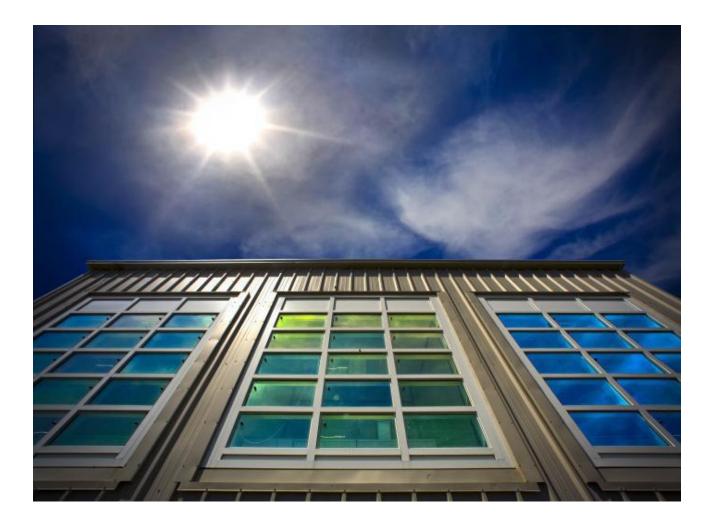
## WINDOW 7 User Manual



Lawrence Berkeley National Laboratory

March 2019



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LBNL-48255

## WINDOW 7 User Manual

Robin Mitchell, Christian Kohler, Dragan Curcija, Ling Zhu, Simon Vidanovic, Stephen Czarnecki and Dariush Arasteh Windows and Daylighting Group Building Technologies Department Environmental Energy Technologies Division Lawrence Berkeley National Laboratory Berkeley, California 94720 http://windows.lbl.gov/software/software.html

> John Carmody College of Architecture and Landscape Architecture University of Minnesota Minneapolis, Minnesota

Charlie Huizenga Center for Environmental Design Research University of California Berkeley, California

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This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Building Technology, Building Technologies Program of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.

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## 1.1. Overview

WINDOW is a state-of-the-art, Microsoft Windows<sup>TM</sup>-based computer program developed at Lawrence Berkeley National Laboratory (LBNL) for use by manufacturers, engineers, educators, students, architects, and others to determine the thermal and solar optical properties of glazing and window systems.

WINDOW capabilities include:

- Calculation of whole product and glazing system U-factor, Solar Heat Gain Coefficient (SHGC), and Visible Transmittance (Tvis)
- Compatibility with the National Fenestration Rating Council and the Attachments Energy Rating Certification procedures
- Ability to model shading devices and complex glazing systems such as
  - Venetian blinds
  - Roller Shades
  - Cellular / Honeycomb shades
  - Fritted glass
  - Storm Panels
  - Applied Films
- Microsoft<sup>TM</sup> Access database for storing data and results, that can be accessed outside of WINDOW
- Updated algorithms consistent with ASHRAE SPC142 and ISO15099
- A Condensation Resistance Index in accordance with a draft version of NFRC 500.
- A surface temperature map
- Radiance rendering of the glazing system
- Links to other LBNL window analysis software:
  - THERM, for calculating 2-D frame and edge effects
  - RESFEN, for calculating the energy effects of windows in typical houses throughout the United States
  - AERCalc, for calculating the AERC annual energy performance certification values
  - COMFEN, for calculating the energy effects of facades in commercial buildings
  - Optics, for the optical properties of all user created glazing layers, laminates, and applied films.
  - International Glazing Database (IGDB), for the optical properties of coated and uncoated glazing layers and predefined laminates.
  - Complext Glazing Database (CGDB) for the optical and thermal proper

Graphic representation

## 2.1. Main Screen (Window Library)

The WINDOW main screen (which is the "detail screen" of the Window Library) for defining a complete window product, shown below, has 4 main screen areas:

- Left hand column for buttons (such as Calc, List, Details) and other common tools
- Input values such as Name, Size, etc.
- Graphic representation of the window. This representation has the various elements (glazing systems, frames, and dividers) which can be selected for a particular window by clicking on the element (this is shown in the following figures).
- Results
- Feedback about currently selected window or window component.

				of window
Menu - Toolbar -			s Record Tools View Help	• III # I II # I II II
Input values	▲	List Calc (F9) New Copy Delete Save Report V Dividers Dividers	ID # 1 • Name Picture Mode NFRC • Type Fixed (picture) • >> Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 90 Environmental Conditions NFRC 100-2010 •	
Resul	lts —	Display mode: Normal	SHGC 0.487 VT 0.513	Click on a component to display characteristics below Trame Name ID 3 Uedge 2.725 W/m2-K Source 1 Edge area 0.060 m2 4rea 0.079 m2 Abs 0.900

Feedback about selected element (Frame, Glazing System, or Divider)

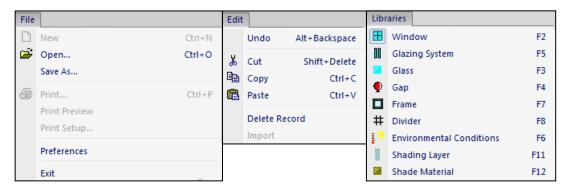
Figure 2-1. Main Screen (Window Library, Detail View).

## 2.2. Menu System

There are seven menus in the WINDOW program:

File	Used to open and save WINDOW databases.
Edit	Used to edit information in the input fields
Libraries	Used to move between the WINDOW libraries
Record	Used to move between records in the WINDOW libraries, as well as calculate the results for active records
Tools	Used to activate other programs such as Optics5 and THERM5
View	Used to move between the list and detailed views in the library, as well as control the display of the toolbar and status bar
Halm	Used to view the program version number as well as the program Help

*Help* Used to view the program version number as well as the program Help.



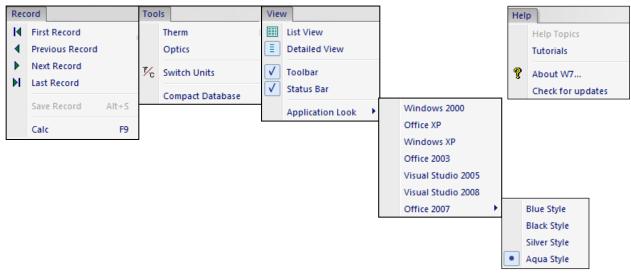


Figure 2-2. File Menu choices.

#### 2.2.1. File

The File menu is used to operate on WINDOW databases. The menu options are:

New	Disabled
Open	Open an existing database
Save As	Save the current database to a new name
Print	Disabled
Print Preview	Disabled
Print Setup	Disabled
Preferences	Access the Preference dialog for various program settings
List of previously opened databases	The last four WINDOW databases that were opened
Exit	Close the program

#### 2.2.2. Edit

The Edit menu is used to control the editing of individual fields in a record, as well as the record itself. The menu options are:

Undo	Revert the last action to it's previous state
Cut	Delete the highlighted information
Сору	Copy the highlighted information
Paste	Paste the previously cut or copied information
Delete Record	Delete the current record (when in Detail view)
Import	Import records from another WINDOW database

#### 2.2.3. Libraries

The Libraries menu is used to access the libraries in the WINDOW program. The menu options are:

Window	Open the Window Library (in Detail view)
Glazing System	Open the Glazing System Library (in Detail view)
Glass	Open the Glass Library (in List view)
Gap	Open the Gap Library (in List view)
Frame	Open the Frame Library (in List view)

Divider	Open the Divider Library (in List view)
Environmetnal Conditions	Open the Environmental Conditions Library (in List view)
Shading Layer	Open the Shading Layer Library (in List view)
Shade Material	Open the Shade Material Library (in List view)

## 2.2.4. Record

The Record menu is used to move between the records in the currently open library. The menu options are:						
First Record	When in Detail view, go to the first record in the current library					
Previous Record	When in Detail view, go to the previous record in the current library					
Next Record	When in Detail view, go to the next record in the current library					
Last Record	When in Detail view, go to the last record in the current library					
Save Record	When in Detail view, save the changes to the record					
Calc	Calculate the current record (highlighted in List view or open in Detail view)					

#### 2.2.5. Tools

The Tools menu is used to start other programs in the LBNL software suite. The menu options are:

THERM	Launch the THERM program
Optics	Launch the Optics program
Switch Units	Switch between SI and IP units
Compact Database	Compact the WINDOW Microsoft Access <sup>TM</sup> database. This will reduce it's size.

