system created for the product, as shown in the figure below.

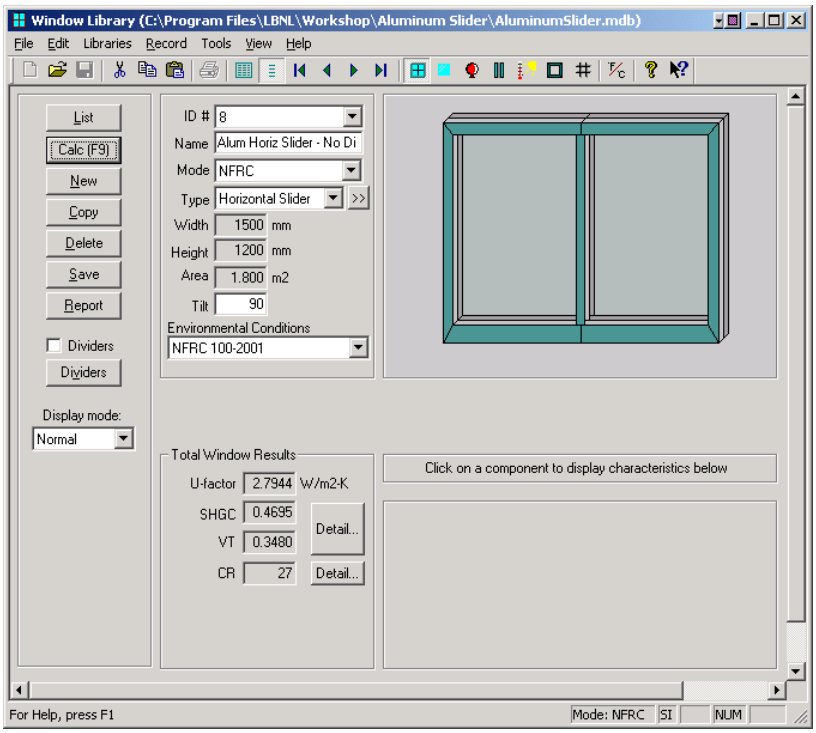


Figure 9-23. WINDOW total product U-factor calculation.The following table shows the overall product U-factor, from WINDOW, with and without dividers.

Table 9-10. Total Product U-factors

Glazing Options (19.0 mm overall thickness)		Total Product U-factor	
		(W/m^2-°C)	($Btu/hr-ft^2$-°F)
1	Clear, Argon, Low-e, Without dividers	2.7944	0.4921

9.3.6. Individual Product SHGC and VT using SHGC 0 & 1 and VT 0 & 1

The methodology for determining the Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) for products is outlined in *NFRC 200* using values of $SHGC_0$, $SHGC_1$, VT_0, VT_1. These values are calculated in WINDOW for the best glazing option modeled with the highest frame and edge U-factor frame, as outlined in *NFRC 200*, Section 6.1.1 (a).

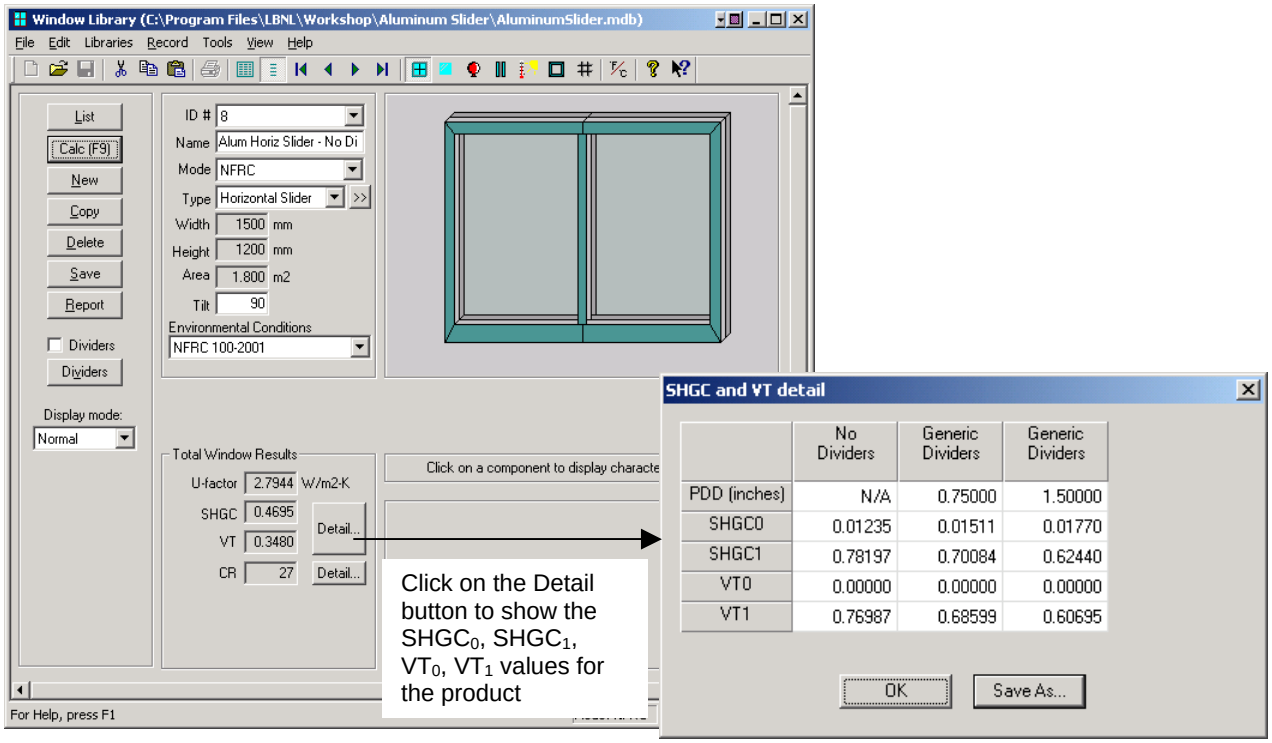


Figure 9-24. Dimensioned drawing for vinyl fixed window.

9.3.7. Drawings for Aluminum Horizontal Slider Window

The following pages contain detailed drawings for this window:

Page 1

Sliding Head

(NFRC-VT-HD)

Glass Thickness	A
3mm	$0.120^{+0.010}_{-0.005}$
4mm	$0.155^{+0.005}_{-0.005}$
5mm	$0.185^{+0.005}_{-0.005}$
6mm	$0.225^{+0.005}_{-0.005}$

Note : All Weather Strippings are Type-I

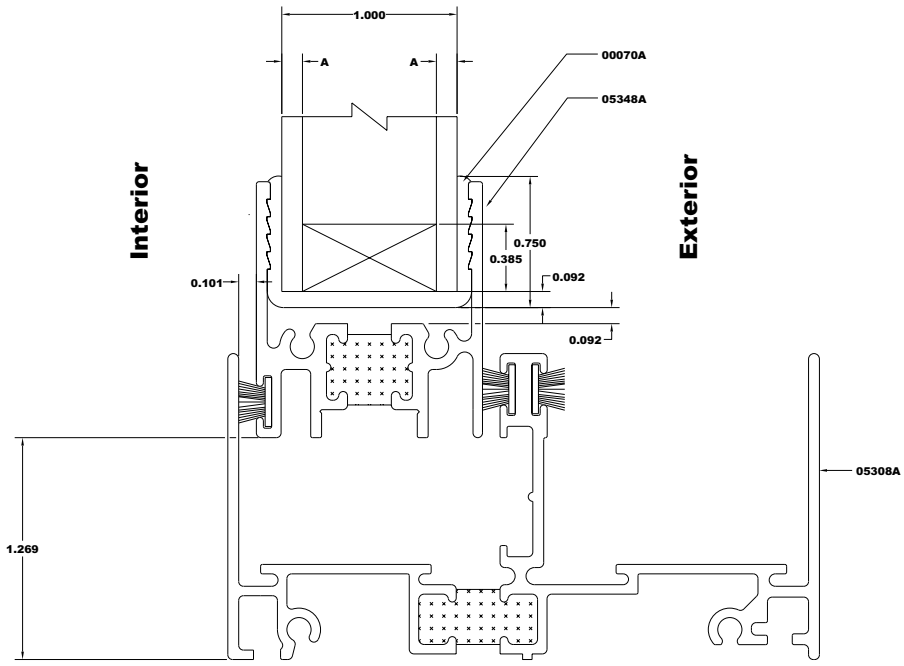


Figure 9-25. ***Vent Head Drawing for Horizontal Aluminum Slider.***

Page 2

Fix Jamb

(NFRC-FX-JB)

Glass Thickness	A
3mm	$0.120^{+0.010}_{-0.005}$
4mm	$0.155^{+0.005}_{-0.005}$
5mm	$0.185^{+0.005}_{-0.005}$
6mm	$0.225^{+0.005}_{-0.005}$

Note: All Weather Strippings are Type-I

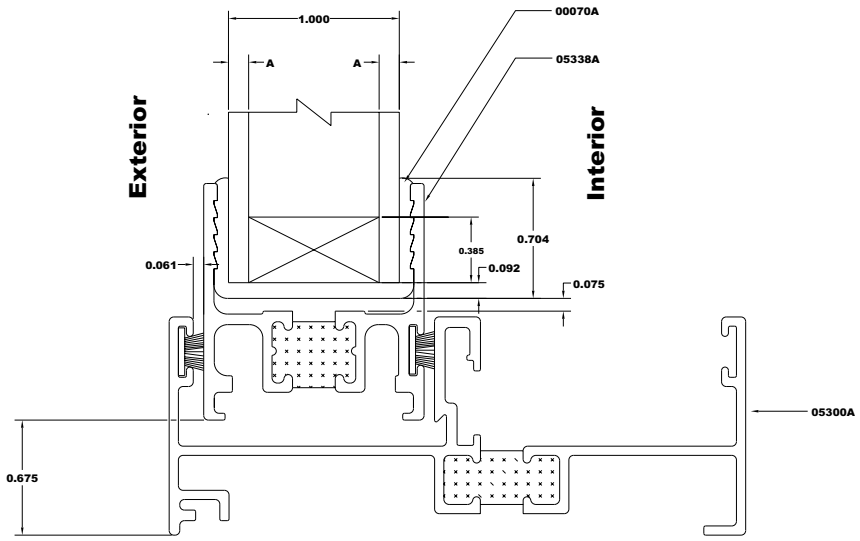


Figure 9-26. Fixed Jamb Drawing ***for Horizontal Aluminum Slider.***

Sliding Sill

Page 3

(NFRC-VT-SL)

Glass Thickness	A
3mm	$0.120^{+0.010}_{-0.005}$
4mm	$0.155^{+0.005}_{-0.005}$
5mm	$0.185^{+0.005}_{-0.005}$
6mm	$0.225^{+0.005}_{-0.005}$

Note : All Weather Strippings are Type-I

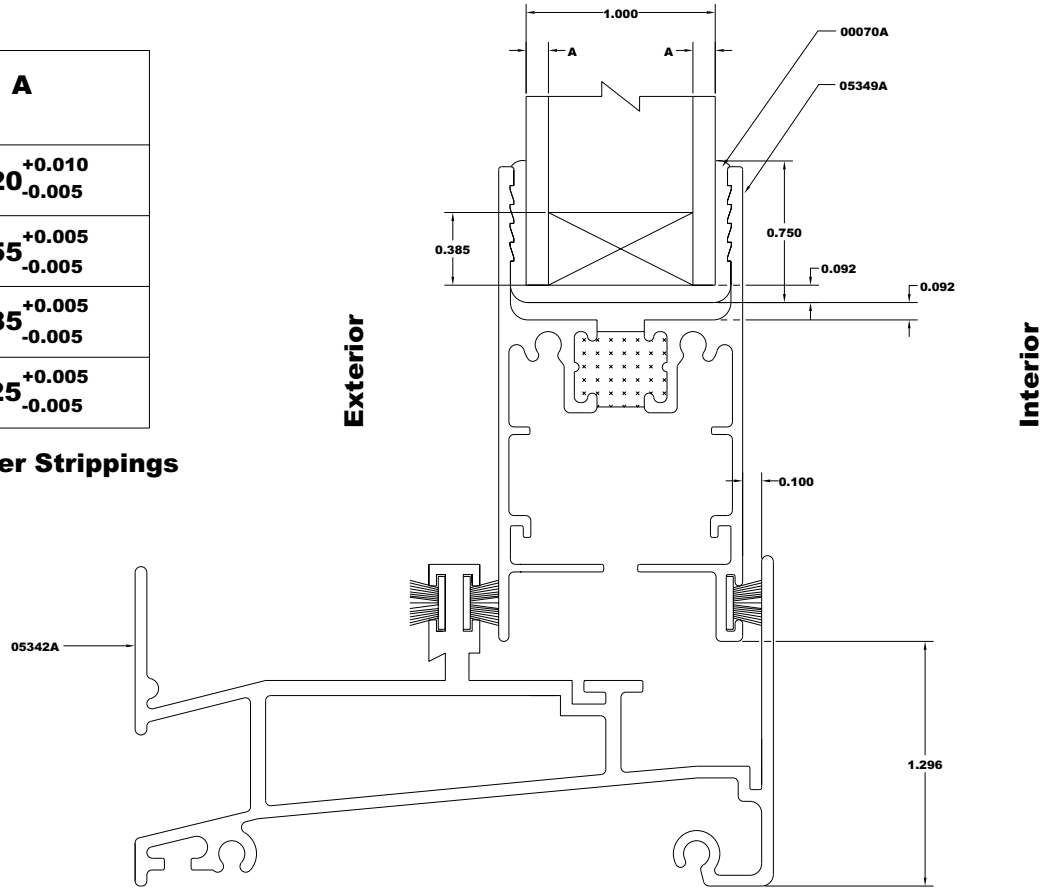


*Figure 9-27. **Vent** Sill Drawing **for Horizontal Aluminum Slider**.*

Page 4

Fix Head

(NFRC-FX-HD)

Glass Thickness	A
3mm	$0.120^{+0.010}_{-0.005}$
4mm	$0.155^{+0.005}_{-0.005}$
5mm	$0.185^{+0.005}_{-0.005}$
6mm	$0.225^{+0.005}_{-0.005}$

Note : All Weather Strippings are Type-I

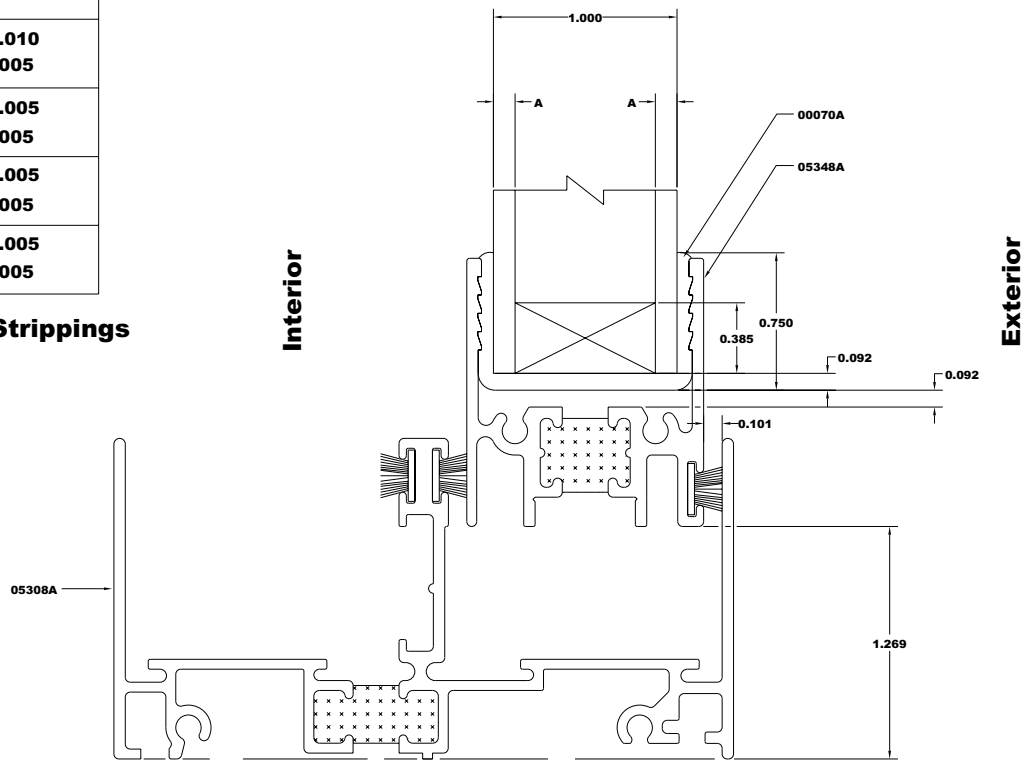


Figure 9-28. Fixed Head Drawing ***for Horizontal Aluminum Slider***

Page 5

Sliding Jamb

(NFRC-VT-JB)

Glass Thickness	A
3mm	$0.120^{+0.010}_{-0.005}$
4mm	$0.155^{+0.005}_{-0.005}$
5mm	$0.185^{+0.005}_{-0.005}$
6mm	$0.225^{+0.005}_{-0.005}$

Note : All Weather Strippings are Type-I

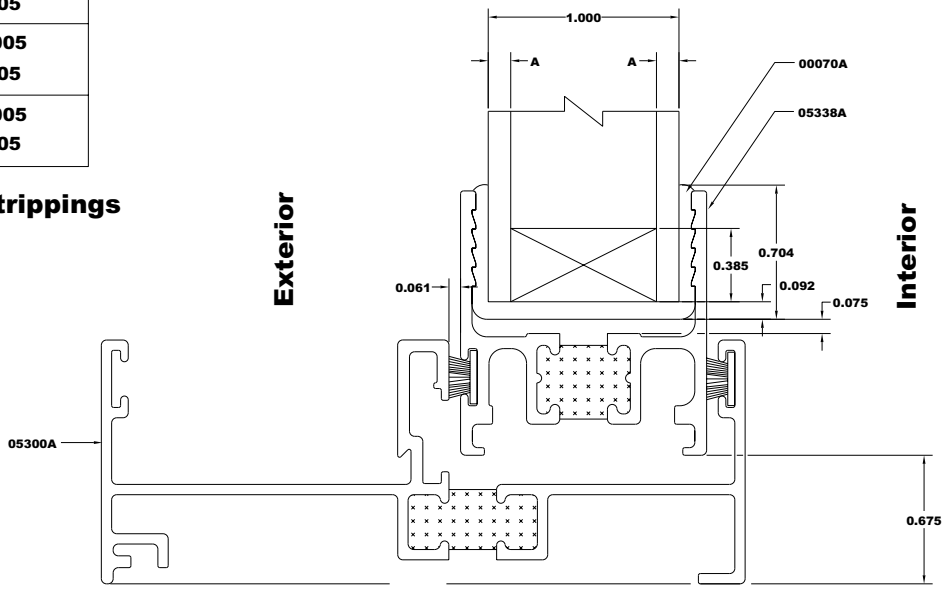


Figure 9-29. ***Vent*** *Jamb Drawing* ***for Horizontal Aluminum Slider.***

Fix Sill

Page 6

(NFRC-FX-SL)

Glass Thickness	A
3mm	$0.120^{+0.010}_{-0.005}$
4mm	$0.155^{+0.005}_{-0.005}$
5mm	$0.185^{+0.005}_{-0.005}$
6mm	$0.225^{+0.005}_{-0.005}$

Note : All Weather Strippings are Type-I

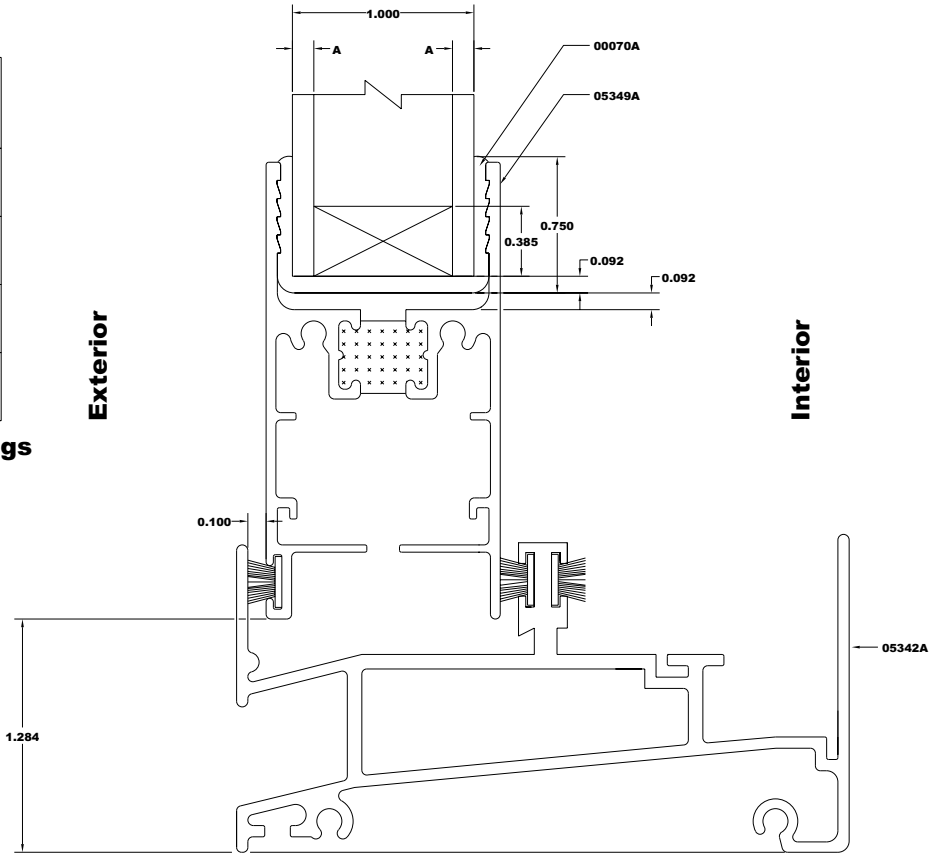


Figure 9-30. Fixed Sill Drawing ***for Horizontal Aluminum Slider****.*

Page 7

Meeting Rail

(NFRC-MTG)

Glass Thickness	A
3mm	$0.120^{+0.010}_{-0.005}$
4mm	$0.155^{+0.005}_{-0.005}$
5mm	$0.185^{+0.005}_{-0.005}$
6mm	$0.225^{+0.005}_{-0.005}$

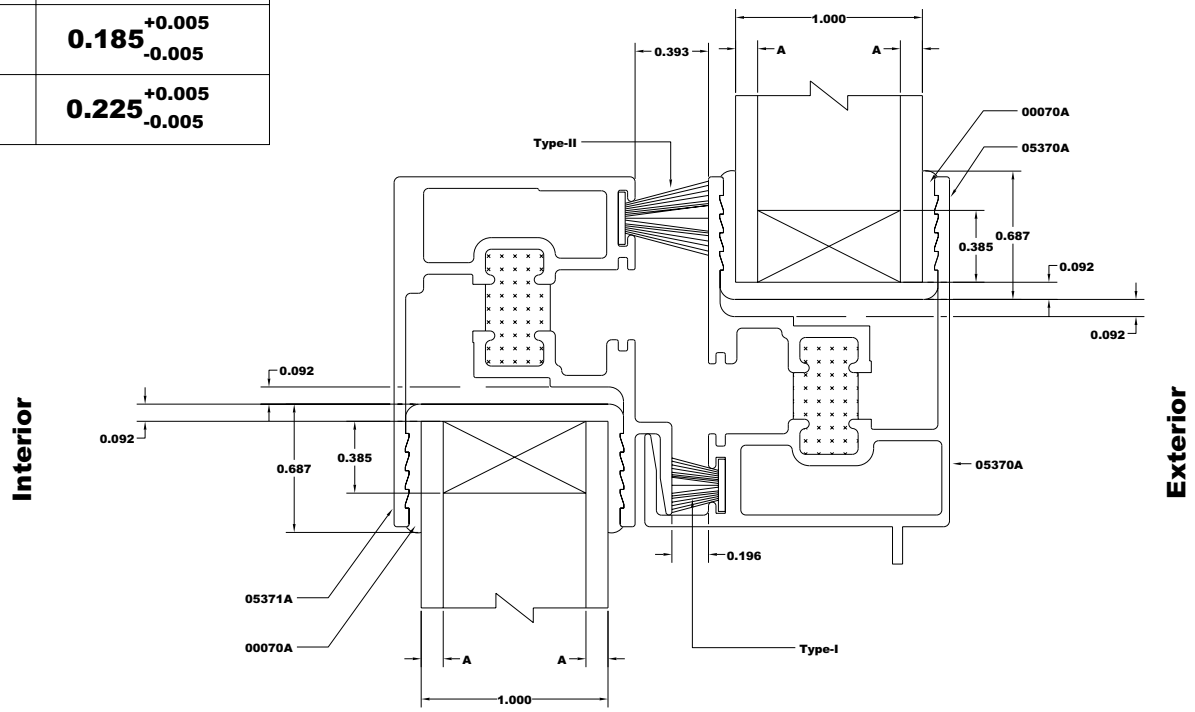


Figure 9-31. Meeting Rail Drawing ***for Horizontal Aluminum Slider****.*

05300-A

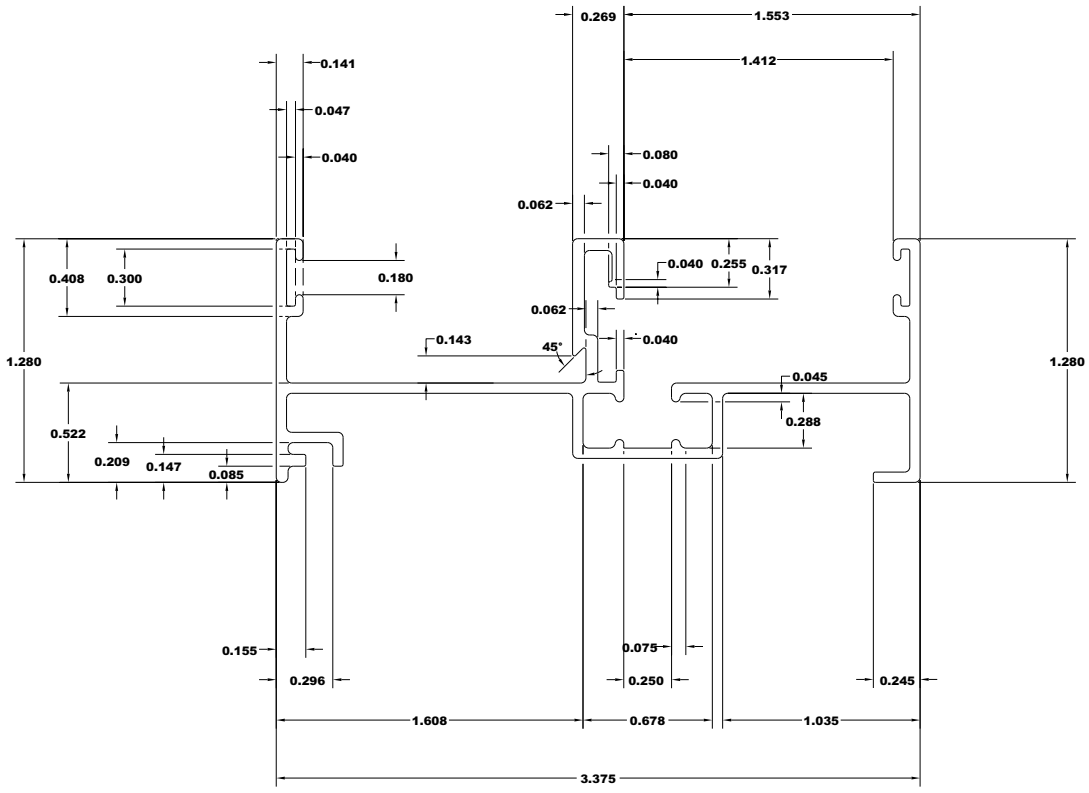


Figure 9-32. Fixed Jamb Drawing for Horizontal Aluminum Slider.

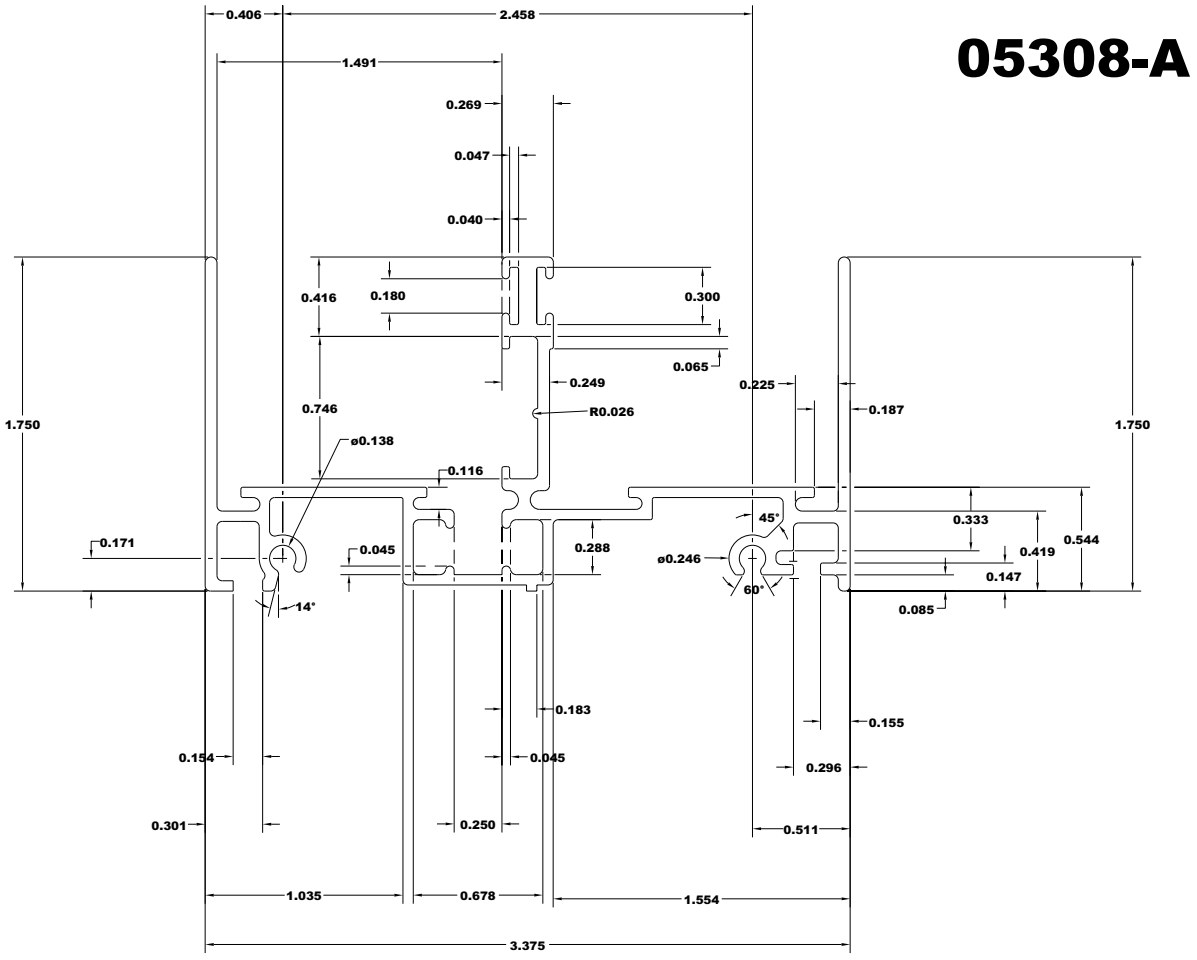
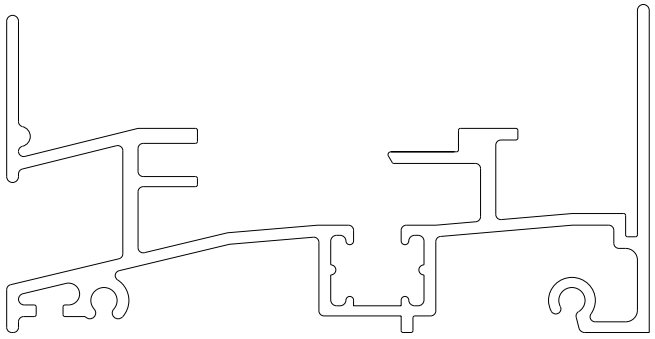


Figure 9-33. Head Drawing for Horizontal Aluminum Slider.



05342-A

Figure 9-34. Sill Drawing for Horizontal Aluminum Slider.

5338-A

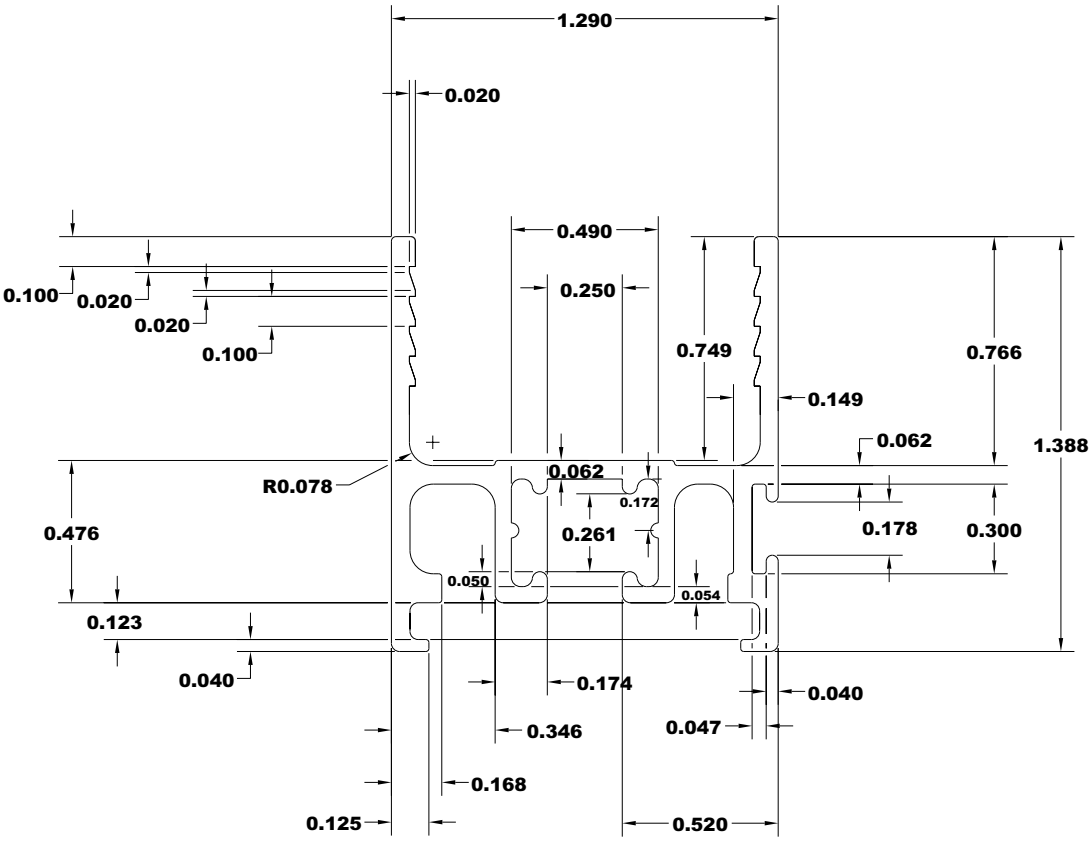


Figure 9-35. Stile-Fixed Drawing for Horizontal Aluminum Slider.

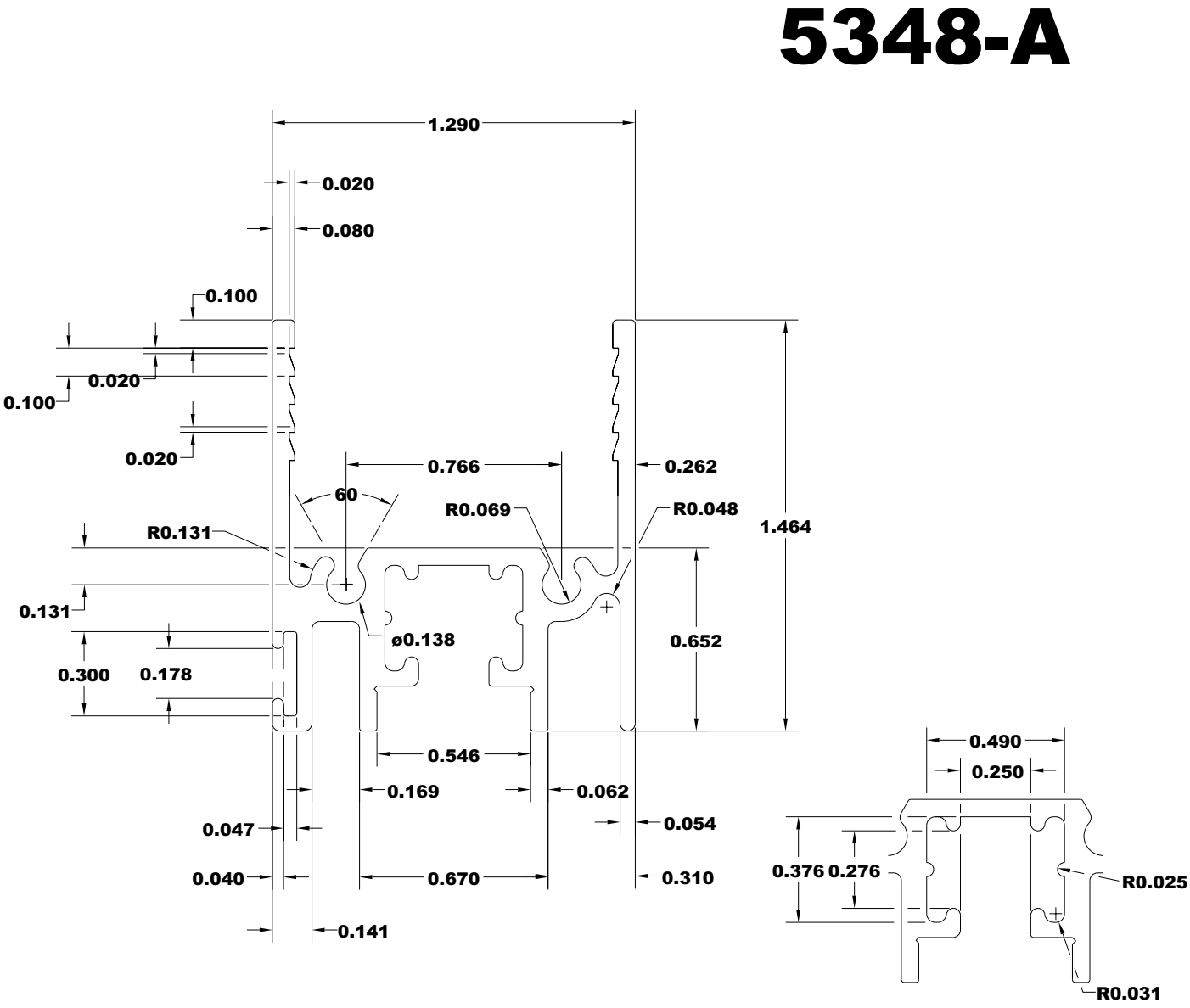


Figure 9-36. Stile-Fixed Drawing for Horizontal Aluminum Slider.