#### 2.2.6. View

The View menu is used to move between the List and Detailed views of the libraries, as well as control the toolbars for the program. The menu options are:

List View	View the library in the List view
Detailed View	View the library in the Detail view
Toolbar	Toggle to have the toolbar display
Status Bar	Toggle to have the status bar (at the bottom of the screen) display
Application Look	Allows selecting different colors and styles

## 2.2.7. Help

The Help menu is used to access the WINDOW help topics, as well as version information. The menu options are:

Help Topics	Disabled						
Tutorials	Opens the WINDOW documentation page on windows.lbl.gov						
About	Displays the current version number of WINDOW, including the version numbers of the associated DLL files						
Check for updates	Click this menu option to have the program check the LBNL server to see what the latest versions of WINDOW, IGDB and Radiance are current, and compare to the versions installed on your computer. The program displays this dialog box:						
	LBNL Updates						
	No updates available. Current Versions: WINDOW 7.6.24						

Installed IGDB: 62.0.0 Radiance for WINDOW: 1.2.0

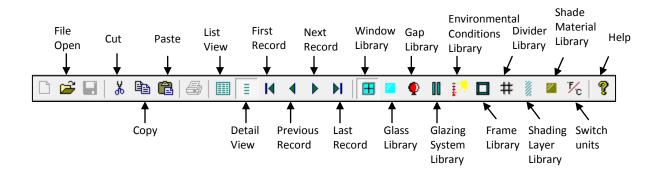
Project Glass library records up to IGDB version: 62.0.0

OK

## 2.3. Toolbar

The toolbar offers shortcut buttons for several common functions, including navigating between each of the libraries. The figure below shows the toolbar with labels for each button.

Figure 2-3. Toolbar buttons.



## 2.4. Construct a Window Product

#### 2.4.8. Select the Glazing System for the Window

To view the characteristics of the glazing system of the window, click on the glazing system component and the information is displayed in the lower right group box, as shown below. This information is from the **Glazing System Library**.

To select a new glazing system for this window, click on the glazing system to be changed, and either use the pulldown list to see the names of all the records in the **Glazing System Library**, or click on the double arrow button, and another window will open which displays all the values from the **Glazing System Library**.

				lelp	<b>H</b>	● II [ <sup>1</sup> □ # ※	🗖 🏹	?								
	List alc (F9) New Copy Delete Save Report Dividers ividers	ID # 1 Name Pict Mode NFF Type Fixe Width Height Area Tilt Environmenta NFRC 100-2	ure 3C d (picture) 1200 mm 1500 mm 1.800 m2 90 al Conditions	• •	>>>						to select will be h change, been se Step 3: To chan	lick on the t it. The g nashed, an to indica lected. ge the se System, e	lazing sy nd the co te that i lected	ystem olor wil		
Norma	lay mode: al ▼ C/VT Detail	Total Windo U-factor SHGC VT CR	w Results ? ? ? ? ? ?	W/m2K	<	Click on a component to Glazing System Name Sample GlzSys ID 8 Nlayers 2 Area 1.271 m2 Edge area 0.305 m2	Ucen	ter	-	≫> W.m2-K	Click on see the <b>Glazing</b> Or Click on button showing	the pulld names fro <b>System L</b> the doub to open a g all the ir e <b>Glazing</b>	lown list om the <b>.ibrary</b> ole arrow window nformati	v v ion		
beca butto	ults show " ouse the Ca on has not vated.	alc	glazing sys box. The <b>Glazir</b> dependen	stem ar <b>ng Syst</b> a nt on th	re dis <b>em</b> c e he	the currently select splayed in the lower enter-of-glass resul ight of the final win e Calc button is pres	group ts are dow ar	/	/							
				💷 Sele	ect											x
				Sele	ect	Cancel		Find		ID 🔻	26 records fo	ound.				
					ID	Name	# of Layers	Mode	Tilt	Environmental Conditions	Overall Thickness	Uval	SHGC	Tvis	Tdw-ISO	*
											mm	W/m2-K				
					4	Double Clear with Argon	2	#	90	NFRC 100-2010	18.80	2.576	0.764	0.814	0.738	
					5	Triple Clear	3	#	90	NFRC 100-2010	42.55	1.744	0.617	0.703	0.601	

Figure 2-4. Select a Glazing System for the window.

#

90

2

2 #

NFRC 100-2010

90 NFRC 100-2010

25.93

8.06

1.935

0.634

Double high solar gain low-e

9 Double low-e (vacuum)

7

0.686

0.354

0.741

0.691

0.635

0.517

#### 2.4.9. Select the Frame for the Window

To view the characteristics of the frame of the window, click on a frame component and the information is displayed in the lower right group box. This information is from the **Frame Library**.

To select a new frame for this window, click on the frame component to be changed, and either use the pulldown list to see the names of all the frames in the **Frame Library**, or click on the double arrow button, and another window will open which displays all the values from the **Frame Library**.

File Edit Librarie	es Record	Tools	View Help	• 11	10 ‡	ŧ	∛c   <b>?</b>							
List Calc (F9) New Copy Delete Save Report Dividers	ID # 1 Name Pic Mode NF Type Fix Width Height Area Tilt Environmen NFRC 100-	RC ed (pict 1200 1500 1.800 90 tal Con	mm mm m2							2 0 1 0 1 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 0 1 0 1 0 10 1	Step 1: Single clic compone The fram change to t has bee Step 3: To chang	ent to le colo o indio en sel	sele or w cate ecte	ect it. ill that ed.
Display mode: Normal - SHGC/VT Detail CR Detail	Total Wind U-factor SHGC VT CR	ow Res	W/m2-K	Frame	sample-sill. 7 2	THM Ei W/m2-K	uedge dge area PFD Abs	istics below		/	Frame, e Click on to see th Frame Li Or Click on button to showing informat Frame Li	the print the print brary the do o ope all th	: ulldo nes oubl n a v e rom	own list from the le arrow window
Results show "?" I the <b>Calc</b> button ha been clicked.			Step 2: The characteristics of th displayed in the lower r				*						×	
	Sele		Cancel	Fi	ind		> ▼7	records found	<u>.</u>				~	
		ID	Name	Source	Туре	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness		Abs	Color	*	
			Vinyl	ACUDAS	NI JA	W/m2-K	W/m2-K	Claud	mm	mm	0.00			
		4	vinyi sample-head.THM	ASHRAE	N/A Head	1.700 2.024	N/A 2.346	Class1 N/A	N/A 25.9	69.8 42.9	0.90			
		5	sample-jamb.THM	Therm Therm	Jamb	2.024	2.346	N/A N/A	25.9	42.9	0.30		Ξ	
		о 7	sample-sill.THM	Therm	Sill	2.014	2.337	NVA	25.9	42.9	0.30			
		ļ		Theath	0.00		2.001		20.0	1 12.0	0.00		- T	

Figure 2-5. Select a Frame for the window.

## 2.4.10. Add Dividers to the Window

To add dividers to the window without dividers, click on the Divider button above the Results group box.

	File Edit Librarie	es Record Tools View H	elp • • • E	🗣 II 🚺 🗖 🗰 🕷 🛛 🎋   ۹	?
Step 1: Click on the <b>Dividers</b> button.	List Calc (F9) New Copy Delete Save Report Dividers Dividers	ID # 1 Name Picture Mode NFRC Type Fixed (picture) Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 90 Environmental Conditions NFRC 100-2010	•		
	Display mode: Normal SHGC/VT Detail CR Detail	Total Window Results U-factor 1.995 SHGC 0.603 VT 0.648 CR 49	W/m2-K	Click on a component to display char	acteristics below
Ster The		ion dialog box will appear.	# of H # o	Configuration Iorizontal Dividers Automatic f Vertical Dividers Automatic oply to Vision Area All	Cancel Apply
	ect the correct numl i <b>ders</b> , and click the <b>(</b>	per for <b>Horizontal</b> and <b>Verti</b> <b>DK</b> button.	cal		

Figure 2-6. Specify the number of dividers for the window.