5371-A

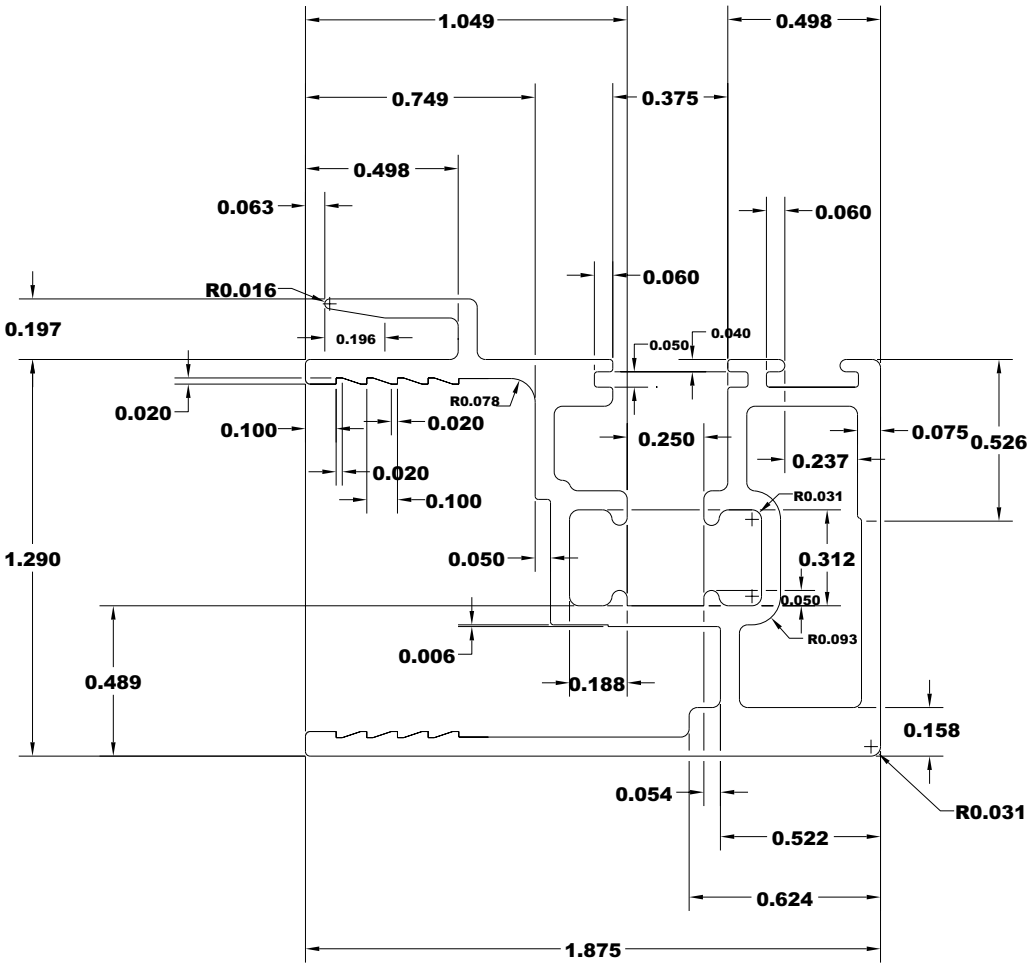


Figure 9-37. Stile-Slide / Silt - Fix Drawing for Horizontal Aluminum Slider.

5370-A

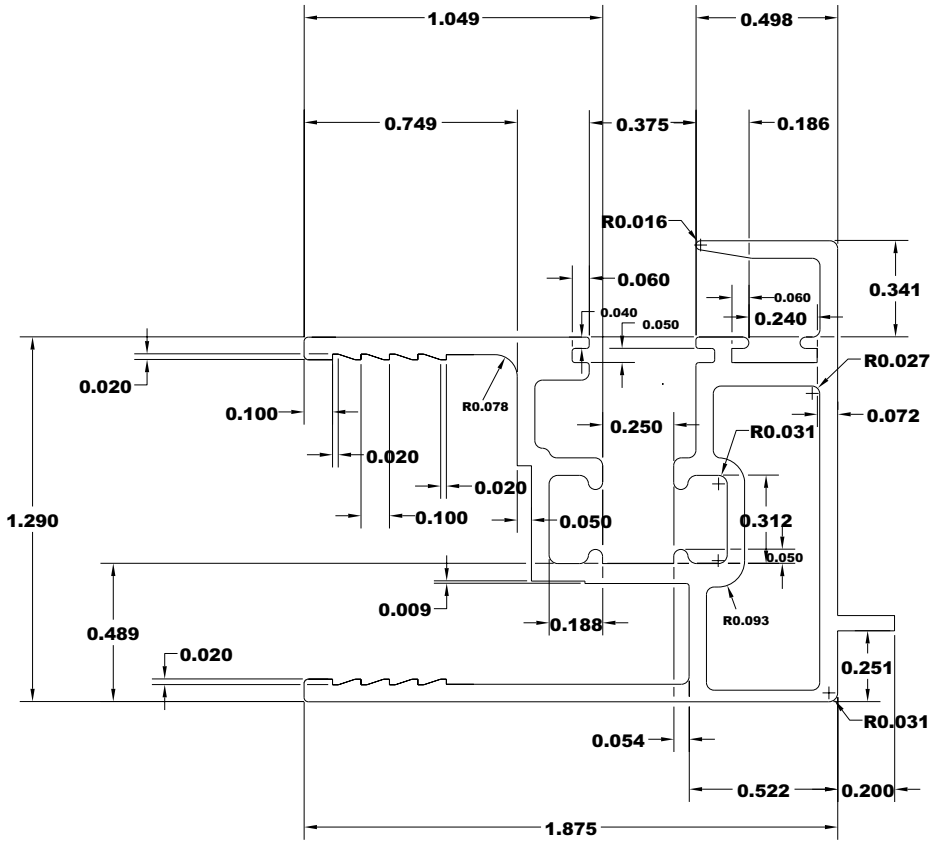
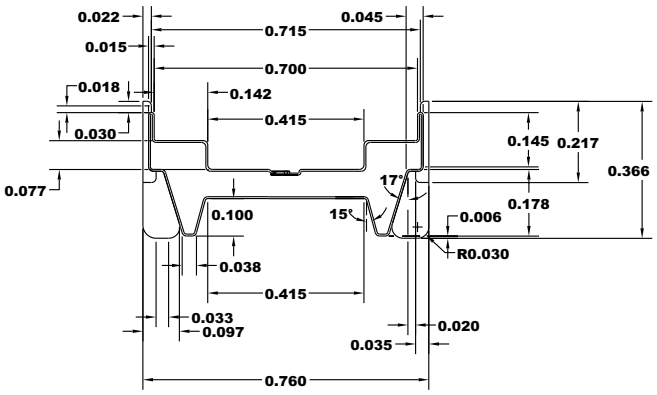
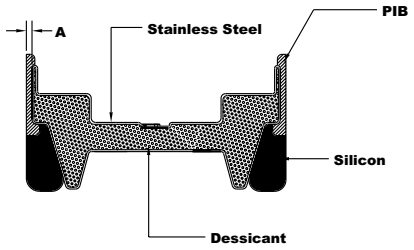


Figure 9-38. Stile-Fixed Drawing for Horizontal Aluminum Slider.

00030-A

Page 16



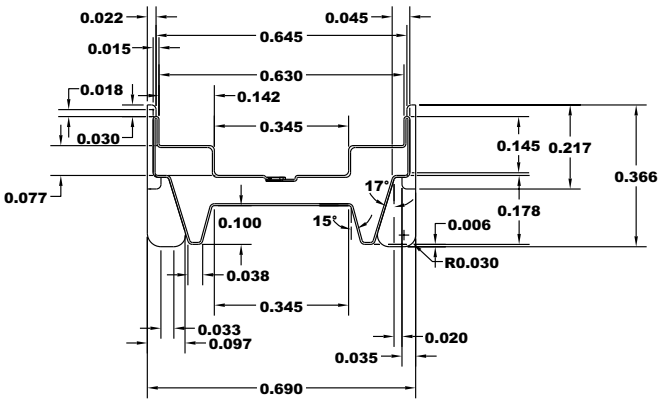


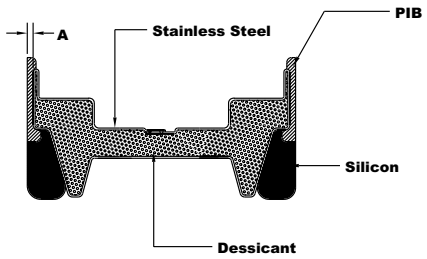
Glass Thickness	A
3mm	$0.015^{+0.010}_{-0.005}$
4mm	$0.015^{+0.005}_{-0.005}$
5mm	$0.015^{+0.005}_{-0.005}$
6mm	$0.015^{+0.005}_{-0.005}$

Figure 9-39. Spacer Horizontal Aluminum Slider.

00040-A

Page 17

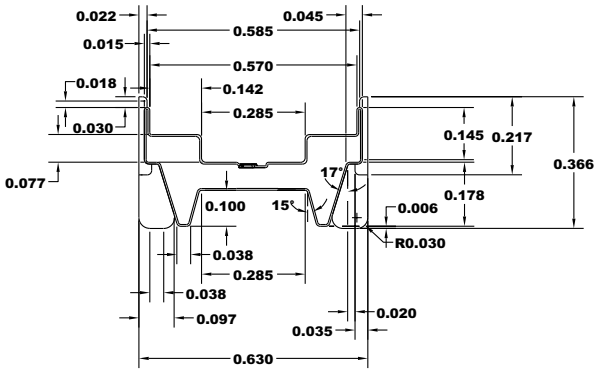


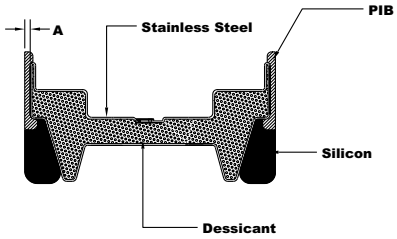


Glass Thickness	A
3mm	$0.015^{+0.010}_{-0.005}$
4mm	$0.015^{+0.005}_{-0.005}$
5mm	$0.015^{+0.005}_{-0.005}$
6mm	$0.015^{+0.005}_{-0.005}$

Figure 9-40. Spacer for Horizontal Aluminum Slider.

00050-A Page 18

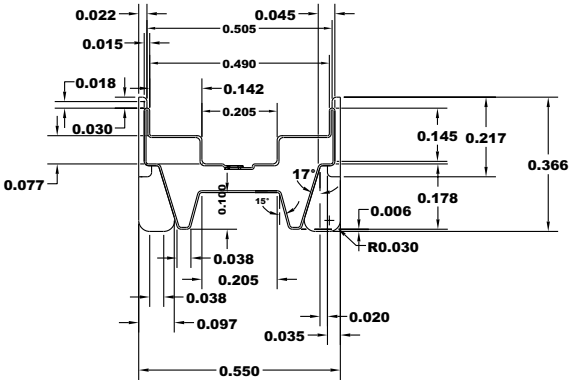


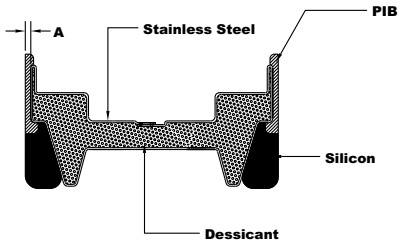


Glass Thickness	A
3mm	$0.015^{+0.010}_{-0.005}$
4mm	$0.015^{+0.005}_{-0.005}$
5mm	$0.015^{+0.005}_{-0.005}$
6mm	$0.015^{+0.005}_{-0.005}$

Figure 9-41. Spacer Horizontal Aluminum Slider.

00060-A Page 19



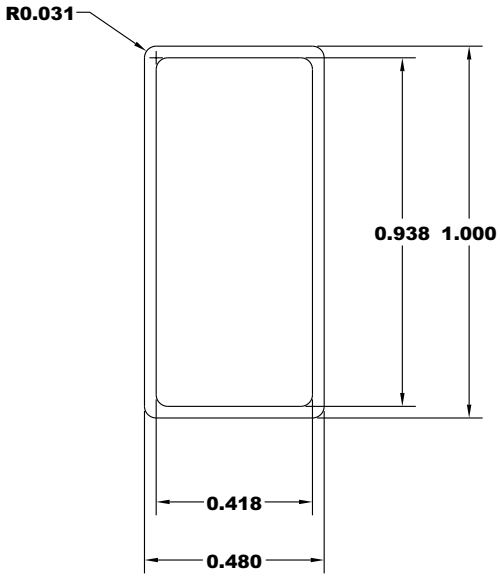


Glass Thickness	A
3mm	$0.015^{+0.010}_{-0.005}$
4mm	$0.015^{+0.005}_{-0.005}$
5mm	$0.015^{+0.005}_{-0.005}$
6mm	$0.015^{+0.005}_{-0.005}$

Figure 9-42. Spacer Horizontal Aluminum Slider.

00080-A Page 21

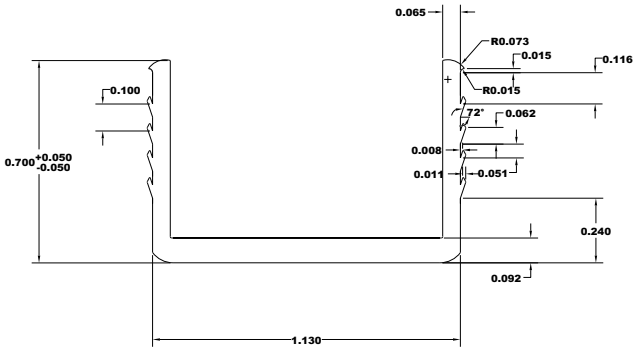
Divider type A

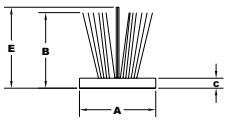


Aluminum
Metal
white

Figure 9-43Divider for Horizontal Slider

00070-A Page 20





		I	II
A		.260 +0.020 -0.020	.260 +0.020 -0.020
B		.280 +0.011 -0.008	.380 +0.011 -0.008
C		.035 +0.005 -0.005	.035 +0.005 -0.005
E		.300 +0.010 -0.015	.400 +0.010 -0.015

U-Chanel

*Figure 9-44. **U-channel for Horizontal Slider***

9.4 Problem 3: Skylight

9.4.1. Description

Window Type	Skylight
Frame Material	Wood
Overall Size	1181 mm (46.5") by 1181 mm (46.5")
Spacer type	Aluminum folded spacer.
Weather strip	Not applicable.
Cross Sections	Head, sill, and jambs – the jambs are each the same so only one needs to be modeled
Dividers	Not applicable
Glazing System	See the glazing matrix in Table 9-14.

9.4.2. Glazing Matrix

The following table shows the glazing matrix that is to be simulated for this window.

Table 9-11. Center-of-glazing U-factor Results for the Matrix of Glazing Options

	Glazing Options	Grid Option	Manufacturer
1	Clear (3 mm), Air, Clear (3mm)	N/A	Generic

9.4.3. Center-of-glazing Modeling (WINDOW)

In WINDOW, create the glazing system(s) needed for the Glazing Matrix, making sure to set the **Tilt** to 20° (from horizontal). The center-of-glass U-factor is displayed in the **U-factor** column of the **Center-of-glazing Results** tab in the WINDOW **Glazing System Library**. This glazing system will be brought into the THERM cross-sections.

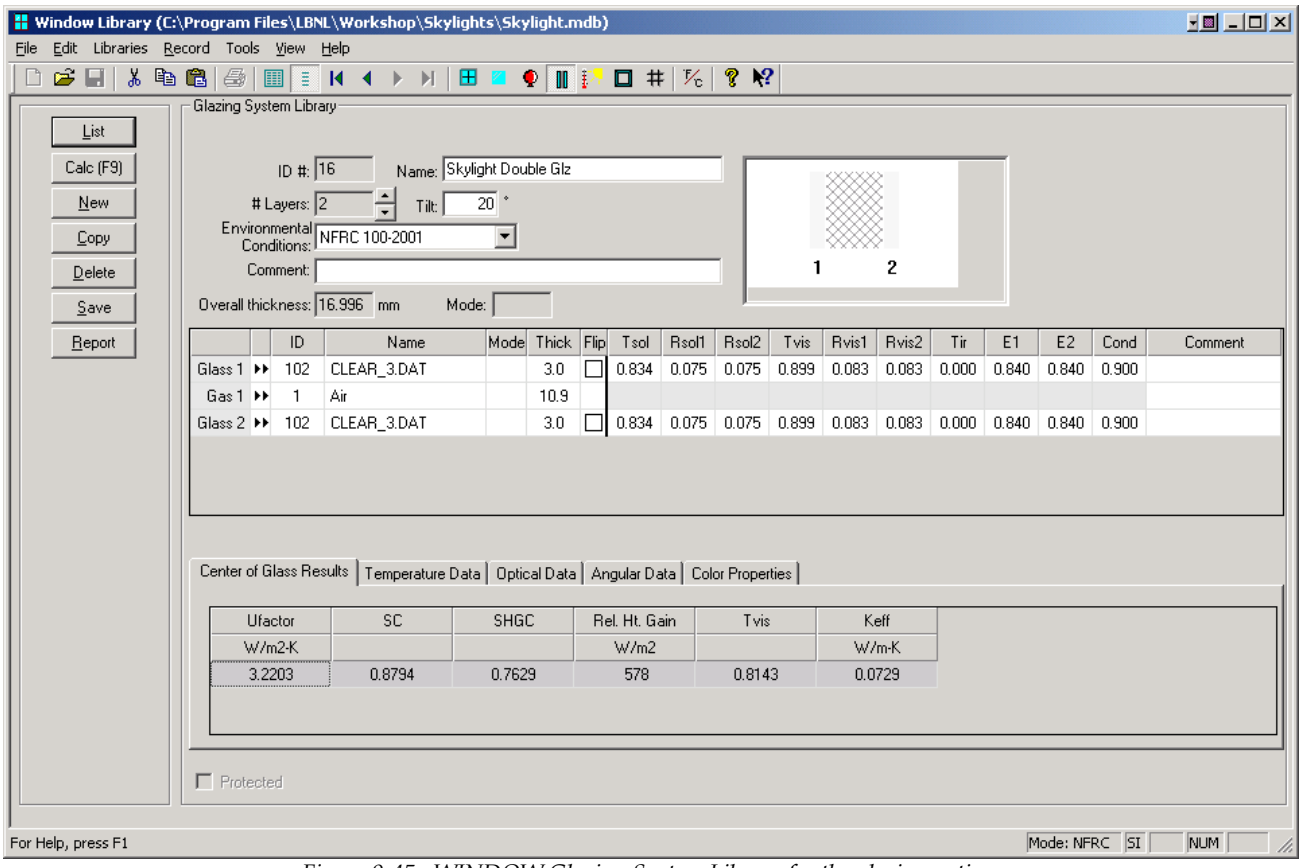


Figure 9-45. WINDOW Glazing System Library for the glazing option.

The results for the WINDOW center-of-glazing U-factor are shown in the following table.

Table 9-12. WINDOW Center-of-glazing U-factor Results for the Matrix of Glazing Options

		Center-of-glazing U-factor	
	Glazing Options (1.0" overall thickness)	**W/m^2-°C**	**(Btu/hr-ft^2-°F)**
1	Clear (3 mm), Air, Clear (3mm)	3.220	0.5671

9.4.4. Edge-of-glazing and Frame Modeling (THERM)

Model skylights in the same manner as other products, with separate THERM files for Sill, Head, Jamb and so forth, and use the AutoEnclosure radiation model for each cross section. See Section 8-5 of this manual for detailed instructions about modeling skylights.

Table 9-16 lists the cross sections to be modeled, and any associated files (DXF and THERM files) that are found on the CD.

Table 9-13. Cross sections to be modeled with their associated dxf and THERM files

Cross Section	DXF Filename	THERM file
Sill	N/A	Skylight Sill.thm
Head	N/A	Skylight Head.thm
Jamb	N/A	Skylight Jamb.thm

Table 9-17 shows the resulting U-factors from each cross section.

Table 9-14. Frame and Edge THERM U-factor Results

	Frame U-factor		Edge U-factor	
Cross Section	**(W/m^2-°C)**	**(Btu/hr-ft^2-°F)**	**(W/m^2-°C)**	**(Btu/hr-ft^2-°F)**
Head	5.133	0.904	3.414	0.601
Sill	5.691	1.002	3.255	0.672
Jamb	5.693	1.003	3.816	0.573

Figures 9-52 and 9-54 on the following pages show THERM files and U-factor results screens for each of the cross sections.