File Edit Librari		Tools View	v Help	🍨 III 📴 ‡	± 🐰 🗖	K 💡							
List Calc (F9) New Copy Delete Save Report	ID # 1 Name Pic Mode Nf Type Fib Width Height Area Tilt	cture FRC (picture) 1200 mm 1500 mm 1.800 m2 90 ntal Conditions							Step 3: The approduced dividers w window. Step 4: Single clic compone Step 5: Fo change either:	will be d ck on a d ont to sel	isplayed livider lect it.	d in th	
Dividers Display mode: Normal * SHGC/VT Detail CR Detail	Total Winc U-factor SHGC VT CR	low Results ? ? ? ? ? ?	W/m2-K	Click on a compo Divider Name Divider.TH ID 7 Source 2 Ufactor ? Area 0.213	HM 2 E 2 W/m2-K	Uedge Uedge Edge area PFD Abs	•	Vm2-K	Or •	Click or list to so from th records Click or arrow b window informa Divider	ee the r le Divid the do button t v showi ation fro	names er Lib ouble to ope ng all om th	s orary en a the
		Select										F	x
			Cancel	Fir	nd		> ▼7	records found	±.				
		ID	Name	Source	Туре	Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs	Color	*
			Wood/Divided	400045	<b>C</b>	W/m2-K	W/m2-K	<u></u>	mm	mm	0.00		
		3	Insul/Divided		Suspende	N/A	N/A	Class3	N/A	15.9 15.9	0.90		
		4		ASHRAE	Suspende	N/A	N/A	Class4	N/A	15.9	0.90		
		5	Alum/Suspended	ACHDAE	Suspende	N/A	N/A	Class5	N/A	16.0	0.30		=

Figure 2-7. Select a Divider for the window.

×.

Divider.THM

-

#### 2.4.11. Calculation

WINDOW will calculate the total product properties for the current record when the **Calc** button is clicked.

	File Edit Librarie	s Record Tools View	Help					
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Click the <b>Calc</b> button and the program will calculate the <b>Total</b> <b>Window Results</b> .	List Calc (F9) New Copy Delete Save Report V Dividers Dividers Display mode: Normal SHGC/VT Detail CR Detail	ID # 1 Name Picture Mode NFRC Type Fixed (picture) Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 90 Environmental Conditions NFRC 100-2010 Total Window Results U-factor 1.867 SHGC 0.525 VT 0.561 CR 49	▼ ▼ >> V/m2-K	Click Divider Name ID Source Ufactor Area	on a component to Divider.THM 7 1.309 W/m2- 0.213 m2	Uedge Edge area	•	>> ₩/m2-K

Figure 2-8. Calculate the whole product properties.

## 2.4.12. Results

WINDOW calculates the following values for the Total Window Results:

U-value	Total Product U-value
SHGC	Solar Heat Gain Coefficient.
VT	Visible Transmittance
CI	Condensation Index, calculated according to NFRC 500 Procedures (Draft). It is possible to see the intermediate values used for the CI calculation by pressing the Detail button, explained in detail in Chapter 4 of this manual.

## 2.4.13. Temperature Map for Window

Click on the **Temperature Map** button in the **Total Window Results** group box to display a temperature map of the window, as shown below.

				View Help						
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Click on the D Mode pulldov		List Calc (F9) New Copy Delete Save Report	ID # 1 Name Picture Mode NFRC Type Fixed (pictur Width 1200 Height 1500 Area 1.800 Tilt 90 Environmental Condit NFRC 100-2010	mm mm m2						•
select Temper see the temper map. Click on the Im	rature to erature	Div ders Display mode: Temperature ▼ Image Control	Total Window Resul		Hold left b	utton and move	mouse to rotate	• (	Reset	
Control buttor control the temperatures map.	in the	SHGC//T Detail	SHGC 0.525 VT 0.561 CR 49	W/m2-K	-10.0 -6.9	-3.8 -0.6	2.5 5.6		11.9 15.0	
	Image con © Infrare Minim	d image		1	-10.0 -0.9	-5.8 -0.0	2.5 5.0	0.0	11.5 15.0	
	C Conde	nsation image side Temperature 21 Inside RH 50	°C Zoom °C % °C %	Tempera map.	ture legend a	appears with	n the tempe	rature		

Figure 2-9. Click on the Temperature Map radio button to see the temperature map for the current window.

Note the following (see also *Section 4.3,* "Window Library" and *Section 4.7,* "Frame Library") about the Temperature Map data:

- It is necessary to use THERM 5 Alpha in order to get the proper temperature data. Older versions of the program will not have the correct data.
- It is necessary to model the THERM profiles with the CI feature turned on (this is turned on when importing the glazing system, or can be turned on after the glazing system is imported in the Options/Preferences menu, Therm File Options tab).

## 2.5. Saving Projects

#### 2.5.1. Saving the Entire Database

It is possible to save the results and associated data (for each library) into different WINDOW5 databases for different projects.

For example, after having created the glazing systems, imported the THERM files into the Frame Library, and constructed the desired Windows in the Window Library, this set of data can be saved into a project database with a unique name.

The **File/Save As** menu can be used to save the data currently in the working project database as a different name. The project database that is shipped with the WINDOW is called W5.mdb, but a database can be saved with any name.

Save As								
Computer > OS (C:) > Users > Public > LBNL > WINDOW7.7 > - 4 Search WINDOW7.7								٩
Organize 🔻 New	w folder							0
퉬 UsersPublicLB	NL ·	*	Name	Date modified	Туре	Size		-
indow 🔒			🔊 w7.mdb	1/29/2019 6:59 PM	Microsoft Access	317,640 KB		
cygwin			W7 Pre-Version-7.7.04.mdb	1/11/2019 7:32 PM	Microsoft Access	317,640 KB		
Recent Places			🕘 W7 Pre-Version-7.7.03.mdb	1/3/2019 3:28 PM	Microsoft Access	317,640 KB		≡
🕼 Dropbox (BT K			🕘 W7 Pre-Version-7.7.02.mdb	1/3/2019 2:33 PM	Microsoft Access	317,640 KB		
👝 Google DriveF	5		IGSDB Web Example Data-EN410	12/19/2018 4:03 PM	Microsoft Access	1,568 KB		
Desites.			🕘 w7BlankDB.mdb	11/5/2018 5:04 PM	Microsoft Access	1,484 KB		
🧫 Desktop 詞 Libraries			퉬 Samples	1/29/2019 6:29 PM	File folder			
		Ŧ	\mu XML	1/29/2019 6:28 PM	File folder			-
File name:	Another D	)atab	ase					•
Save as type:	WINDOW7 Database (*.mdb)							
Hide Folders						Save	Cancel	

Figure 2-10. Use the File/Save menu to save the current data into a different project database

The File/Open menu can be used to open a previously saved project database located in any directory.

#### 2.5.2. Saving Only Referenced Entries

It is possible to make a much smaller WINDOW5 project database by saving only the records in each library that are used in the defined glazing systems and windows. For example, saving a project database in this fashion would mean that only the glass layers referenced by the glazing system would be saved in the glass library, rather than the entire glass library that is installed with the program. The database size reduction is significant – a database with the entire Glass Library records is 15+ MB, while a database with only the referenced glass layers can be less than 1 MB.

The steps to save a WINDOW database in this manner are the following:

• Select the Library "level" that the export should start from:

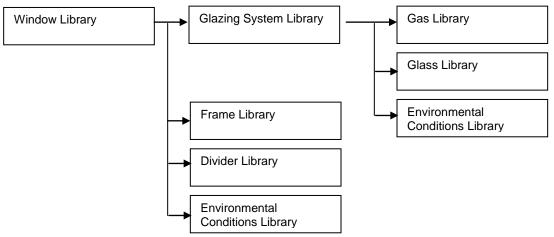


Figure 2-11. The database heirarchy in the WINDOW project database.

- Starting from the **Window Library** will mean that records from all the other libraries that are used either directly or indirectly from those libraries will be included in the project database:
  - Glazing System Library: All the glazing systems referenced in the Window Library entries
  - **Frame Library:** All the frames referenced in the Window Library entries
  - **Divider Library:** All the dividers referenced in the Window Library entries, if dividers are modeled.
  - **Glass Library:** All the glass layers referenced from the glazing systems used in the Window Library entries
  - **Gas Library:** All the gases referenced from the glazing systems used in the Window Library entries
  - Environmental Conditions Library: All the environmental conditions referenced from the glazing systems and the Window Library entries.
- Starting from the Glazing System Library will mean that records from the other libraries used to define the glazing systems will be written into the project database, and no other entries:
  - Glazing System Library: All the glazing systems referenced in the Window Library entries
  - **Glass Library:** All the glass layers referenced from the glazing systems used in the Window Library entries
  - **Gas Library:** All the gases referenced from the glazing systems used in the Window Library entries

- **Environmental Conditions Library:** All the environmental conditions referenced from the glazing systems and the Window Library entries.
- From the desired library, go the List View and click on the Export button

Export				(	x
Export: Selected record All records	(s)				
Format WINDOW	'Database	•			
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Organize 🔻 New f	older					0
📔 My Videos	*	Name	Date modified	Туре	Size	
퉬 OpenStudio 🍺 Saved Games		W7-THERMSampleDB.mdb	11/9/2018 11:49 AM	Microsoft Access	1,488 KB	
Searches Tracing VirtualBox VMs						
Computer	Ξ					
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File name: N	ew WINDO	W DB				•
Save as type: WINDOW7 Databases (*.mdb)						
Hide Folders				Save	Cance	:

## 3.1. System Requirements

WINDOW5 requires the following minimum computer requirements:

- Pentium class or better.
- At least 32 MB of random access memory (RAM). For optimal operation, 64 MB or more of RAM is
  preferrable.
- Microsoft Windows operating system. (The program WILL NOT run with Windows 3.1<sup>TM</sup>, Windows NT 3.51<sup>TM</sup> or Windows 95<sup>TM</sup>).
- Hard disk drive with at least 40 MB of available disk space
- Printer supported by Microsoft Windows (serial, parallel, or shared over a network).

## 3.2. Installation Procedures

#### 3.2.1. Before Installing WINDOW

Close all programs before installing WINDOW and uninstall and previous versions of the WINDOW program before starting the installation of this version.

You **must be Administrator** on your machine in order to successfully install WINDOW.

#### 3.2.2. Installing WINDOW

Download the installation file from the windows.lbl.gov/software website.

Double click on the installation file and the program will walk through the installation steps.

You will be asked to agree to the license. If you do not agree, the program will not install the program.

If you have previous versions of WINDOW installed, the program will make copies of the databases created with that version.

The program will be installed by default in this directory:

C:\Program Files (x86)\LBNL\

The working directory, where the program database is installed, is:

C:\Users\Public\LBNL

Depending on the operating system version, an icon for WINDOW will be added to the desktop, and will also be available under **LBNL Software**.

## 4.1. Overview

Much of the information in this chapter is taken from *Residential Windows: A Guide to New Technologies and Energy Performance* by John Carmody, Stephen Selkowitz, and Lisa Heschong.

Although glazing materials are the focus of much of the innovation and improvement in fenestration products, the overall performance of any unit is determined by the complete fenestration product assembly. The assembly includes the operating and fixed parts of the product frame as well as associated hardware and accessories. These are defined and illustrated at the beginning of this section. The next sections address the different options available for sash operation and new advances in frame materials designed to improve product energy efficiency. Proper installation is an important aspect of their performance as well.

## 4.2 Fenestration Product Sash Operation

There are numerous operating types available for fenestration products. Traditional operable types include projected or hinged types such as casement, awning, and hopper, and the sliding types such as double- and single-hung and horizontal sliding. In addition, the current market includes storm windows, sliding and swinging patio doors, skylights and roof-mounted (i.e., sloping) windows, and systems that can be added to a house to create bay or bow windows, miniature greenhouses, or full sun rooms.



Figure 4-1. Fenestration Operator Types

## 4.2.1. Projected or Hinged Windows

Hinged windows include casements, awnings, and hoppers – hinged at the side, top, and bottom, respectively. Some manufacturers also make pivoting and combination windows that allow for easier cleaning of the exterior surfaces. Hinged windows, especially casements, project outward, providing significantly better ventilation than sliders of equal size. Because the sash protrudes from the plane of the wall, it can be controlled to catch passing breezes, but screens must be placed on the interior side. Virtually the entire casement window area can be opened, while sliders are limited to less than half of the window area.

#### 4.2.2. Sliding Windows

Sliders are the most common type of windows and include horizontal sliders and single-hung and doublehung windows. Ventilation area can vary from a small crack to an opening of one-half the total glass area. Screens can be placed on the exterior or interior of the window unit.

In double-hung or double-sliding units, both sashes can slide. In double-sliding units, the same net amount of glass area can be opened for ventilation as in single sliders, but it can be split between the top and bottom or two ends of the window for better control of the air flow.

## 4.2.3. Sliding Glass Doors

Sliding glass doors (patio doors) are essentially big sliding windows. As extremely large expanses of glass, patio doors exaggerate all of the issues related to comfort and energy performance. Since the proportion of glass to frame is very high for a glass sliding door, the selection of high-performance glass can have significant benefits.

## 4.2.4. French Doors and Folding Patio Doors

French doors and folding glazed doors are growing in popularity. A basic double French door consists of two hinged doors with no center mullion, resulting in a 1.5 to 1.8 m (5- to 6-foot) wide opening. Folding doors are typically made of pairs of hinged doors, so that a double folding door with two pairs of doors can create an opening of 3.7 m (12 feet) or more.

#### 4.2.5. Skylights and Roof Windows

The vast majority of skylights are permanently fixed in place, mounted on a curb above a flat or sloped roof. However, hatch-style skylights that can be opened with an extended crank, push latch, or remote control motor are becoming more common. Some skylights have a domed profile made of one or two layers of tinted or diffusing plastic.

A roof window is a hybrid between a skylight and a standard window. They have become increasingly popular as homeowners and designers seek to better utilize space in smaller houses by creating habitable rooms under sloping roofs. They are glazed with glass rather than plastic and are available with most of the glazing and solar control options of standard windows. Both fixed and operable versions are available, and the operable roof windows can be opened manually or by a motorized system. In addition, some manufacturers offer special venting mechanisms that allow some ventilation air flow without actually opening the window. Operable skylights or vents allow hot air that rises to the ceiling level to be effectively exhausted from the space.

Skylights and roof windows present a special case for insulating around windows because they are typically set into the thickest, most heavily insulated framing in the house, and they must also meet much more stringent conditions for shedding water. In order to create a positive water flow around them, skylights are commonly mounted on "curbs" set above the roof plane. These curbs, rising 15 to 30 centimeters (6 to 12

inches) above the roof, create additional heat loss surfaces, right where the warmest air of the house tends to collect. Ideally, they should be insulated to the same level as the roof. In practice, it is often difficult to achieve insulation levels much above R-11. Some manufacturers provide curbs prefabricated out of a rigid insulating foam, which can be further insulated at the site.

Roof windows, mounted in a sloping roof, often include a metal flashing system. If this metal flashing is in contact with a metal window frame, it can create additional surfaces for conducting heat. Thus, as with thermally broken aluminum windows, care should be taken to ensure a thermal separation between the cold outer metal surfaces and metal parts of the window frame that are exposed to the warm interior air.

## 4.3 Performance Implications of Basic Fenestration Types

There are subtle performance differences between a fixed and operable fenestration product that fills an identical rough opening. The fixed unit will typically have a smaller fraction of frame and proportionately more glass than the similar operable unit. Thus, fixed products with high-performance glass will have a better, lower U-factor, but a higher SHGC due to a smaller frame area and larger glass area. Fixed products have very low infiltration rates, but then they also do not provide natural ventilation and do not satisfy building code requirements for fire egress.

For operating fenestration products, the type of operation has little direct effect on the U-factor or SHGC of the unit, but it can have a significant effect on the air infiltration and ventilation characteristics. Operation can be broken into two basic types: sliding products and hinged products. The comments below are a general characterization of American fenestration products; however, they may not apply to a specific product made by a given manufacturer.