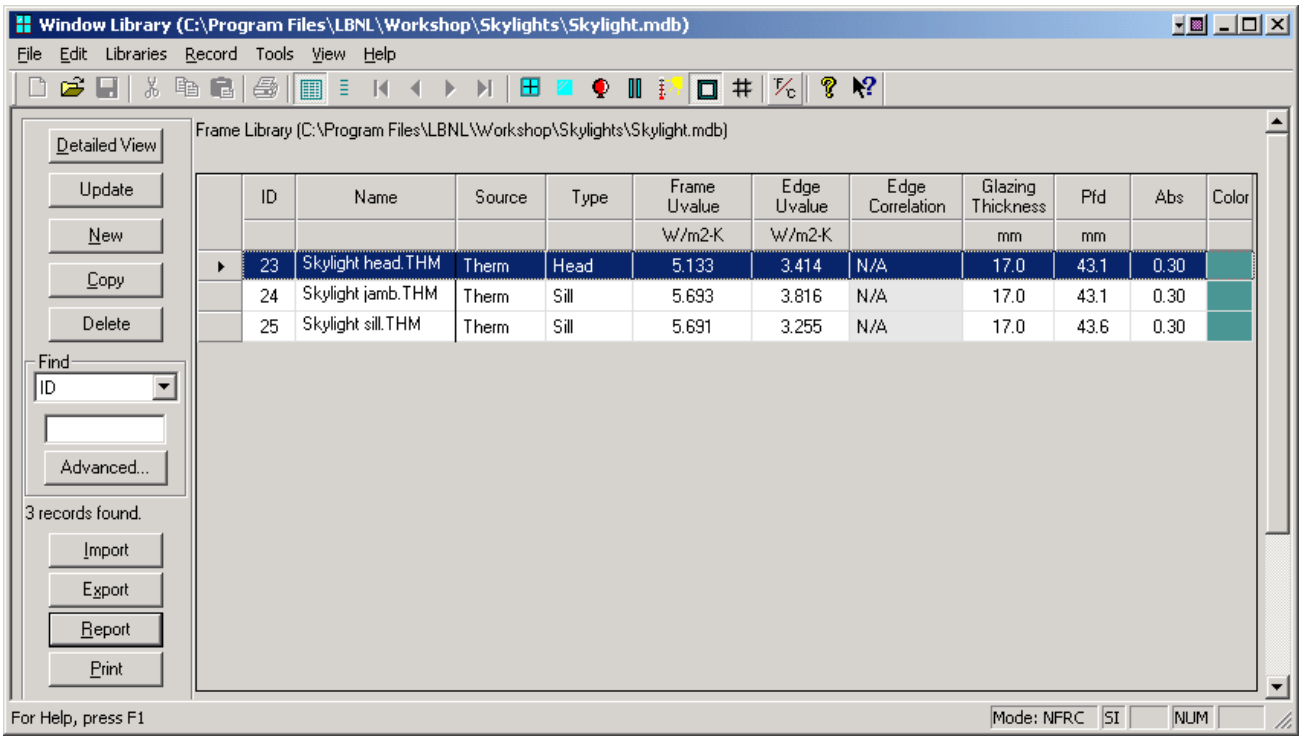
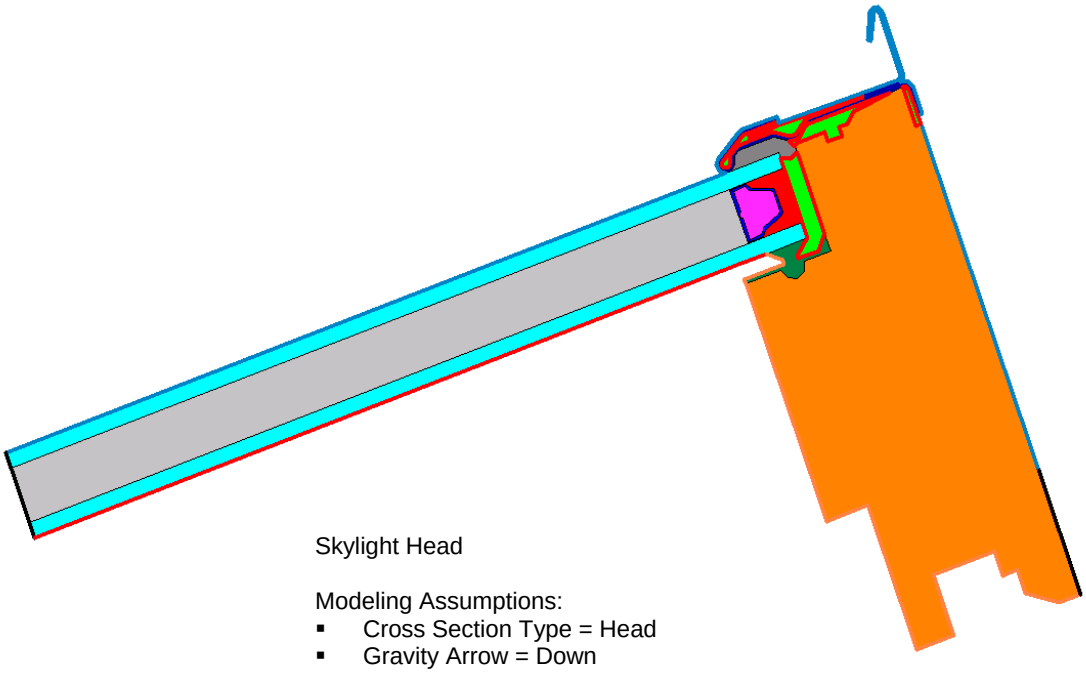


Figure 9-46. WINDOW Frame Library.

Head



Skylight Head

Modeling Assumptions:

- Cross Section Type = Head
- Gravity Arrow = Down
- Glazing System = Down
- File Rotation = 70° Clockwise

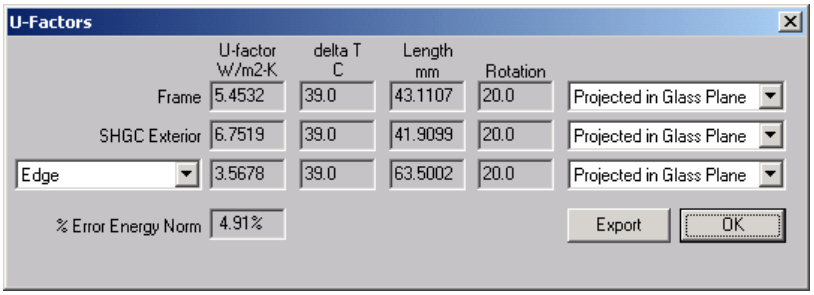
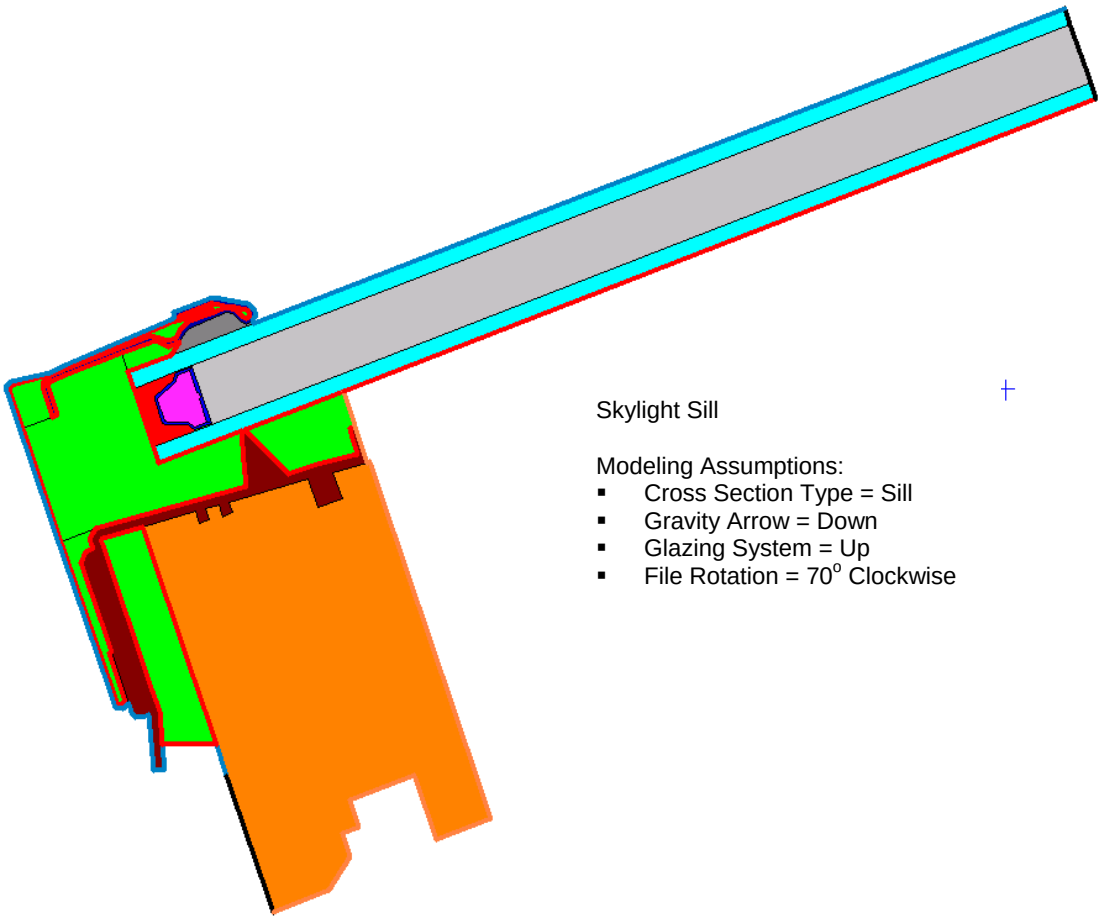


Figure 9-47. THERM file for Head and Sill inset mount skylight cross section.

Sill



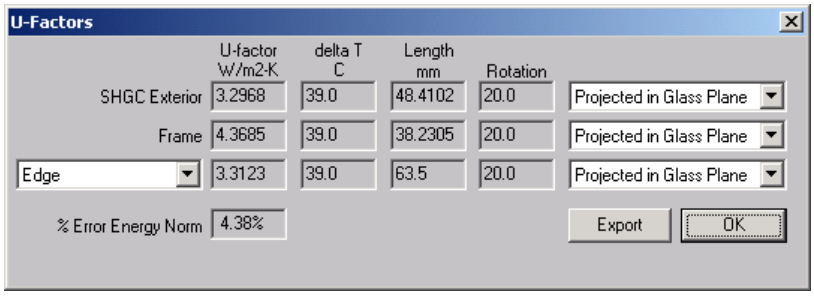


Figure 9-48. THERM file for Head and Sill inset mount skylight cross section.

Jamb

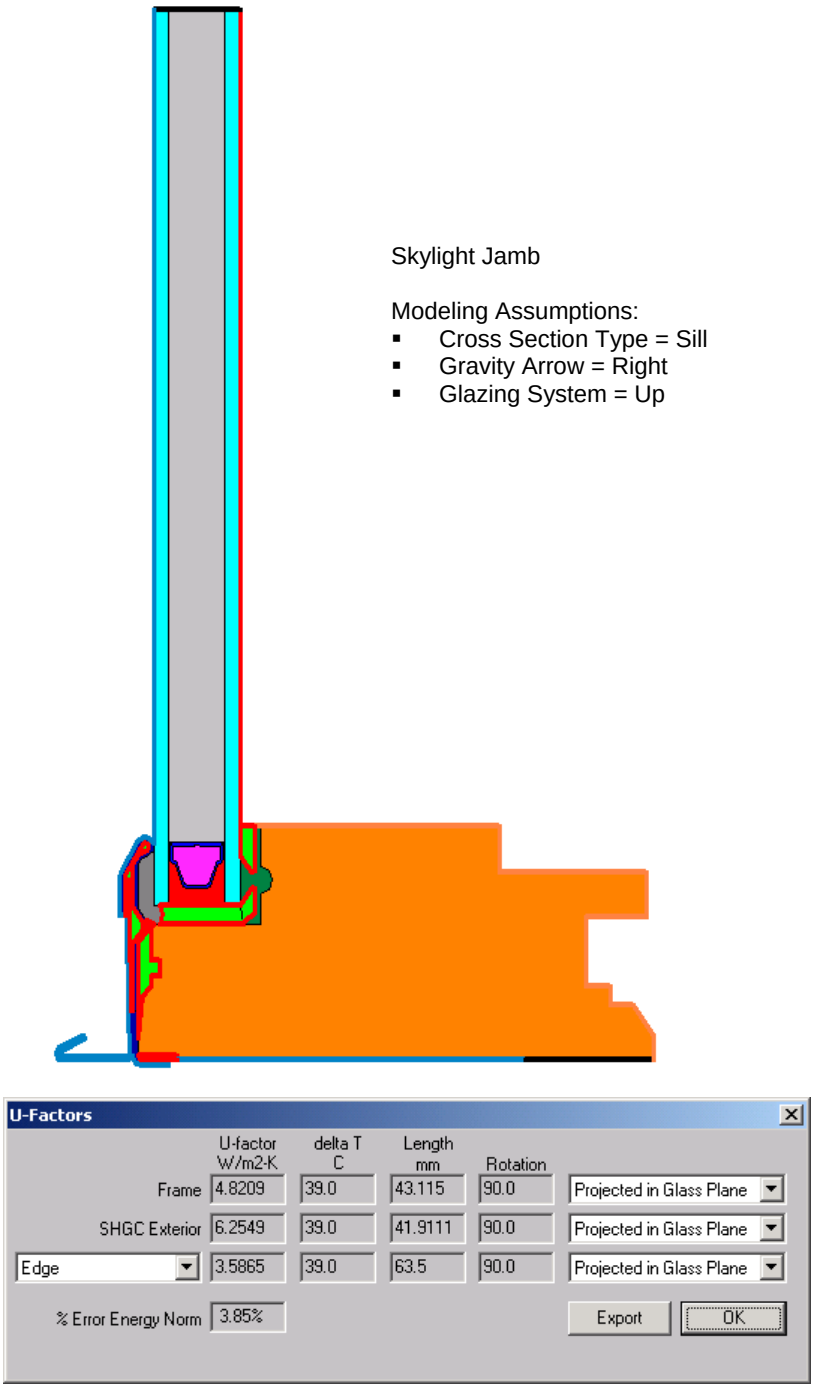


Figure 9-49. THERM file for Jamb inset mount skylight cross section.

9.4.5. Total Product U-Factor

In WINDOW, import the THERM cross sections into the Frame Library.

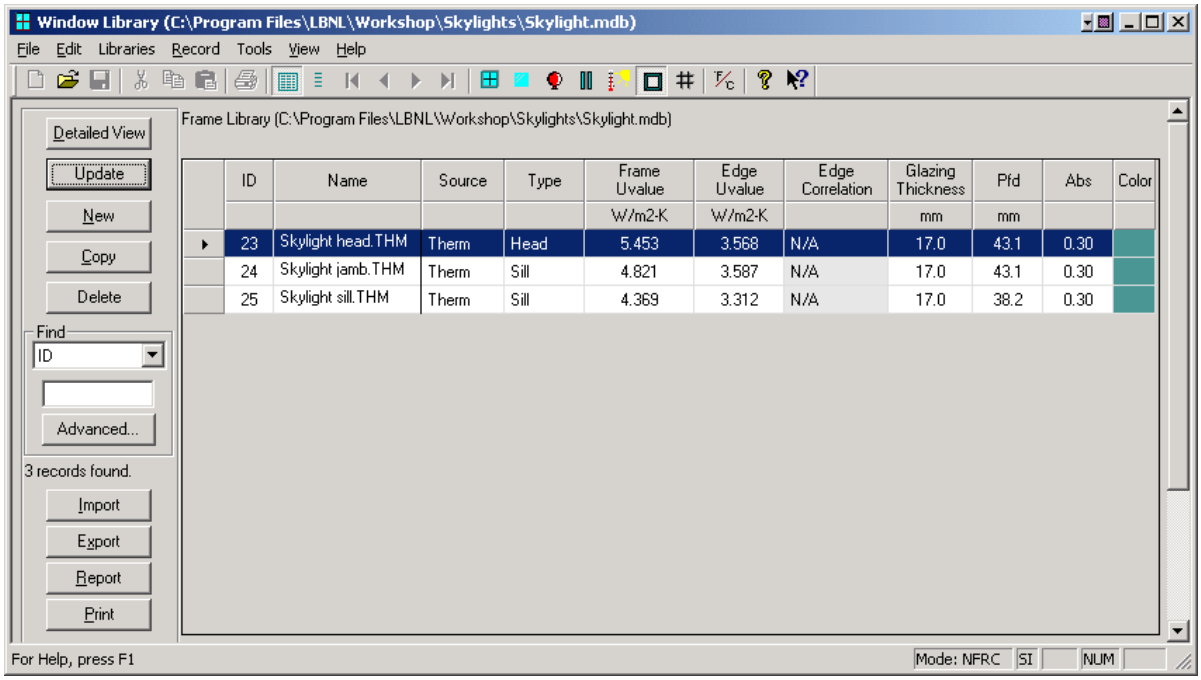


Figure 9-50. THERM files imported into the Frame Library.

In the WINDOW Window Library, one record is created.

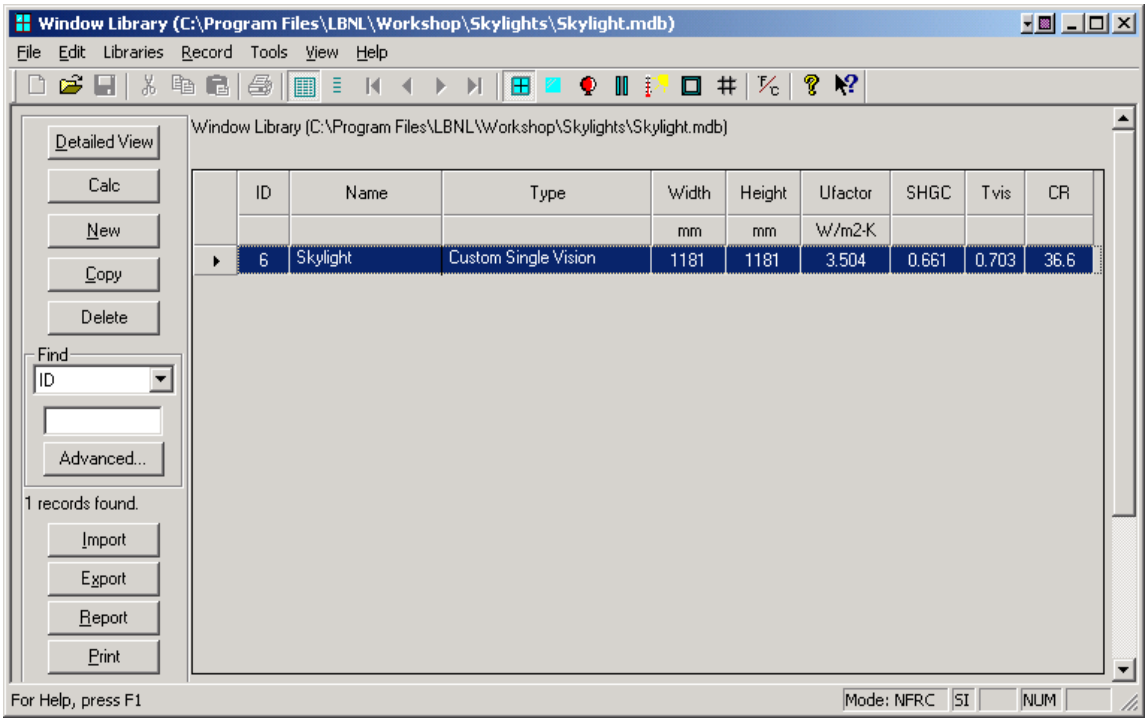


Figure 9-51. Window Library skylight record.

Table 9-20 shows the overall product U-factor from the Window Library.

Table 9-15. Total Product U-factors for skylight

Glazing Options		Total Product U-factor	
		(W/m^2-^oC)	($Btu/hr-ft^2$-^oF)
1	Clear (3 mm), Air, Clear (3mm), No Dividers	3.504	0.617

9.4.6. Individual Product SHGC and VT using SHGC 0 & 1 and VT 0 & 1

The methodology for determining the Solar Heat Gain Coefficient (SHGC) and Visible Transmittance (VT) for products is outlined in *NFRC 200* using values of $SHGC_0$, $SHGC_1$, VT_0, VT_1. These values are calculated in WINDOW for the best glazing option modeled with the highest frame and edge U-factor frame, as outlined in *NFRC 200*, Section 6.1.1 (a).