#### 4.3.1. Hinged Windows

Hinged windows such as casements, awnings, and hoppers generally have lower air leakage rates than sliding windows from the same manufacturer because the sash closes by pressing against the frame, permitting the use of more effective compression-type weatherstripping. In most types, the sash swings closed from the outside, so that additional external wind pressure tends to push the sash more tightly shut. Hinged windows require a strong frame to encase and support the projecting sash. Also, because projecting-type sashes must be strong enough to swing out and still resist wind forces, the stiffer window units do not flex as readily in the wind. In addition, hinged windows have locking mechanisms that force the sash against the weatherstripping to maximize compression. These design details tend to reduce air infiltration of hinged windows in comparison to sliders.

## 4.3.2. Sliding Windows

Sliding windows, whether single-hung, double-hung, or horizontal sliders, generally have higher air leakage rates than projecting or hinged windows. Sliding windows typically use a brush-type weatherstripping that allows the sash to slide past. This type is generally less effective than the compression gaskets found in projecting windows. The weatherstrip effectiveness also tends to be reduced over time due to wear and tear from repeated movement of the sliding sash. The frames and sashes of sliding units can be made with lighter, less rigid frame sections since they only need to support their own weight. This lightness may permit the sliding frames to flex and can allow more air leakage under windy conditions. Manufacturers can choose to engineer greater stiffness in their products by design and material selection.

Slider window performance can also be improved with latching mechanisms that compress the sash to the fixed frame and by the addition of compression weatherstripping at the head and sill of double-hung windows or the end jamb of horizontal sliders.

#### 4.3.3. Sliding Glass and French Doors

As previously noted, sliding doors are essentially big sliding windows. However, they are more complicated because of their size and weight and because the sill is also a door threshold, which must keep water out while allowing easy passage of people and objects. The threshold is typically the most difficult part of the frame to weatherstrip effectively.

French doors benefit from being much more like traditional doors than sliding doors. French doors can use weatherstripping and operating hardware designed for similar non-glazed doors. However, when there are large openings with multiple hinged doors, it is more difficult to positively seal the joints between door leaves and to create the stiffness that will resist infiltration.

## 4.4 Frame Materials

The material used to manufacture the frame governs the physical characteristics of the fenestration product, such as frame thickness, weight, and durability, but it also has a major impact on the thermal characteristics of the product. Increasingly, manufacturers are producing hybrid or composite sash and frames, in which multiple materials are selected and combined to best meet the overall required performance parameters. Thus, a simple inspection of the inner or outer surface of the frame is no longer an accurate indicator of the total material or its performance. Since the sash and frame represent from 10 to 30 percent of the total area of the fenestration unit, the frame properties will significantly influence the total product performance.

#### 4.4.1. Wood Frames

Wood fenestration products are manufactured in all configurations, from sliders to swinging windows. Wood is favored in many residential applications because of its appearance and traditional place in house design.

A variation of the wooden product is to clad the exterior face of the frame with either vinyl or aluminum, creating a permanent weather-resistant surface. Clad frames thus have lower maintenance requirements, while retaining the attractive wood finish on the interior.

From a thermal point of view, wood-framed products perform well. The thicker the wood frame, the more insulation it provides. Wood-framed fenestration products typically exhibit low heat loss rates.

However, metal cladding, metal hardware, or the metal reinforcing often used at corner joints can degrade the thermal performance of wood frames. If the metal extends through the fenestration product from the cold side to the warm side of the frame, it creates a thermal short circuit, conducting heat more quickly through that section of the frame.

## 4.4.2. Aluminum Frames

The biggest disadvantage of aluminum as a fenestration product frame material is its high thermal conductance. It readily conducts heat, greatly raising the overall U-factor of a fenestration unit. Because of its high thermal conductance, the thermal resistance of an aluminum frame is determined more by the amount of surface area of the frame than by the thickness or the projected area, as with other frame materials. Thus, an aluminum frame profile with a simple compact shape will perform much better than a profile with many fins and undulations.

In cold climates, a simple aluminum frame can easily become cold enough to condense moisture or frost on the inside surfaces of fenestration product frames. Even more than the problem of heat loss, the condensation problem spurred development of a more insulating aluminum frame.

The most common solution to the heat conduction problem of aluminum frames is to provide a "thermal break" by splitting the frame components into interior and exterior pieces and use a less conductive material to join them. There are many designs available for thermally broken aluminum frames. The most prevalent

technique used in residential fenestration products is called "pouring and debridging." The frame is first extruded as a single piece with a hollow trough in the middle. This is filled with a plastic that hardens into a strong intermediate piece. The connecting piece of aluminum is then milled out, leaving only the plastic to join the two halves of aluminum. Functionally, the resulting piece is cut, mitered, and assembled like a simple aluminum extrusion. Thermally, the plastic slows the heat flow between the inside and outside. There are other manufacturing techniques for producing a thermal break (such as crimped-in-place polymer strips), but the thermal results are similar.

#### 4.4.3. Vinyl Frames

Plastics are relative newcomers as fenestration product frame materials in North America. Vinyl, also known as polyvinyl chloride (PVC), is a versatile material with good insulating value.

The thermal performance of vinyl frames is roughly comparable to wood. Large hollow chambers within the frame can allow unwanted heat transfer through convection currents. Creating smaller cells within the frame reduces this convection exchange, as does adding an insulating material. Most manufacturers are conducting research and development to improve the insulating value of their vinyl fenestration product assemblies.

#### 4.4.4. Fiberglass and Engineered Thermoplastics

In addition to vinyl fenestration products two other polymer-based technologies have become available, fiberglass and thermoplastics. Frames can be made of glass-fiber-reinforced polyester, or fiberglass, which is pultruded into lineal forms and then assembled into fenestration products. These frames are dimensionally stable and have good insulating value by incorporating air cavities (similar to vinyl).

#### 4.4.5. Wood Composites

Most people are familiar with composite wood products, such as particle board and laminated strand lumber, in which wood particles and resins are compressed to form a strong composite material. The wood fenestration product industry has now taken this a step further by creating a new generation of wood/polymer composites that are extruded into a series of lineal shapes for frame and sash members. These composites are stable, and have the same or better structural and thermal properties as conventional wood, with better moisture resistance and more decay resistance. They can be textured and stained or painted much like wood. They were initially used in critical elements, such as sills and thresholds in sliding patio doors, but are now being used for entire units. This approach has the added environmental advantage of reusing a volume of sawdust and wood scrap that would otherwise be discarded.

#### 4.4.6. Hybrid and Composite Frames

Manufacturers are increasingly turning to hybrid frame designs that use two or more of the frame materials described above to produce a complete fenestration product system. The wood industry has long built vinyland aluminum-clad products to reduce exterior maintenance needs. Vinyl manufacturers and others offer interior wood veneers to produce the finish and appearance that many homeowners desire. Split-sash designs may have an interior wood element bonded to an exterior fiberglass element.

## 4.5 Basic Glazing Materials

Two basic materials are used for fenestration product glazing: glass, which is by far the most common, and plastics, which have many specialized applications.

## 4.5.1. Glass

Traditionally, fenestration products have been made of clear glass. Most residential-grade clear glass today is produced with the float technique in which the glass is "floated" over a bed of molten tin. This provides extremely flat surfaces, uniform thicknesses, and few if any visual distortions. The glass has a slight greenish cast, due to iron impurities, but this is generally not noticeable except from the edge. An even higher-quality glass with reduced iron content eliminates the greenness and also provides a higher solar energy transmittance. This is commonly called "water-white glass."

Obscure glasses still transmit most of the light but break up the view in order to provide privacy. This effect is generally achieved either with decorative embossed patterns or with a frosted surface that scatters the light rays.

By adding various chemicals to glass as it is made, glass can be produced in a wide variety of colors. Glass colors are typically given trade names, but the most frequently used colors can be generally described as clear, bronze, gray, and blue-green. After clear glass, the gray glasses are most commonly used in residential construction, as they have the least effect on the perceived color of the light. Tinted glass is discussed later in this chapter.

The mechanical properties of glass can be altered, as well as its basic composition and surface properties. Heat-strengthening and tempering make glass more resistant to breakage. Heat-strengthened glass is about twice as strong as standard glass. Tempered glass is produced by reheating and then quickly chilling the glass. It breaks into small fragments, rather than into long, possibly dangerous shards. Laminated glass is a sandwich of two outer layers of glass with a plastic inner layer that holds the glass pieces together in the event of breakage. Fully tempered and laminated glass is required by building codes in many door and fenestration product applications.

## 4.5.2. Plastics

Several plastic materials have been adapted for use as glazing materials. Their primary uses are fenestration products with special requirements and skylights.

The following list of plastic glazing materials covers the major types of plastic glazing materials and compares their general properties:

- Clear acrylic is widely available and relatively inexpensive. It is available in various tints and colors. It
  has excellent visible light transmittance and longevity. However, it is softer than glass, which makes it
  vulnerable to scratching.
- Frosted acrylic is like clear acrylic, except that it diffuses light and obscures the view. It comes in varying degrees of light transmittance. Most bubble skylights are made of frosted acrylic.
- Clear polycarbonate is like acrylic sheet, but it is harder and tougher, offering greater resistance to scratching and breakage. It is more expensive than acrylic.
- Fiber-reinforced plastic is a tough, translucent, flexible sheet material with good light-diffusing properties. Short lengths of fiberglass are embedded in a polymer matrix to form flat or ribbed sheets. Stiff, insulating, translucent panels are created by bonding double layers to a metal frame and adding fiberglass insulation. It is also formed into corrugated sheets as a translucent roofing material. Surface erosion may shorten its useful life.
- Extruded multicell sheet, usually made with acrylic or polycarbonate plastic, is a transparent or tinted plastic extruded into a double- or triple-wall sheet with divider webs for stiffness, insulating value, and light diffusion.
- Polyester is a thin film used to carry specialized coatings and/or to divide the air space between two layers of glass into multiple air spaces. Highly transparent, it is protected from abuse and weathering by

the two exterior glass layers. It can also be used in tinted or coated forms as film that is glued to the inner surface of existing fenestration products for retrofitting applications.

## 4.6 Improved Glazing Products

There are three fundamental approaches to improving the energy performance of glazing products:

- 1. Alter the glazing material itself by changing its chemical composition or physical characteristics. An example of this is tinted glazing. The glazing material can also be altered by creating a laminated glazing.
- 2. Apply a coating to the glazing material surface. Reflective coatings and films were developed to reduce heat gain and glare, and more recently, low-emittance and spectrally selective coatings have been developed to improve both heating and cooling season performance.
- 3. Assemble various layers of glazing and control the properties of the spaces between the layers. These strategies include the use of two or more panes or films, low-conductance gas fills between the layers, and thermally improved edge spacers.

Two or more of these approaches may be combined. Each of these improvements to the glazing is discussed below

#### 4.6.1. Tinted Glazing

Both plastic and glass materials are available in a large number of tints. The tints absorb a portion of the light and solar heat. Tinting changes the color of the fenestration product.

Tinted glazings retain their transparency from the inside, so that the outward view is unobstructed. The most common colors are neutral gray, bronze, and blue-green, which do not greatly alter the perceived color of the view and tend to blend well with other architectural colors. Many other specialty colors are available for particular aesthetic purposes.

Tinted glass is made by altering the chemical formulation of the glass with special additives. Its color changes with the thickness of the glass and the addition of coatings applied after manufacture. Every change in color or combination of different glass types affects transmittance, solar heat gain coefficient, reflectivity, and other properties. Glass manufacturers list these properties for every color, thickness, and assembly of glass type they produce.

Tinted glazings are specially formulated to maximize their absorption across some or all of the solar spectrum and are often referred to as "heat-absorbing." All of the absorbed solar energy is initially transformed into heat within the glass, thus raising the glass temperature. Depending upon climatic conditions, up to 50 percent of the heat absorbed in a single layer of tinted glass may then be transferred via radiation and convection to the inside. Thus, there may be only a modest reduction in overall solar heat gain compared to other glazings.

There are two categories of tinted glazing: the traditional tints that diminish light as well as heat gain, and spectrally selective tints that reduce heat gain but allow more light to be transmitted to the interior. The traditional tinted glazing often forces a trade-off between visible light and solar gain. For these bronze and gray tints, there is a greater reduction in visible light transmittance than there is in solar heat gain coefficient. This can reduce glare by reducing the apparent brightness of the glass surface, but it also reduces the amount of daylight entering the room.

To address the problem of reducing daylight with traditional tinted glazing, glass manufacturers have developed new types of tinted glass that are "spectrally selective." They preferentially transmit the daylight portion of the solar spectrum but absorb the near-infrared part of sunlight. This is accomplished by adding special chemicals to the float glass process. Like other tinted glass, they are durable and can be used in both monolithic and multiple-glazed fenestration product applications. These glazings have a light blue or green

tint and have visible transmittance values higher than conventional bronze- or gray-tinted glass, but have lower solar heat gain coefficients. Because they are absorptive, they are best used as the outside glazing in a double-glazed unit. They can also be combined with Low-E coatings to enhance their performance further.

## 4.6.2. Reflective Coatings and Films

As the solar heat gain is lowered in single-pane tinted glazings, the visible light transmission drops even faster, and there are practical limits on how low the solar heat gain can be made using tints. If larger reductions are desired, a reflective coating can be used to lower the solar heat gain coefficient by increasing the surface reflectivity of the material. These coatings usually consist of thin metallic layers. The reflective coatings come in various metallic colors (silver, gold, bronze), and they can be applied to clear or tinted glazing (the substrate). The solar heat gain of the substrate can be reduced a little or a lot, depending on the thickness and reflectivity of the coating, and its location on the glass.

As with tinted glazing, the visible light transmittances of reflective glazings are usually reduced substantially more than the solar heat gain.

#### 4.6.3. Double Glazing

Storm windows added onto the outside of window frames during the stormy winter season were the first double-glazed fenestration products. They reduce infiltration from winter winds by providing a seal around all the operating sash and they improve the insulating value of the glazing as well.

When manufacturers began to experiment with factory-sealed, double-pane glass to be installed for yearround use, they encountered a number of technical concerns, such as how to allow for different thermal movement between the two panes, how to prevent moisture from forming between the panes and condensing on an inaccessible surface, and how to allow for changes in atmospheric pressure as the assembly was moved from factory to installation site. These issues have been successfully addressed over the years with a variety of manufacturing techniques and material selections.

When double-glass units first came on the market, the two glass layers were often fused around the perimeter to make a permanently sealed air space. In recent years, however, spacers and polymer sealants have largely replaced glass-to-glass seals, and have proven sufficiently durable for residential applications. The layers of glass are separated by and adhere to a spacer, and the sealant, which forms a gas and moisture barrier, is applied around the entire perimeter. Normally, the spacer contains a desiccant material to absorb any residual moisture that may remain in the air space after manufacture. Sealed insulating glass units are now a mature, well proven technology. Designs utilizing high-quality sealants and manufactured with good quality control should last for decades without seal failure.

## 4.6.4. Glass Coatings and Tints in Double Glazing

Both solar reflective coatings and tints on double-glazed fenestration products are effective in reducing summer heat gain; however, only certain coatings contribute to reducing winter heat loss, and tints do not affect the heat loss rates at all. It is possible to provide reflective coatings on any one of the four surfaces, although they are usually located on the outermost surface or on the surfaces facing the air space. Coating location can also depend on the type of coating. Some vacuum-deposited reflective coatings must be placed in a sealed air space because they would not survive exposure to outdoor elements, finger prints, or cleaning agents. Pyrolytic coatings that are created with a high-temperature process as the glass is formed are extremely hard and durable and can be placed anywhere. Each location produces a different visual and heat transfer effect. Other advanced coatings such as low-emittance and spectrally selective coatings are normally applied to double-glazed or triple-glazed fenestration products. These applications are discussed later in this chapter.

Double-pane units can be assembled using different glass types for the inner and outer layers. Typically, the inner layer is standard clear glass, while the outer layer can be tinted, reflective, or both. The solar heat gain coefficient is reduced because the tinted glass and clear glass both reduce transmitted radiation. In addition, this design further reduces solar heat gain because the inner clear glass, the gas fill, and any Low-E coating keep much of the heat absorbed by the outer glass from entering the building interior.