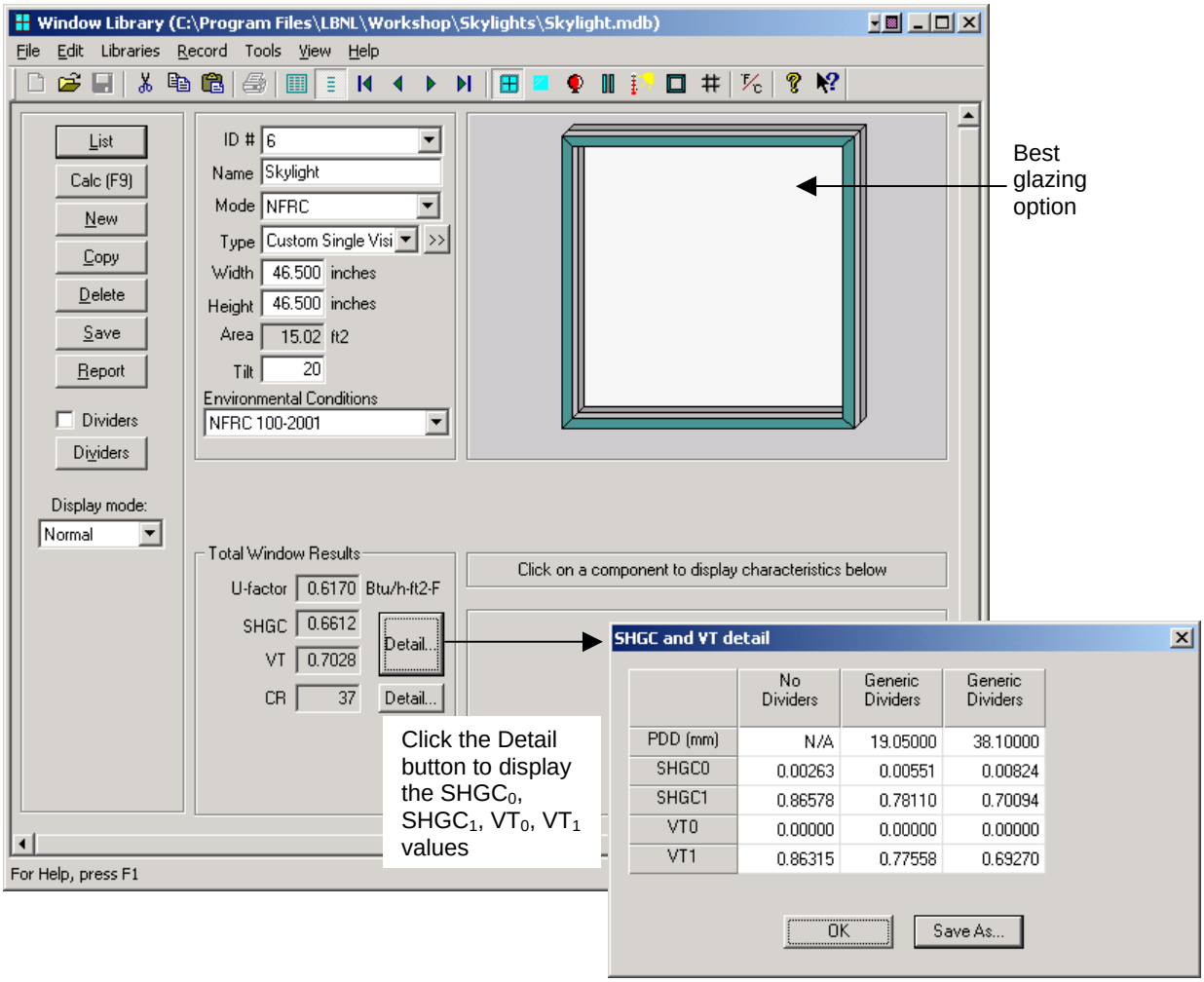


Figure 9-52. Window Library Detail button calculates $SHGC_0$, $SHGC_1$, VT_0, VT_1.

9.4.7. Skylight Drawings.

Drawings for the skylight are not available.

9.5 Problem 4: Door

For this wood stile and rail door, calculate the U-factor, SHGC and VT.

9.5.1. Description

Door Type	Wood stile and rail door
Frame Material	Wood with a thermal-break aluminum sill
Overall Size	1000 mm x 2000 mm (39″x79″) door slab
Glazing System	Double glazing, 0.500″ overall IG thickness. There are four individual glass options all with two layers of double-strength PPG glass (0.129″ thickness). The first option is two layers of clear glass air filled, the second is two layers of clear glass argon filled (90% two probe filling), the third is two layers of clear glass with Solarban 60 on surface 2 and air filled, the fourth option is two layers of clear glass with Solarban60 on surface 2 and argon filled.
Spacer Type	Intercept™ tin-plate with butyl sealant on three sides
Glazing Method	Wet glazed with Silicone on both sides
Dividers	There are no dividers in this product
Drawings	There are detailed drawings for this door shown in Section 9.5.7. Also included on the CD are the DXF files of the assembly drawings for this door.

9.5.2. Glazing Matrix

The table below lists the four glazing options for the door.

Table 9-16. Glazing Options Matrix

Glass Option
1. Clear_Air_Clear
2. Clear_Argon (95%)_Clear
3. Low-e_Air_Clear
4. Low-e_Argon (95%)_Clear

9.5.3. Center-of-Glazing Modeling (WINDOW)

The four IG units were modeled in WINDOW with double-strength glass, 0.242" air space, 95% argon (where appropriate), and Solarban 60 (where appropriate).

Figure 9-58 shows the WINDOW **Glazing System Library** with all four IG units.

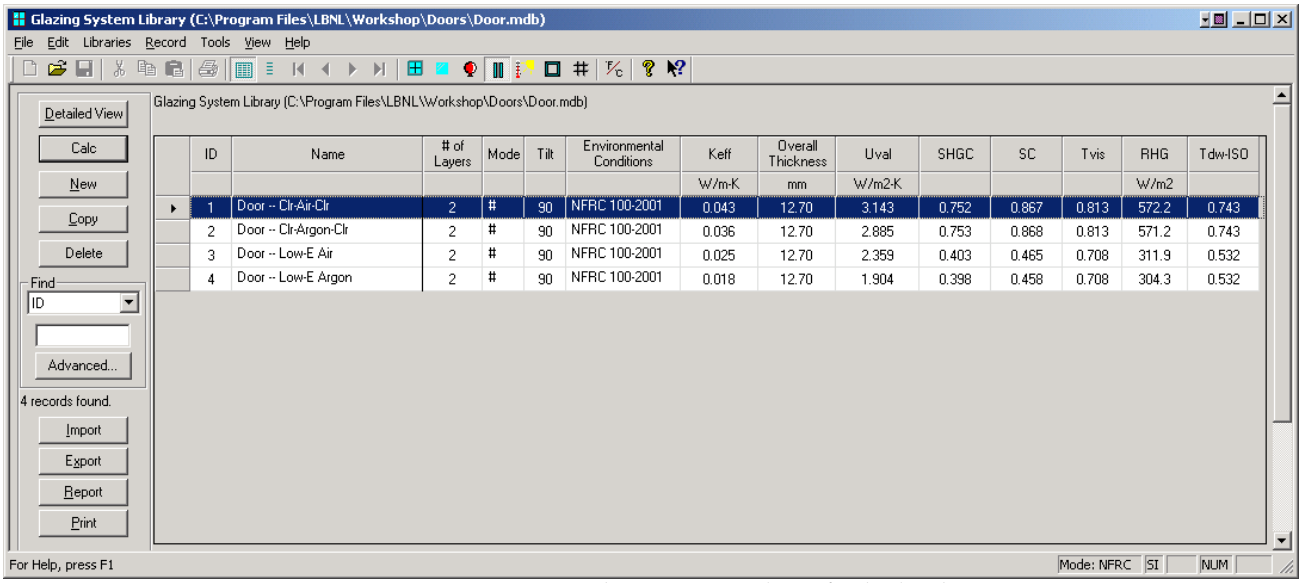


Figure 9-53. WINDOW 5 Glazing System Library for the door lites.

The results for the center-of-glazing U-factor are shown in the following table:

Table 9-17. Center-of-glazing U-factor results from WINDOW

Glazing Options		Center-of-glazing U-factor	
		(W/m^2-°C)	($Btu/hr-ft^2$-°F)
1	Clear (3.277 mm, 0.129"), Air (6.2 mm, 0.242"), Clear (3.277 mm, 0.129")	3.143	0.554
2	Clear (3.277 mm 0.129"), Argon (95%, 6.2 mm, 0.242"), Clear (3.277 mm, 0.129")	2.885	0.508
3	Low-E (3.277 mm 0.129"), Air (6.2 mm, 0.242"), Clear (3.277 mm, 0.129")	2.359	0.416
4	Low-E (3.277 mm, 0.129"), Argon (95%, 6.2 mm, 0.242"), Clear (3.277 mm, 0.129")	1.904	0.335

These U-factors will be used with the edge-of-glazing and frame values from THERM to calculate the overall U-factor for the door in Section 9.5.

9.5.4. Edge-of-Glazing and Frame Modeling (THERM)

An entry door requires eight THERM models to completely model the heat flow through the door. The eight models are:

- Head
- Lock jamb
- Hinge jamb
- Sill
- Panel
- Door lite
- Panel core
- Door core

This door design has identical sections for the head, lock jamb, and hinge jamb so only one THERM model will be required to represent jamb sections. The door core model has been added to the head model and the panel core model has been added to the panel model. Four door lite models are required, one for each glass option.

Table 9-24 shows the files that are included on the CD for this example problem. The Door Lite base case file (Lite.thm) has glazing option 1, and has Glazing System Options defined for the other three glazing options. When Lite.thm is simulated, it will automatically create the four door lite option files, lite_01.thm through lite_04.thm.

Table 9-18. Files associated with the wood door example

Cross Section	THERM file
Head	head.thm
Lock Jamb, Hinge Jamb	jamb.thm
Sill	sill.thm
Panel	panel-edge.thm
Door Lite Base Case (with 4 glazing options)	Lite.thm
Door Lite Option 1	lite_001.thm
Door Lite Option 2	lite_002.thm
Door Lite Option 3	lite_003.thm
Door Lite Option 4	lite_004.thm

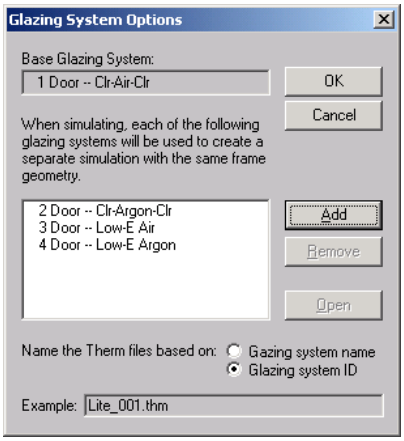


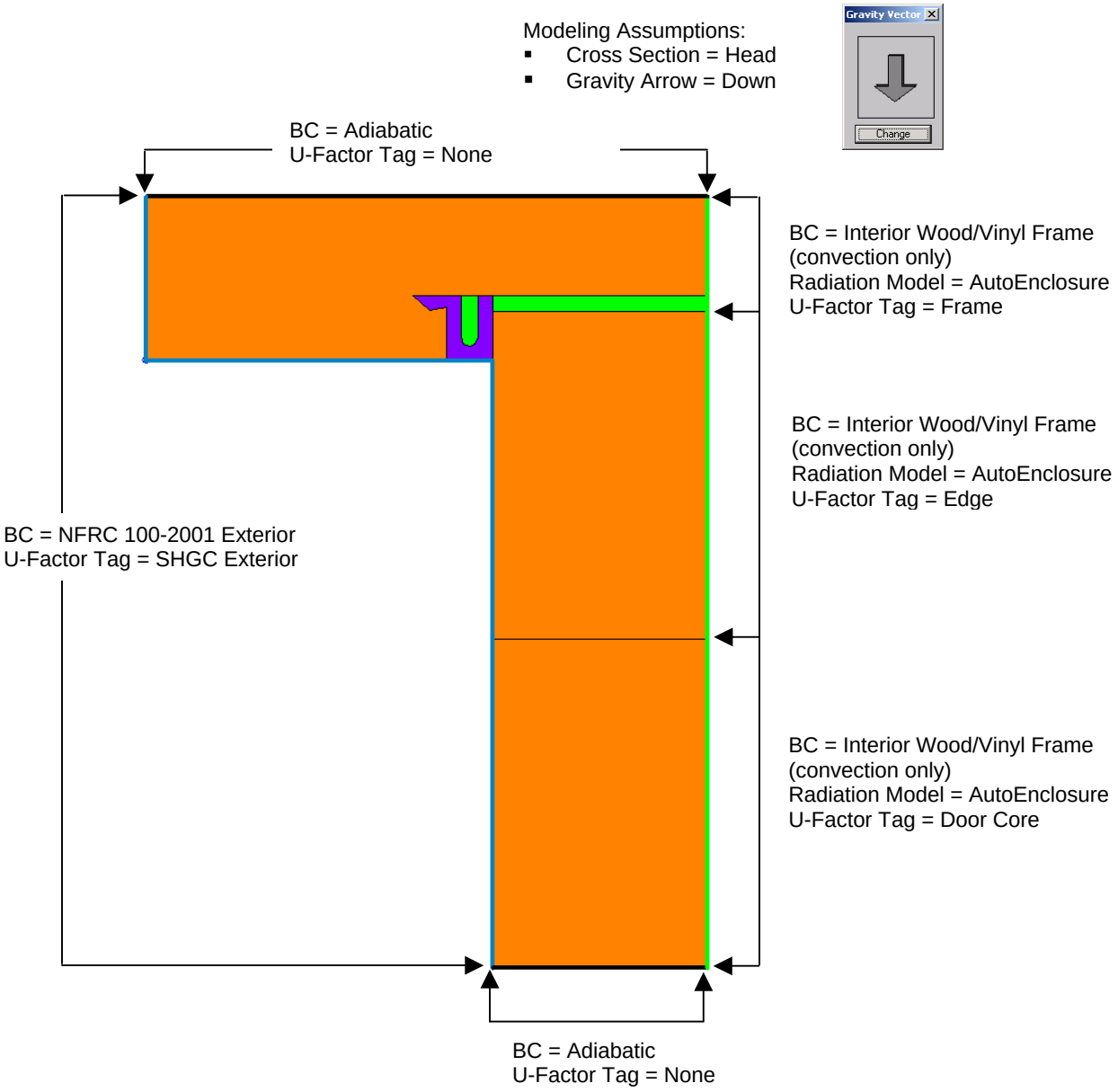
Figure 9-54. Glazing System Options for Lite.thm

Table 9-25 shows the resulting U-factors from each cross section for the 3 mm (with dividers) glazing case.

Table 9-19. THERM results for vinyl window cross sections

	Frame U-factor		Edge U-factor		Frame Height (in)		Edge Height (in)	
Cross Section	**(W/m^2-^oC)**	**(Btu/hr-ft^2-^oF)**	**(W/m^2-^oC)**	**(Btu/hr-ft^2-^oF)**	**mm**	**inch**	**mm**	**inch**
Head	1.7682	0.3114	1.9437	0.3423	22.225	0.875	63.500	2.500
Lock Jamb, Hinge Jamb	1.8431	0.3246	1.9581	0.3448	22.225	0.875	63.500	2.500
Door Core (from the head model)	2.0440	0.3600	N/A	N/A	N/A	N/A	N/A	N/A
Sill	0.7763	0.7763	2.0855	0.3673	39.696	1.563	63.4919	2.500
Panel	2.0076	0.3535	2.9372	0.5172	25.400	1.000	76.597	3.0156
Panel Core (from the panel model)	2.5847	0.4552	N/A	N/A	N/A	N/A	N/A	N/A
Door Lite Option 1	2.799	0.493	3.260	0.574	42.063	1.656	63.500	2.500
Door Lite Option 2	2.780	0.490	3.051	0.537	42.063	1.656	63.500	2.500
Door Lite Option 3	2.744	0.483	2.632	0.464	42.063	1.656	63.500	2.500
Door Lite Option 4	2.716	0.478	2.277	0.401	42.063	1.656	63.500	2.500

Head



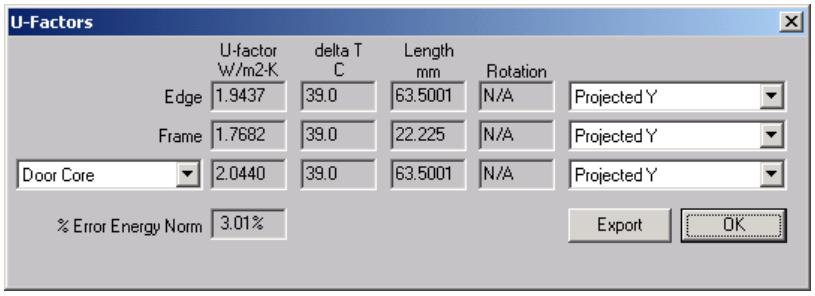


Figure 9-55. Door Head THERM file.

Jamb

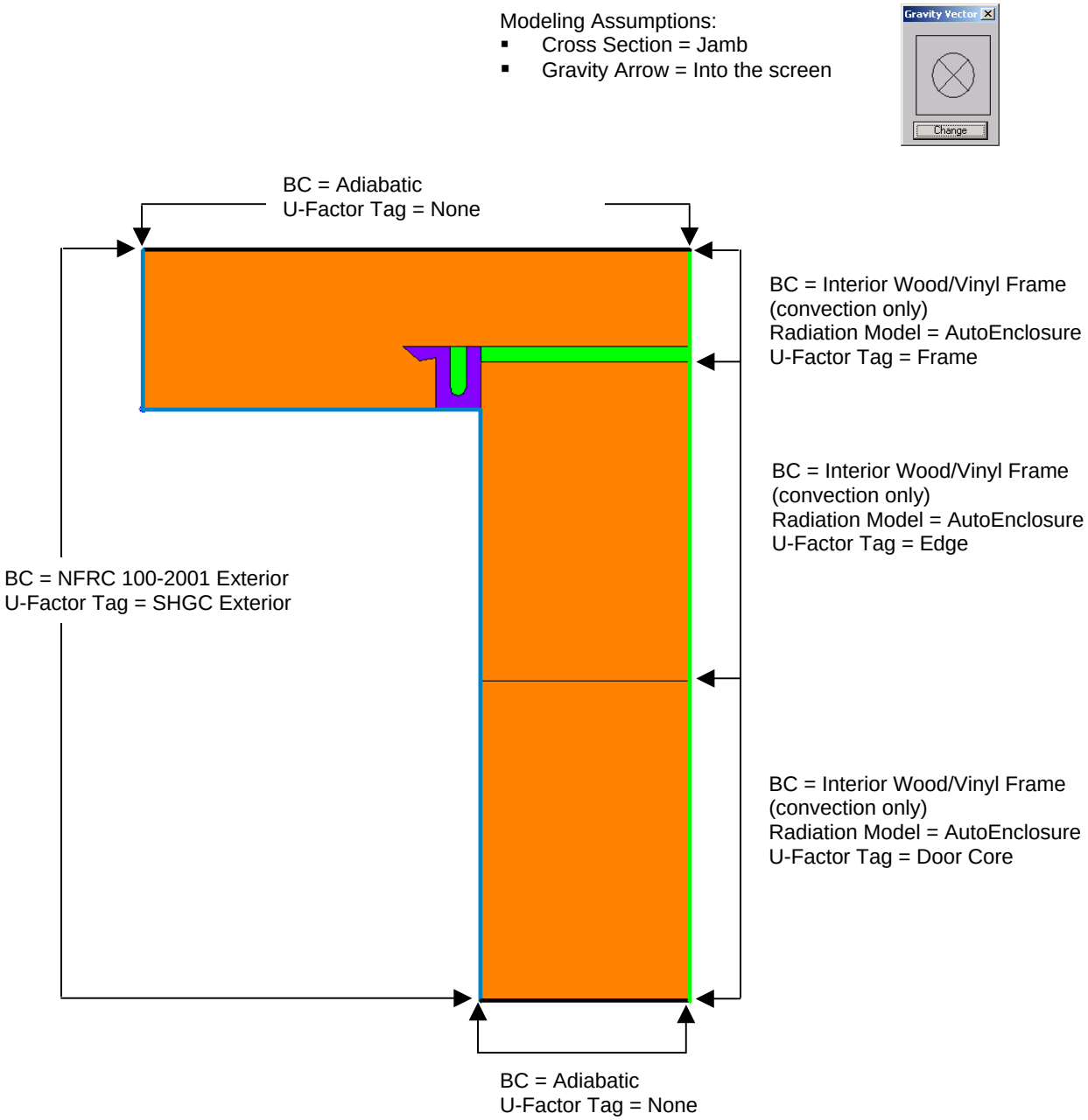


Figure 9-56. Door Jamb THERM file.