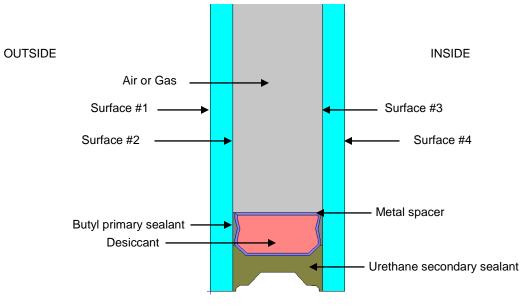


Figure 4-2. Insulating Glass Unit (IGU).

### 4.6.5. Gap Width in Multiple Glazed Units

Fenestration product manufacturers have some flexibility to reduce heat transfer by selecting the best gap width between two or more glazings. The air space between two pieces of glass reaches its optimum insulating value at about 1/2-inch (12 mm) thickness when filled with air or argon. As the gap gets larger, convection in the gap increases and slowly increases heat transfer. Below 3/8 inch (9 mm), conduction through the air gap increases and the U-factor rises more rapidly. Krypton gas has its optimum thickness at about 1/4 inch (6 mm), so that if smaller gas gaps are required, for example in a three-layer fenestration product whose overall exterior dimensions are limited, krypton may be the best selection, although it is also more costly.

### 4.6.6. Divided Lights

Manufacturers have been struggling with the problem of many homeowners' preference for traditional, divided light fenestration products, which have many small panes separated by thin bars called muntins. With single-pane glass, true divided lights actually improved the thermal performance of the fenestration product because the wood muntins had a higher insulating value than the glass. Some manufacturers have introduced "true divided light" insulated units, in which traditional-looking muntins hold small, individual, insulated panes. However, these are expensive and difficult to fabricate with insulated glass and have greater thermal losses due to the number of edges, which now have metal in them.

A second option is to produce a single, large sealed glass unit with "muntins" glued to the inside and outside surfaces, while a grid is placed in the middle of one large insulated unit, giving the visual effect of divided lights. This reduces fabrication costs but does not reduce resistance to heat flow if the muntins in the middle are metal and if they touch both lights of glass.

A third option, which is more energy efficient, is to build a large-pane insulated unit that has snap-on or glued-on grilles to simulate the traditional lights.

The energy performance of the simple snap-on grid will be similar to a unit without any mullions; however, the true divided lights will result in greater heat transfer because of the additional edges.

### 4.6.7. Special Products

Evacuated glazing units (EGU) or vacuum insulating glazing (VIG) are an emerging technology developed as a concept some 20-30 years ago, but only now approaching wide-spread commercialization and acceptance. EGU is therefore an active and rapidly changing area of research. EGU for residential and commercial use is a promising technology capable of meeting the rigorous thermal performance requirements of net-zero energy windows. These products can be modeled in WINDOW. See the windows.lbl.gov Research web page for more information about this technology.

Glass blocks present a very special case of double glazing. They provide light with some degree of visual privacy. Plastic blocks, which have a lower U-factor than glass, are also available. However, when installed, the necessary grouting reduces the energy efficiency. Also, metal mesh and steel reinforcing bars, used between blocks to provide structural stability, provide thermal bridges which also reduce energy efficiency.

Plastic glazings are available in a number of configurations with double layers. Double-glazed acrylic bubble skylights are formed with two layers separated by an air space of varying thickness, ranging from no separation at the edges to as much as 3 inches (7.6 cm) at the top of the bubble. The average separation is used to calculate the effective U-factor.

Multicell polycarbonate sheets, which can be mounted with the divider webs running vertically or horizontally, are available. The divider webs increase the effective insulating value of the glazing by reducing convection exchange within the cells, especially when they are mounted horizontally.

#### 4.6.8. Multiple Panes or Films

By adding a second pane, the insulating value of the fenestration product glass alone is doubled (the U-factor is reduced by half). As expected, adding a third or fourth pane of glass further increases the insulating value of the fenestration product, but with diminishing effect.

Triple- and quadruple-glazed fenestration products became commercially available in the 1980s as a response to the desire for more energy-efficient products. There is a trade-off with this approach, however. As each additional layer of glass adds to the insulating value of the assembly, it also reduces the visible light transmission and the solar heat gain coefficient, thereby reducing the fenestration product's value for providing solar gains or daylighting. In addition, other complications are encountered. Additional panes of glass increase the weight of the unit, which makes mounting and handling more difficult and transportation more expensive.

Because of the difficulties discussed above, it is apparent there are physical and economic limits to the number of layers of glass that can be added to a fenestration product assembly. However, multiple-pane units are not limited to assemblies of glass. One popular innovation is based on substituting an inner plastic film for the middle layer of glass. The plastic film is very lightweight, and because it is very thin, it does not increase the thickness of the unit. The glass layers protect the inner layer of plastic from scratching, mechanical abuse, corrosion, weathering, and visual distortions caused by wind pressure. Thus, the strength and durability of plastic as a glazing material are no longer issues when the plastic is protected from physical abuse and weathering by inner and outer layers of glass. The plastic films are specially treated to resist UV degradation and they are heat shrunk so they remain flat under all conditions.

The plastic inner layer serves a number of important functions. It decreases the U-factor of the fenestration product assembly by dividing the inner air space into multiple chambers. Units are offered with one or two

inner layers of plastic. Secondly, a Low-E coating can be placed on the plastic film itself to further lower the U-factor of the assembly. Also, the plastic film can be provided with spectrally selective coatings to reduce solar gain in hot climates without significant loss of visible transmittance. The performance of multiple-pane fenestration product assemblies with low-emittance coatings and gas fills is described in the following sections.

#### 4.6.9. Low-Emittance Coatings

The principal mechanism of heat transfer in multilayer glazing is thermal radiation from a warm pane of glass to a cooler pane. Coating a glass surface with a low-emittance material and facing that coating into the gap between the glass layers blocks a significant amount of this radiant heat transfer, thus lowering the total heat flow through the fenestration product. The improvement in insulating value due to the Low-E coating is roughly equivalent to adding another pane of glass to a multipane unit.

The solar spectral reflectances of Low-E coatings can be manipulated to include specific parts of the visible and infrared spectrum. A glazing material can then be designed to optimize energy flows for solar heating, daylighting, and cooling.

With conventional clear glazing, a significant amount of solar radiation passes through the fenestration product, and then heat from objects within the house is reradiated back through the fenestration product. For example, a glazing design for maximizing solar gains in the winter would ideally allow all of the solar spectrum to pass through, but would block the reradiation of heat from the inside of the house. The first Low-E coatings were designed to have a high solar heat gain coefficient and a high visible transmittance to transmit the maximum amount of sunlight into the interior while reducing the U-factor significantly.

A glazing designed to minimize summer heat gains but allow for some daylighting would allow visible light through, but would block all other portions of the solar spectrum, including ultraviolet light and nearinfrared, as well as long-wave heat radiated from outside objects, such as paving and adjacent buildings, as shown in Figure 2-3. These second-generation Low-E coatings were designed to reflect the solar nearinfrared, thus reducing the total solar heat gain coefficient while maintaining high levels of light transmission. Variations on this design (modified coatings and/or glazings) can further reduce summer solar heat gain and control glare.

There are three basic types of Low-E coatings available on the market today:

#### 1. High-transmission Low-E:

These Low-E glass products are often referred to as pyrolitic or hard coat Low-E glass, due to the glass coating process. The properties presented here are typical of a Low-E glass product designed to reduce heat loss but admit solar gain.

#### 2. Moderate-transmission Low-E:

These Low-E glass products are often referred to as sputtered (or soft-coat products) due to the glass coating process. (Note: Low solar gain Low-E products are also sputtered coatings.) Such coatings reduce heat loss and let in a reasonable amount of solar gain.

#### 3. Low-transmission Low-E:

These Low-E products are often referred to as sputtered (or soft-coat) due to the glass coating process. (Note: Moderate solar gain Low-E products are also sputtered coatings.) This type of Low-E product, sometimes called spectrally selective Low-E glass, reduces heat loss in winter but also reduces heat gain in summer. Compared to most tinted and reflective glazings, this Low-E glass provides a higher level of visible light transmission for a given amount of solar heat reduction.