Sill

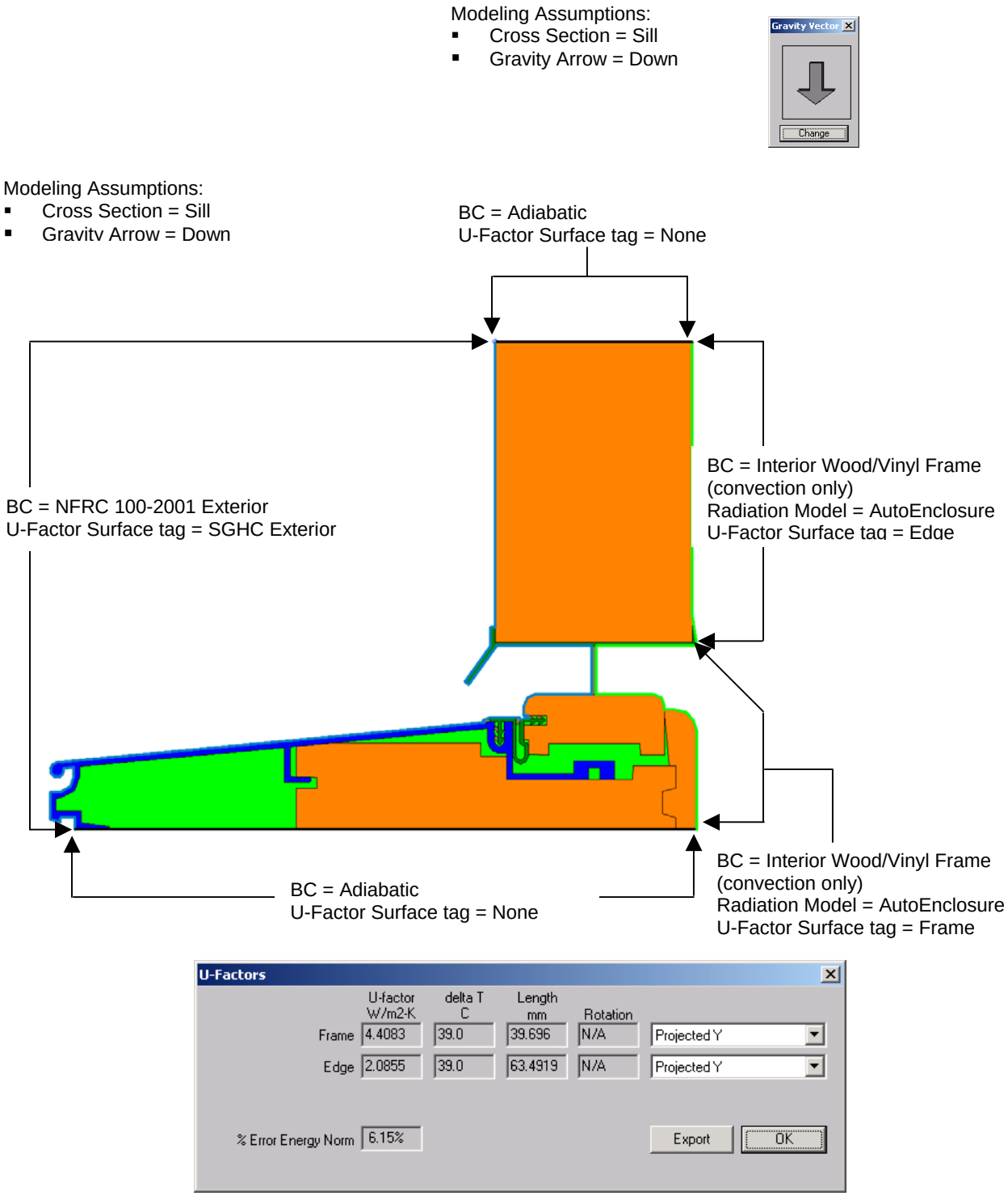
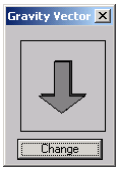
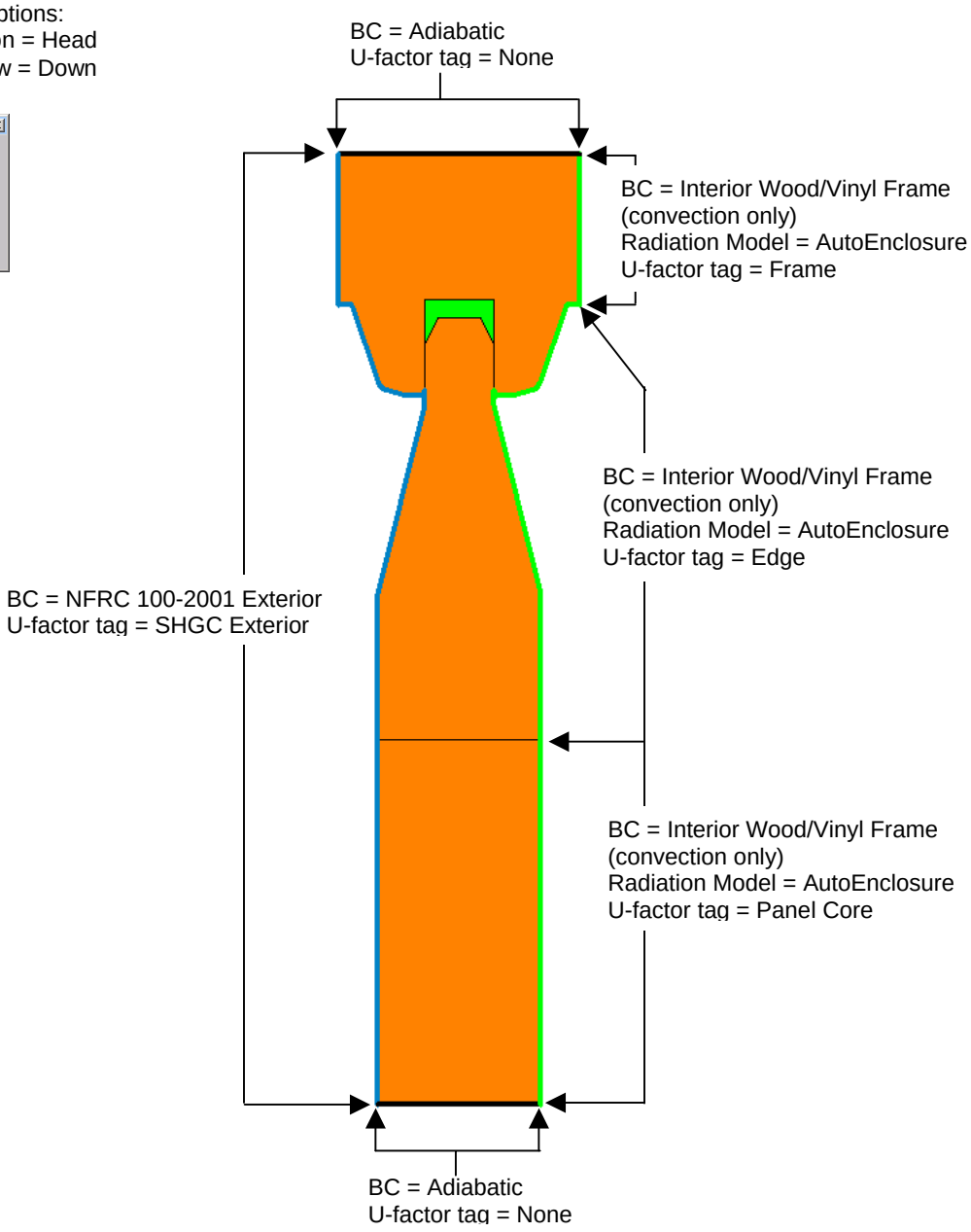


Figure 9-57. Door Sill THERM file.

Panel-Edge

Modeling Assumptions:
- Cross Section = Head
- Gravity Arrow = Down





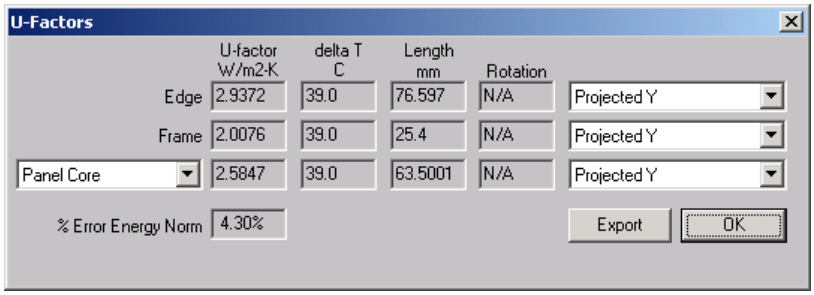


Figure 9-58. Door Panel Edge THERM file.

Door Lite

Modeling Assumptions:

- Cross Section = Sill
- Gravity Arrow = Down

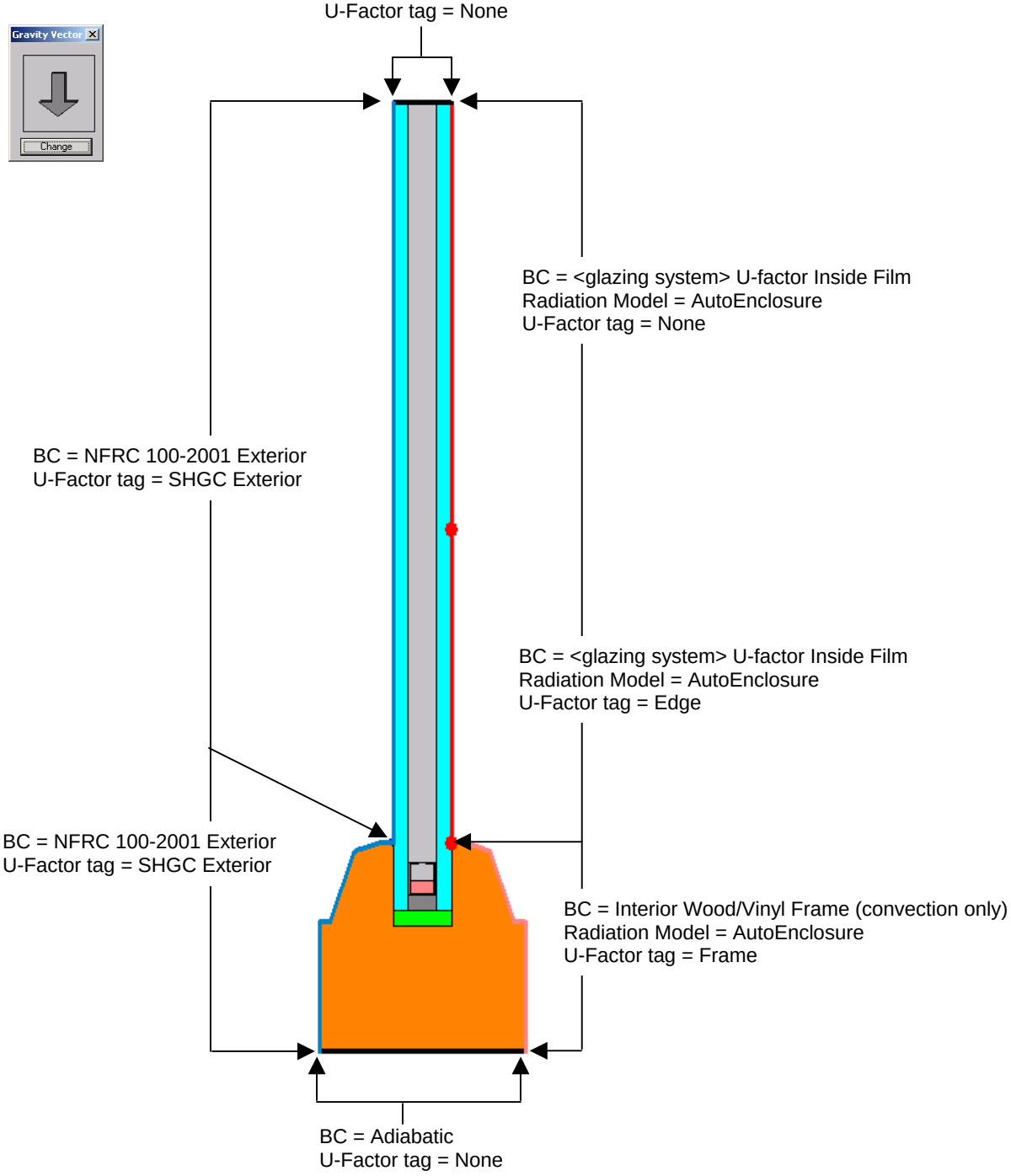


Figure 9-59. Door Lite THERM file.

9.5.5. Total Product U-Factor, SHGC and VT

The results from these THERM and WINDOW runs can be used in a spreadsheet to calculate the total product U-factor, SHGC and VT. That spreadsheet calculation is outside the scope of this manual and is not included.

9.5.7. Wood Stile and Rail Door Drawings.

Note that some of the drawings provided (indicated with an asterisk on the following pages) are patented drawings and shall not be used by anyone without the written consent from NFRC.

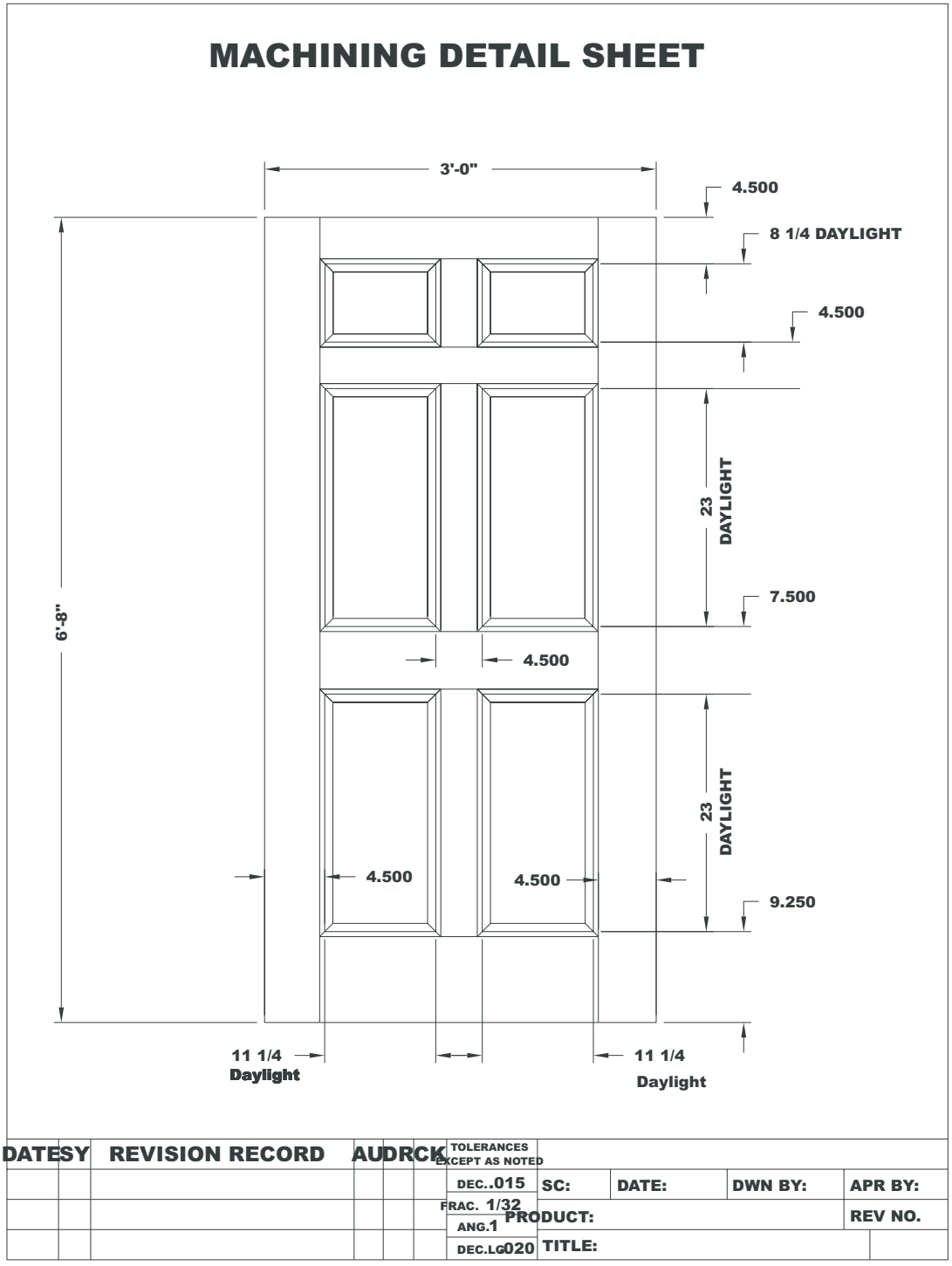


Figure 9-60. 6-Panel Panel Layout.dwg

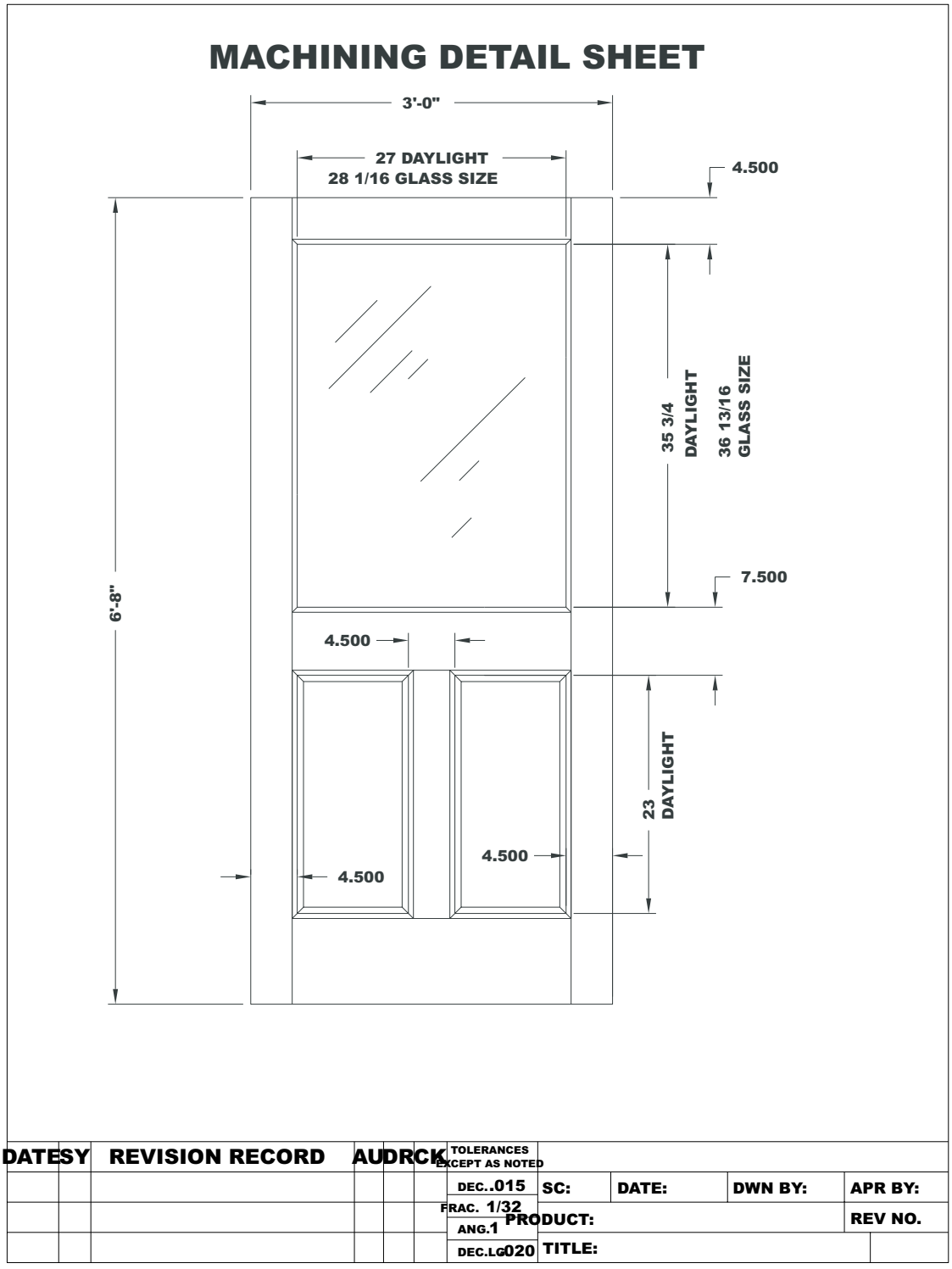


Figure 9-61. Half Panel with Glass Layout.dwg

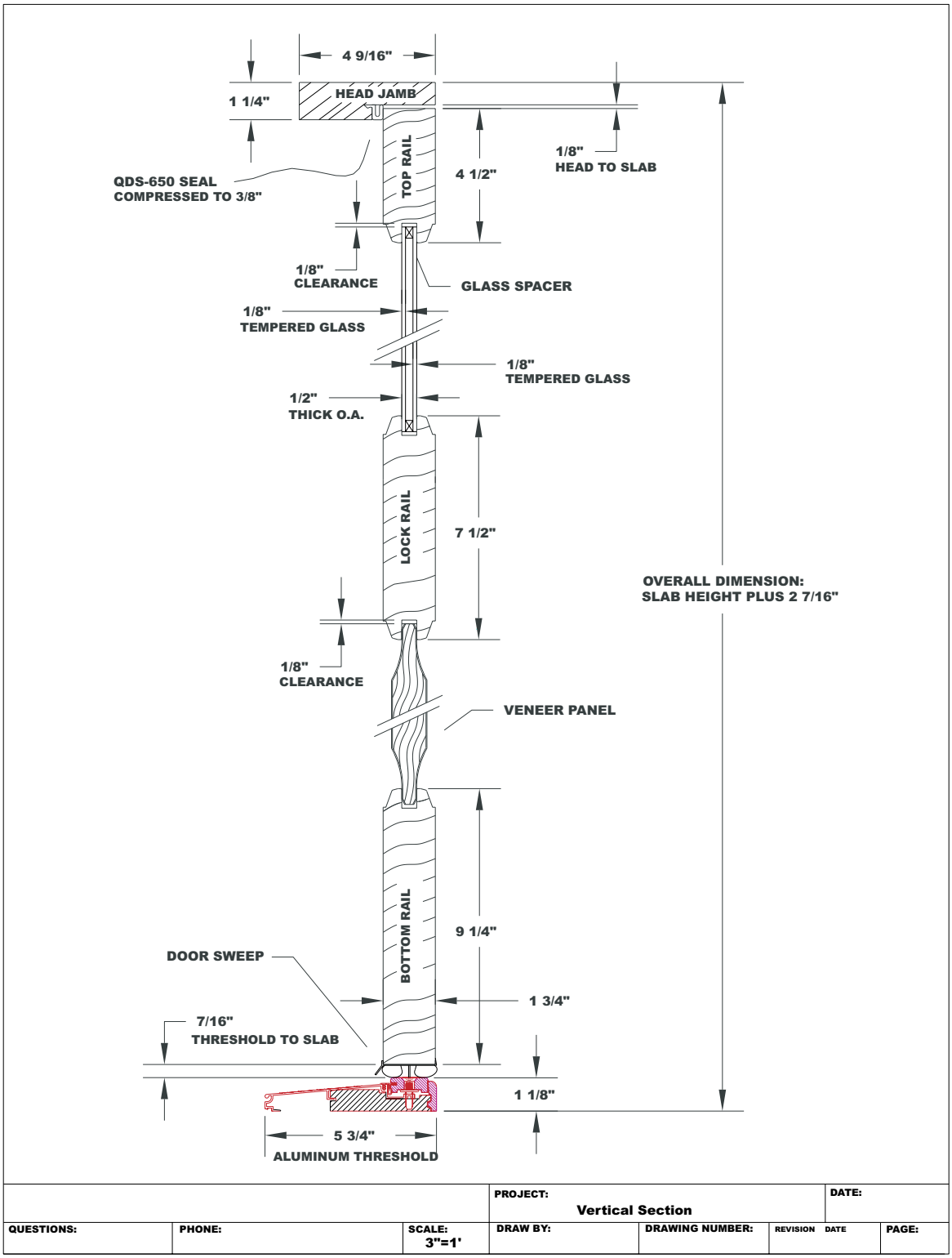


Figure 9-62. Half Panel with Glass Vert Sec.dwg

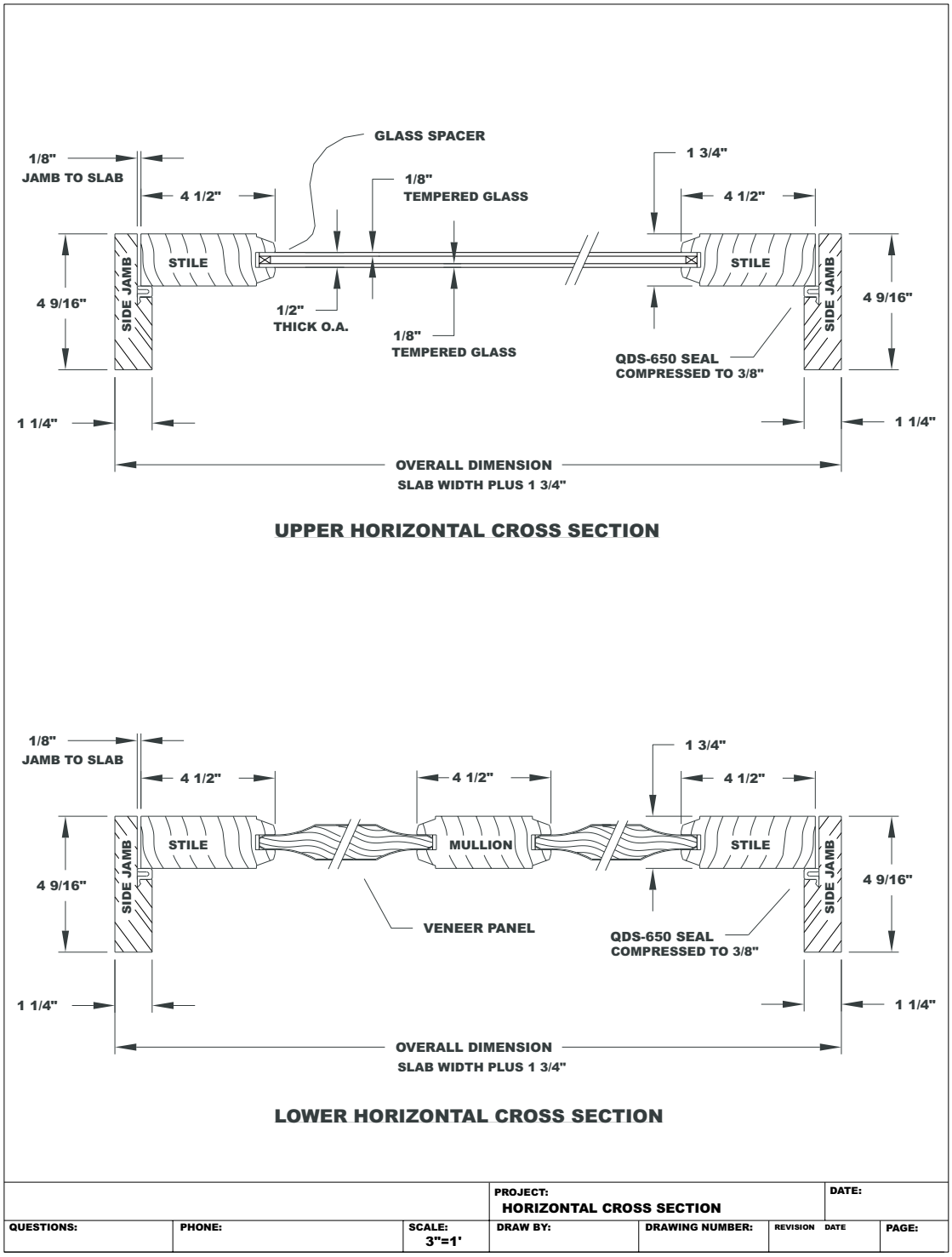


Figure 9-63. Half Panel with Glass Horz Sec.dwg

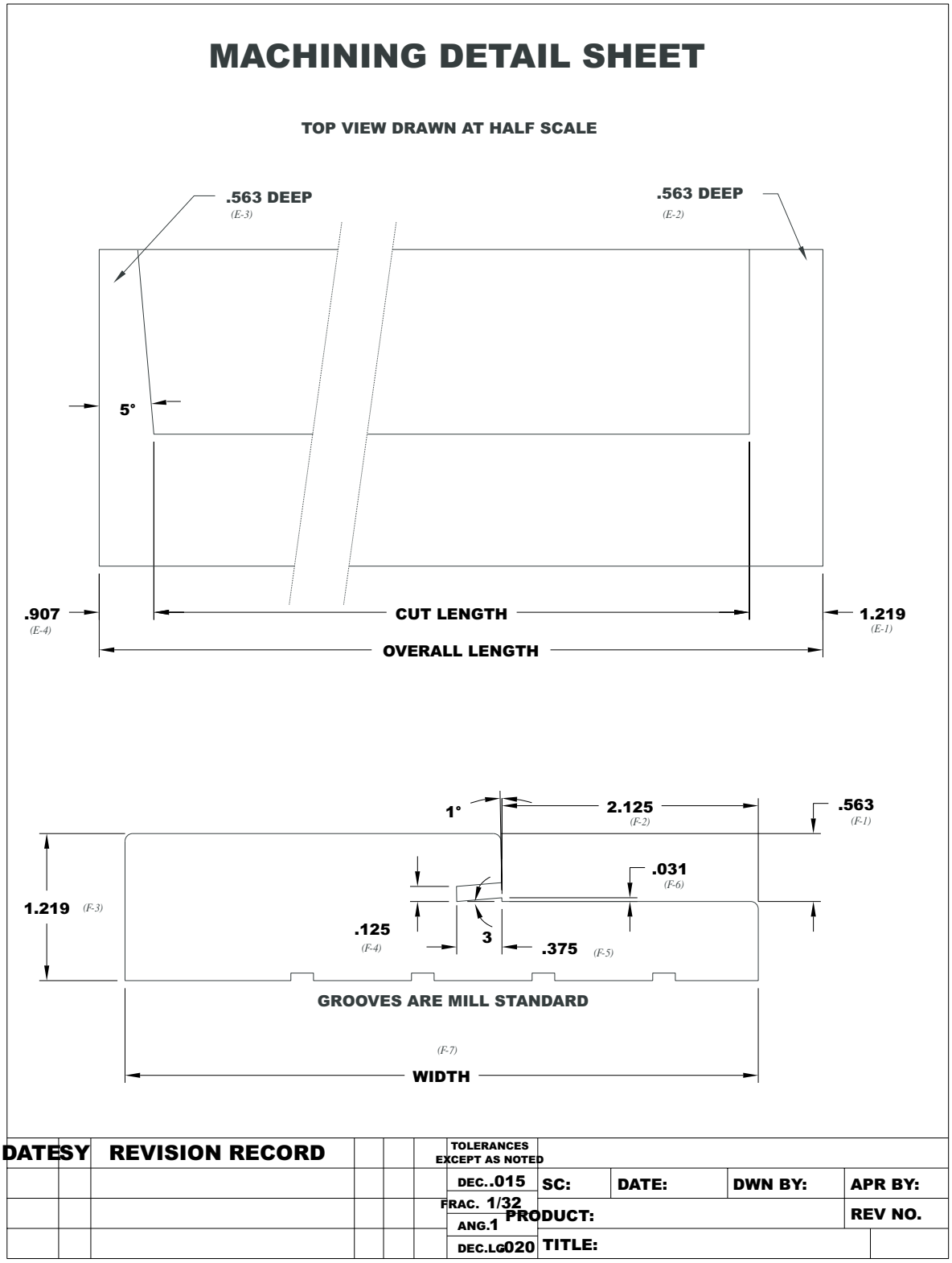


Figure 9-64. 6-Panel Jamb.dwg

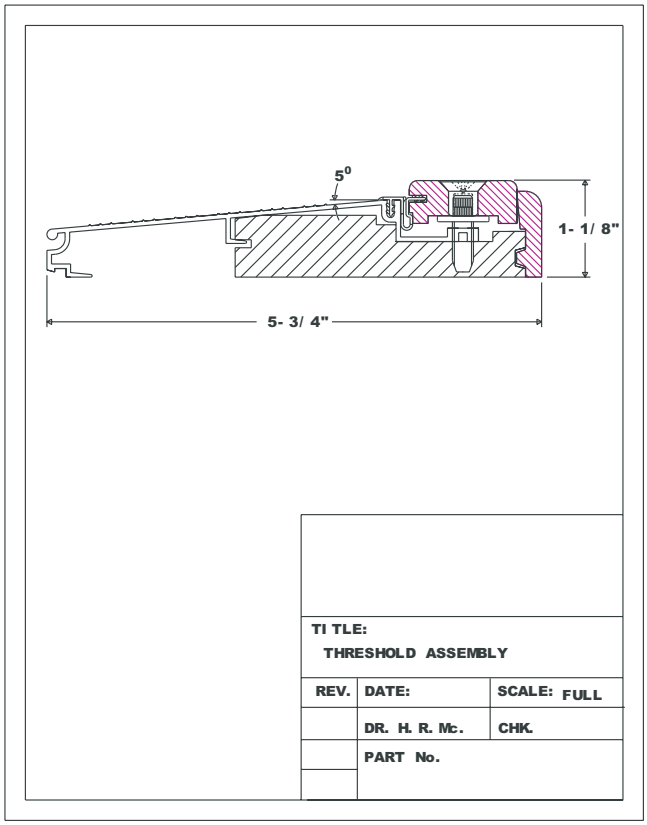


Figure 9-65. 6-Panel Sill.dwg (PATENTED DRAWING)*

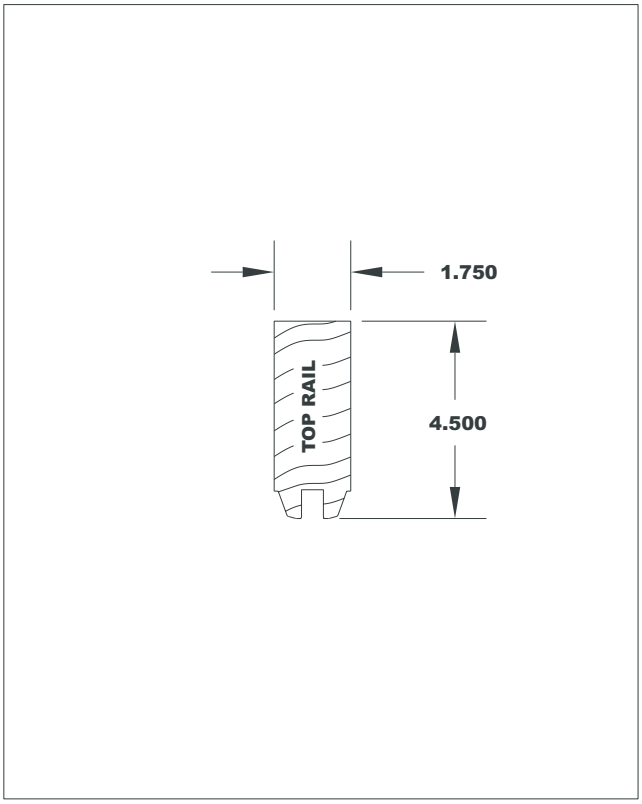


Figure 9-66. 6-Panel Top Rail.dwg

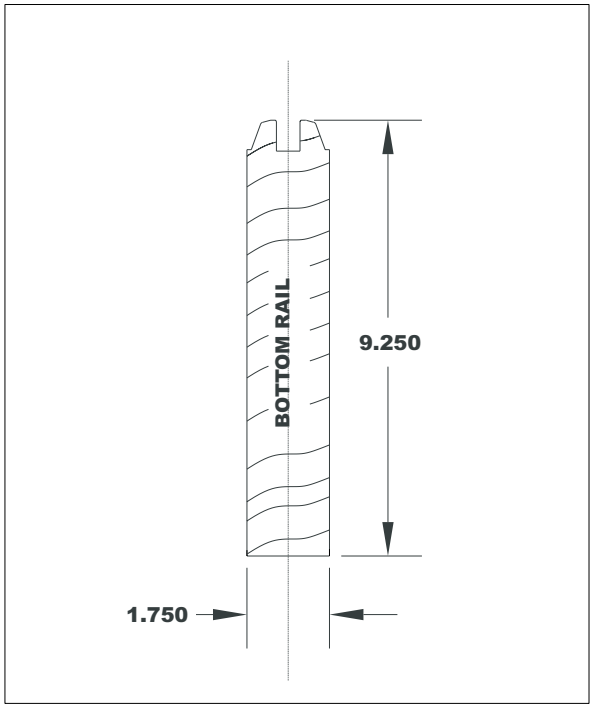


Figure 9-67. 6-Panel Bottom Rail.dwg

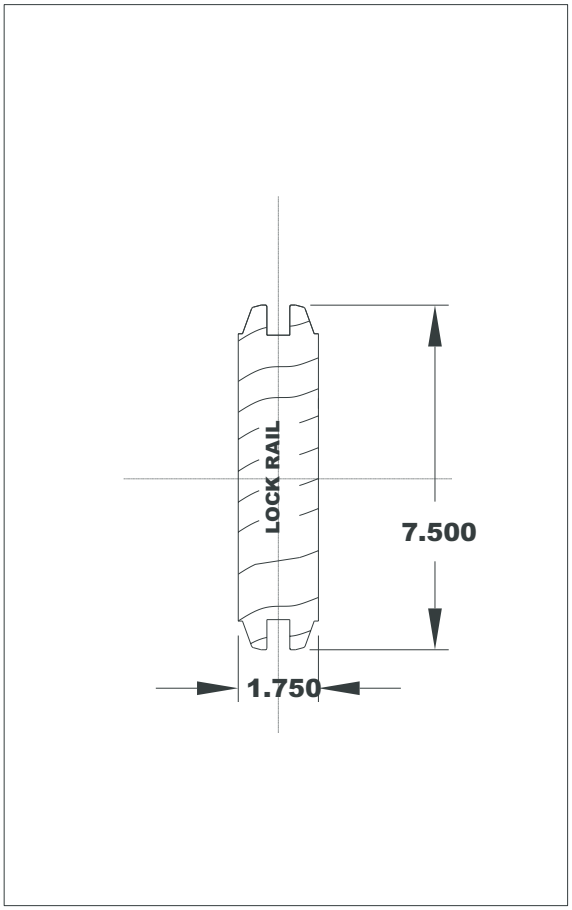


Figure 9-68. 6-Panel Lock Rail.dwg

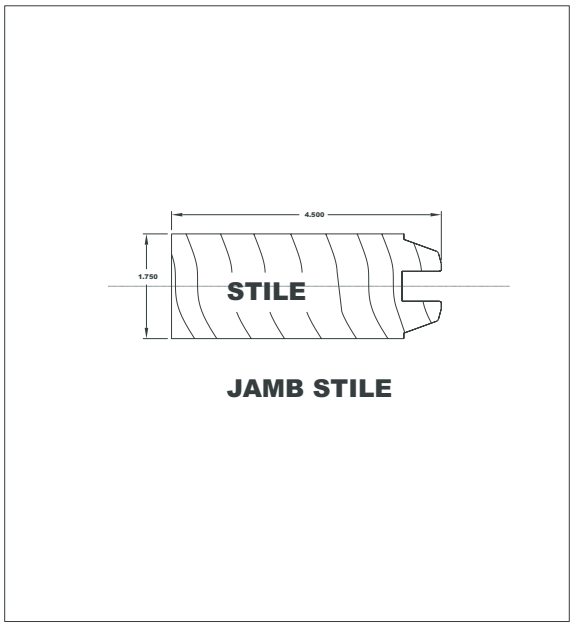


Figure 9-69. 6-Panel Stile.dwg

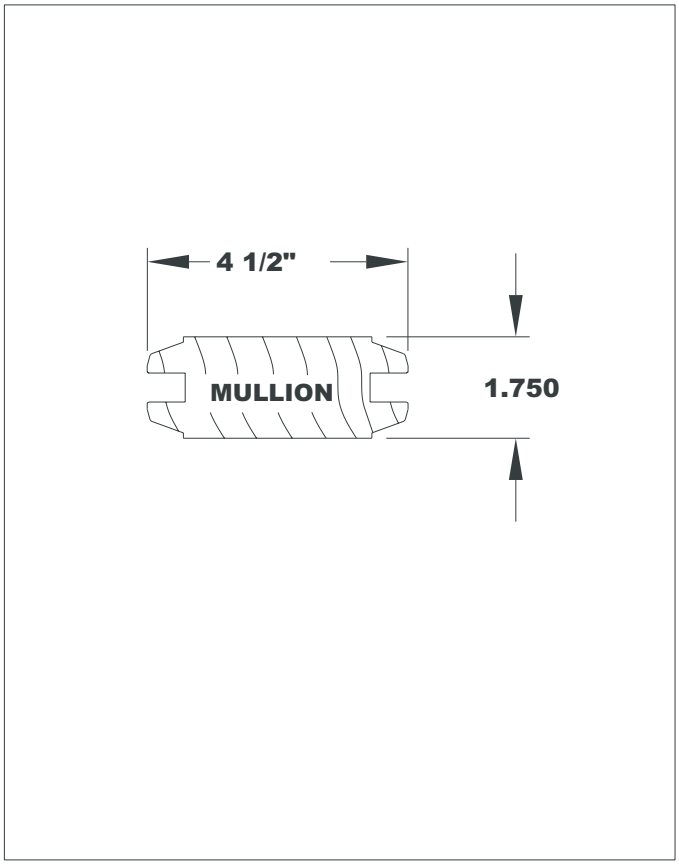


Figure 9-70. 6-Panel Mullion.dwg

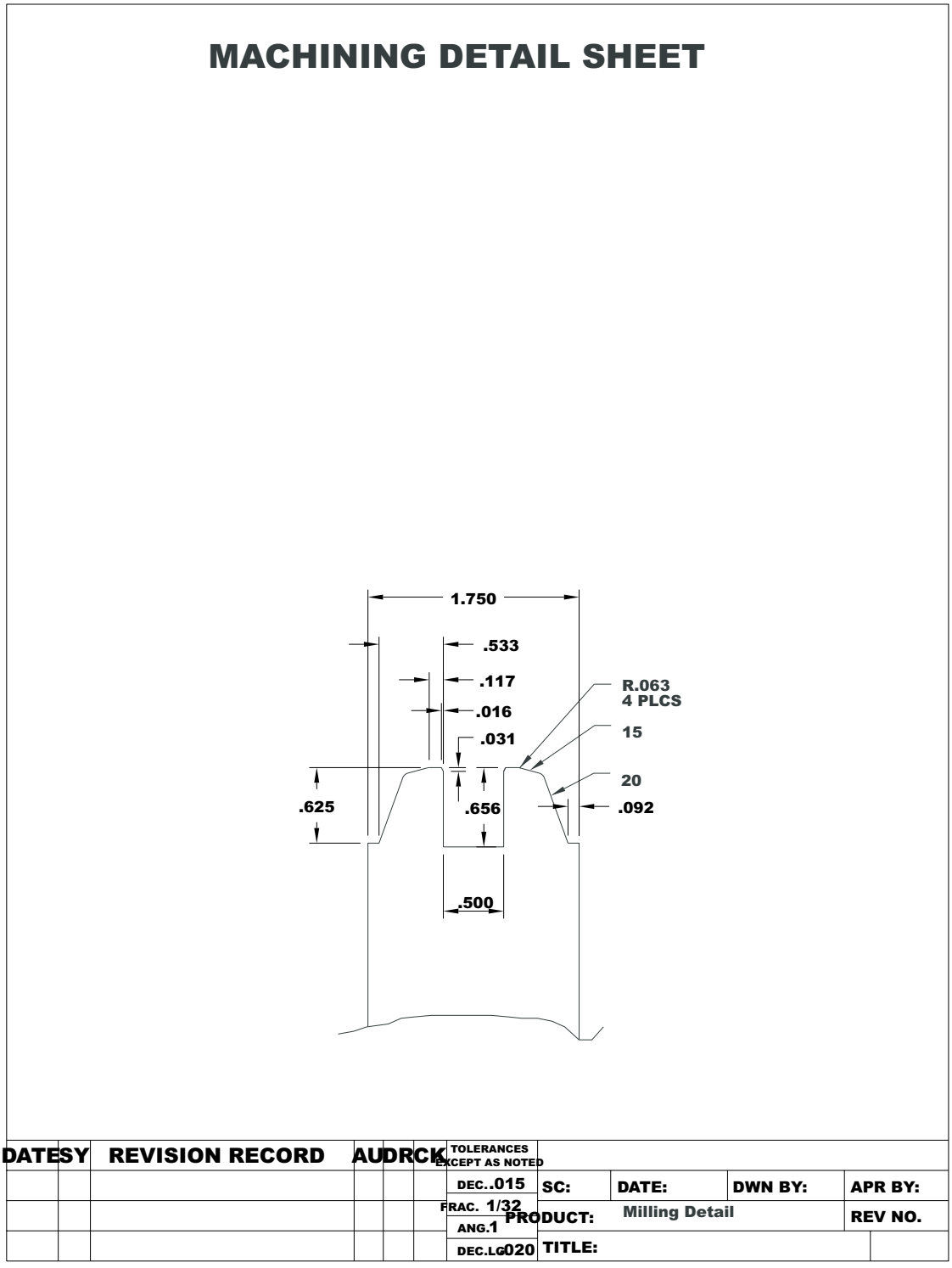


Figure 9-71. 6-Panel Milling Detail.dwg

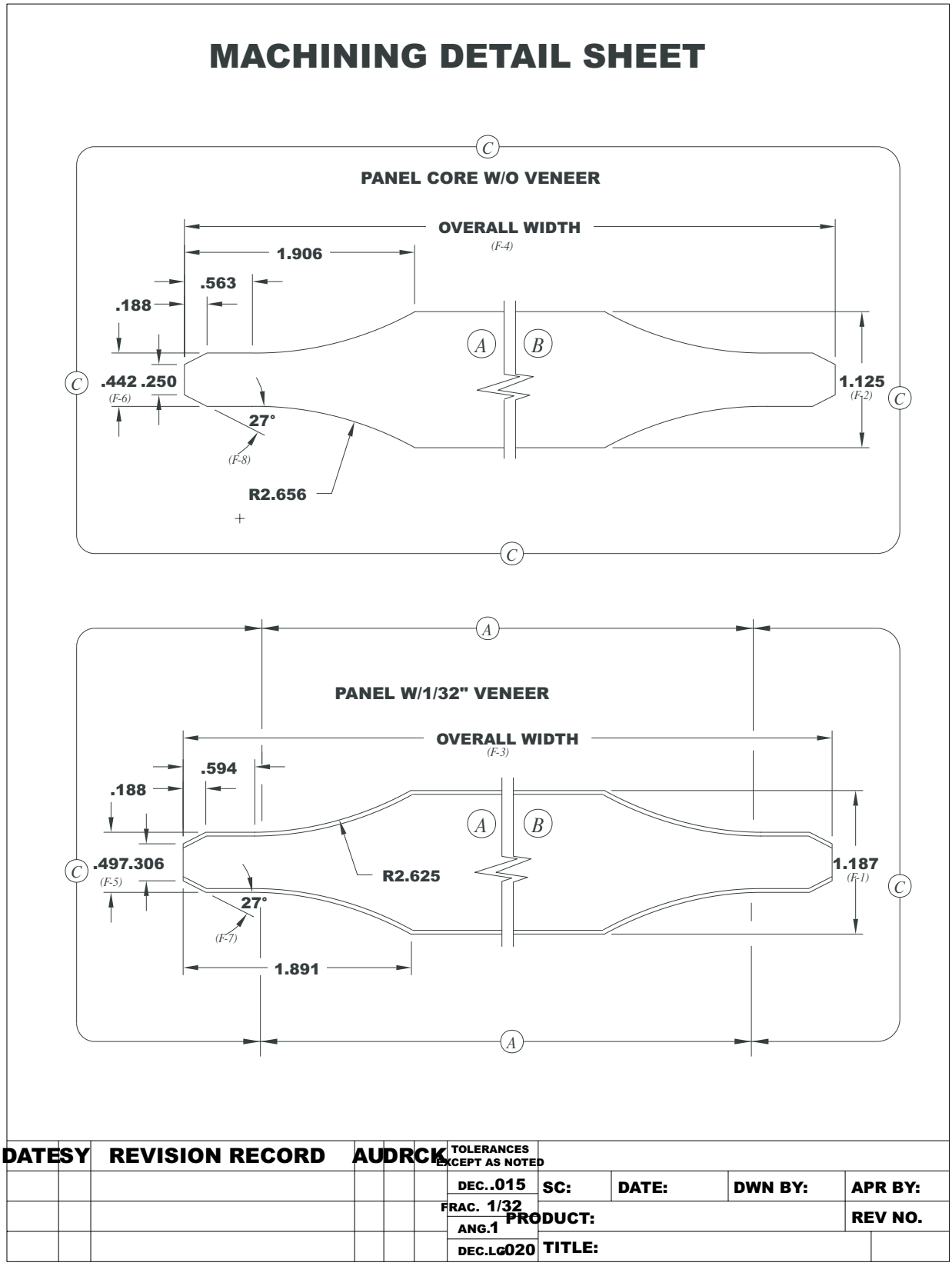


Figure 9-72. 6-Panel Panel.dwg

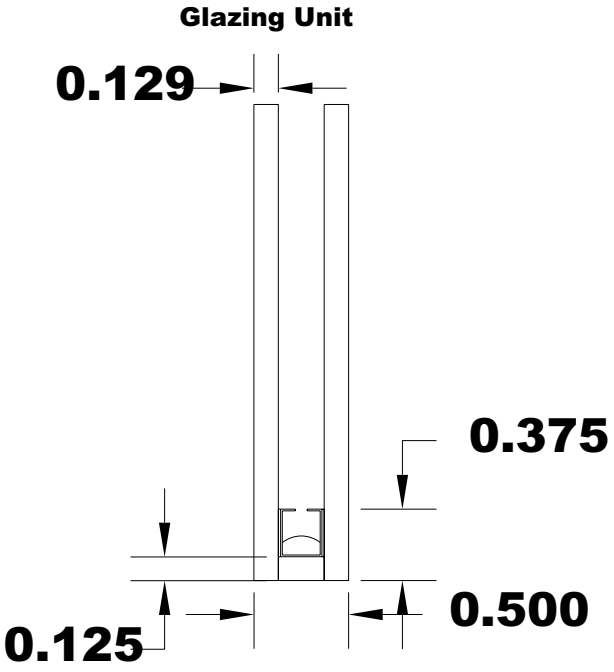
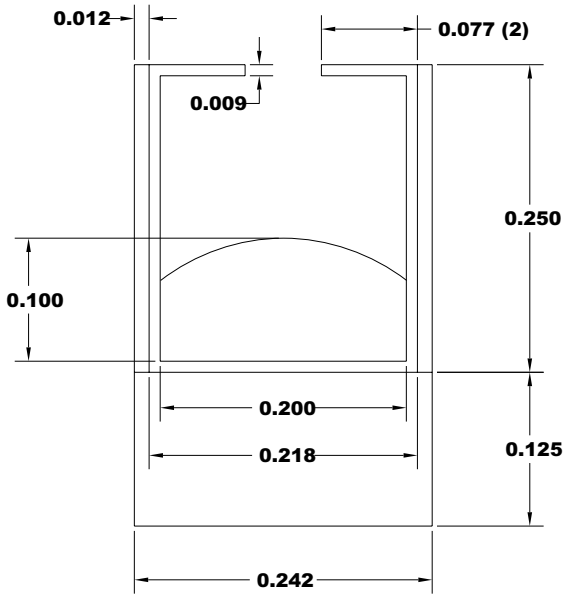


Figure 9-73. 6-Panel Glazing.dwg



Intercept Spacer

Figure 9-74. 6-Panel Spacer.dwg

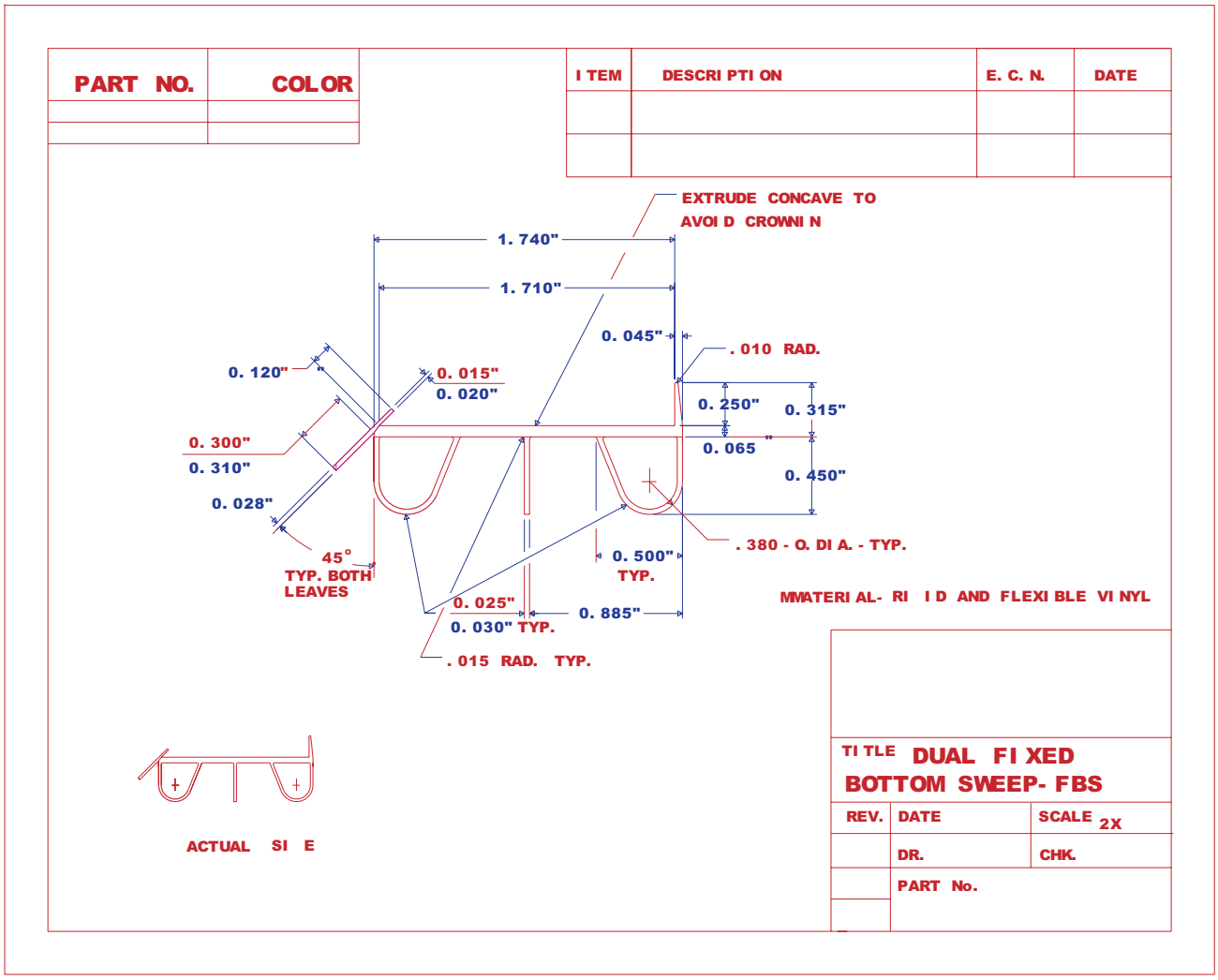


Figure 9-75. 6-Panel Bottom Sweep.dwg (PATENTED DRAWING)*

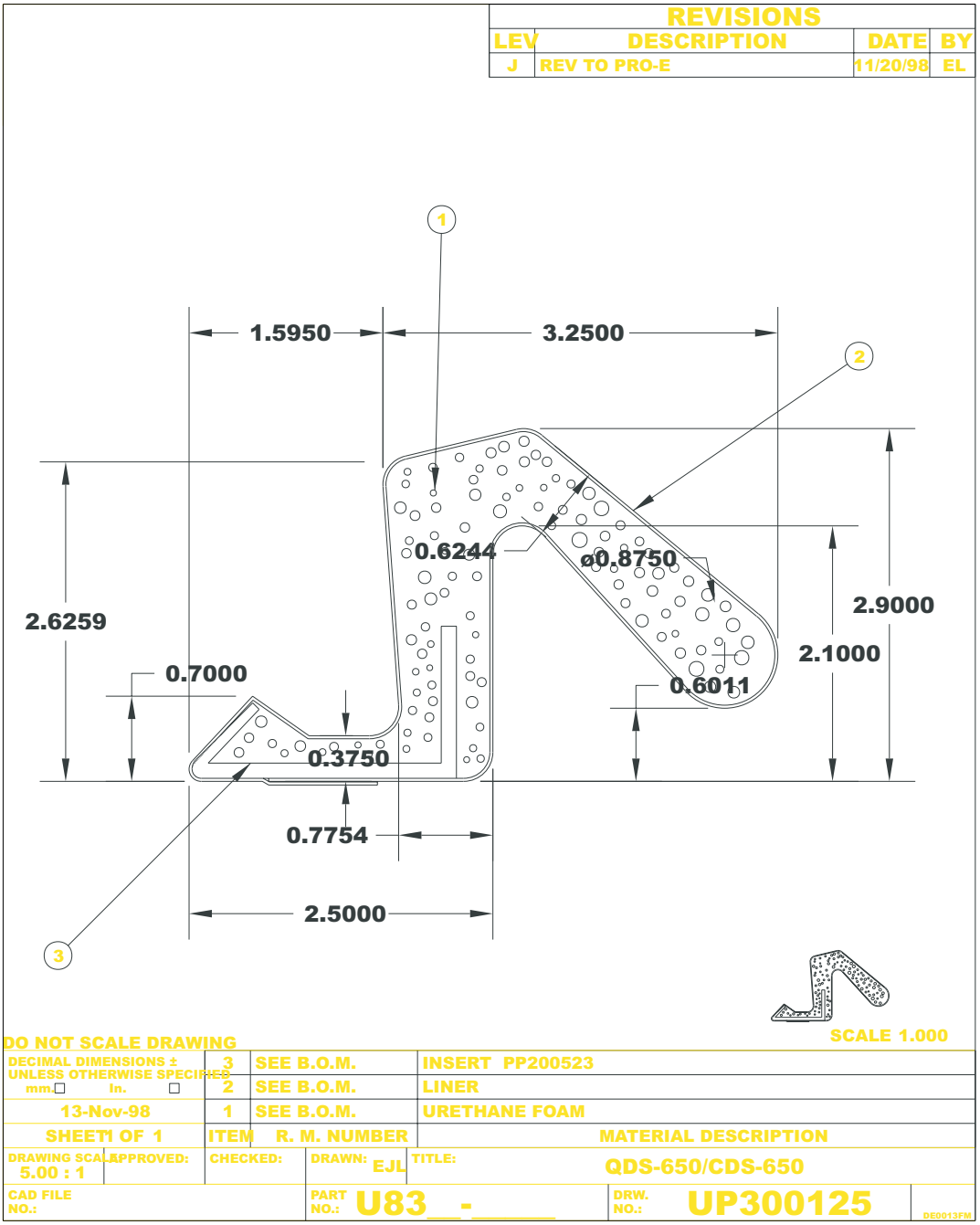


Figure 9-76. 6-Panel Weather Strip.dwg (PATENTED DRAWING)*