The type and quality of Low-E coating will affect not only the U-factor, but also the transmittance and solar heat gain coefficient of a glass. All these properties (U-factor, VT, and SHGC) need to be taken into consideration in characterizing a particular glazing product.

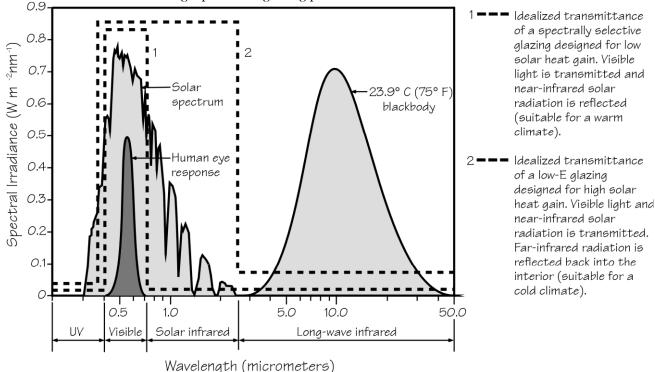


Figure 4-3. Ideal spectral transmittance for glazings in different climates. (Source: "Sensitivity of Fenestration Solar Gain to Source Spectrum and Angle of Incidence." ASHRAE Transactions 10, R. McCluney, June 1996).

### 4.6.9.1. Coating Placement

The placement of a Low-E coating within the air gap of a double-glazed fenestration product does not significantly affect the U-factor but it does influence the solar heat gain coefficient (SHGC). That is why, in heating-dominated climates, placing a Low-E coating on the #3 surface (outside surface of the inner pane) is recommended to maximize winter passive solar gain at the expense of a slight reduction in the ability to control summer heat gain. In cooling climates, a coating on the #2 surface (inside surface of the outer pane) is generally best to reduce solar heat gain and maximize energy efficiency. Manufacturers sometimes place the coatings on other surfaces (e.g., #2 surface in a heating climate) for other reasons, such as minimizing the potential for thermal stress. Multiple Low-E coatings are also placed on surfaces within a triple-glazed fenestration product assembly, or on the inner plastic glazing layers of multipane assemblies referred to as superwindows (discussed later in this chapter), with a cumulative effect of further improving the overall U-factor.

## 4.6.9.2. Coating Types

There are two basic types of Low-E coatings – sputtered and pyrolytic, referring to the process by which they are made. The best of each type of coating is colorless and optically clear. Some coatings may have a slight hue or subtle reflective quality, particularly when viewed in certain lighting conditions or at oblique angles.

A sputtered coating is multilayered (typically, three primary layers, with at least one layer of metal) and is deposited on glass or plastic film in a vacuum chamber. The total thickness of a sputtered coating is only 1/10,000 of the thickness of a human hair. Sputtered coatings often use a silver layer and must be protected

from humidity and contact. For this reason they are sometimes referred to as "soft coats." Since sputtering is a low-temperature process, these coatings can be deposited on flat sheets of glass or thin plastic films. While sputtered coatings are not durable in themselves, when placed into a sealed double- or triple-glazed assembly they should last as long as the sealed glass unit. Sputtered coatings typically have lower emittances than pyrolytic coatings. They are available commercially with emittance ratings of e = 0.10 to as low as e = 0.02 (e =0.20 means that 80 percent of the long-wavelength radiant energy received by the surface is reflected, while e = 0.02 means 98 percent is reflected). For uncoated glass, e = 0.84, which means only 16 percent of the radiant energy received by the surface is reflected.

A typical pyrolytic coating is a metallic oxide, most commonly tin oxide with some additives, which is deposited directly onto a glass surface while it is still hot. The result is a baked-on surface layer that is quite hard and thus very durable, which is why this is sometimes referred to as a "hard coat." A pyrolytic coating can be ten to twenty times thicker than a sputtered coating but is still extremely thin. Pyrolytic coatings can be exposed to air, cleaned with normal cleaning products, and subjected to general wear and tear without losing their Low-E properties.

Because of their greater durability, pyrolytic coatings are available on single-pane glass and separate storm windows, but not on plastics, since they require a high-temperature process. In general, though, pyrolytic coatings are used in sealed, double-glazed units with the Low-E surface inside the sealed air space. While there is considerable variation in the specific properties of these coatings, they typically have emittance ratings in the range of e = 0.20 to e = 0.10.

A laminated glass with a spectrally selective Low-E sputtered coating on plastic film sandwiched between two layers of glass offers the energy performance of single-pane, spectrally selective glass and the safety protection of laminated glass. However, in this configuration, since the Low-E surface is not exposed to an air space, there is no effect on the glazing U-factor.

#### 4.6.10. Gas Fills

Another improvement that can be made to the thermal performance of insulating glazing units is to reduce the conductance of the air space between the layers. Originally, the space was filled with air or flushed with dry nitrogen just prior to sealing. In a sealed glass insulating unit air currents between the two panes of glazing carry heat to the top of the unit and settle into cold pools at the bottom. Filling the space with a less conductive gas minimizes overall transfer of heat between two glass layers.

Manufacturers have introduced the use of argon and krypton gas fills, with measurable improvement in thermal performance. Argon is inexpensive, nontoxic, nonreactive, clear, and odorless. The optimal spacing for an argon-filled unit is the same as for air, about 1/2 inch (12 mm). Krypton has better thermal performance, but is more expensive to produce. Krypton is particularly useful when the space between glazings must be thinner than normally desired, for example, 1/4 inch (6 mm). A mixture of krypton and argon gases is also used as a compromise between thermal performance and cost.

Filling the sealed unit completely with argon or krypton presents challenges that manufacturers continue to work on. A typical gas fill system adds the gas into the cavity with a pipe inserted through a hole at the edge of the unit. As the gas is pumped in, it mixes with the air, making it difficult to achieve 100 percent purity. Recent research indicates that 90 percent is the typical concentration achieved by manufacturers today. Some manufacturers are able to consistently achieve better than 95 percent gas fill by using a vacuum chamber. An uncoated double-pane unit filled with 90 percent argon gas and 10 percent air yields a slightly more than 5 percent improvement in the insulating value at the center of the glass, compared to the same unit filled with air. However, when argon and krypton fills are combined with Low-E coatings and multipane glazings, more significant reductions of 15 to 20 percent can be achieved. Since the Low-E coating has substantially reduced the radiation component of heat loss, the gas fill now has a greater proportional effect on the remaining heat transfer by convection and conduction.

# 4.7 Thermally Improved Edge Spacers

The layers of glazing in an insulating glass (IG) unit must be held apart at the appropriate distance by spacers. The spacer system must provide a number of additional functions in addition to keeping the glass units at the proper dimension:

- accommodate stress induced by thermal expansion and pressure differences;
- provide a moisture barrier that prevents passage of water or water vapor that would fog the unit;
- provide a gas-tight seal that prevents the loss of any special low-conductance gas in the air space;
- create an insulating barrier that reduces the formation of interior condensation at the edge.

Older double-pane wood fenestration products used a wood spacer that could not be hermetically sealed and thus was vented to the outside to reduce fogging in the air gap. Modern versions of this system function well but, because they are not hermetically sealed, cannot be used with special gas fills or some types of Low-E coatings. Early glass units were often fabricated with an integral welded glass-to-glass seal. These units did not leak but were difficult and costly to fabricate, and typically had a less-than-optimal narrow spacing. The standard solution for insulating glass units (IGUs) that accompanied the tremendous increase in market share of insulating glass in the 1980s was the use of metal spacers, and sealants. These spacers, typically aluminum, also contain a desiccant that absorbs residual moisture. The spacer is sealed to the two glass layers with organic sealants that both provide structural support and act as a moisture barrier. There are two generic systems for such IGUs: a single-seal spacer and a double-seal system.

In the single-seal system , an organic sealant, typically a butyl material, is applied behind the spacer and serves both to hold the unit together and to prevent moisture intrusion. These seals are normally not adequate to contain special low-conductance gases.

In a double-seal system , a primary sealant, typically butyl, seals the spacer to the glass to prevent moisture migration and gas loss, and a secondary backing sealant, often silicone, provides structural strength. When sputtered Low-E coatings are used with double-seal systems, the coating must be removed from the edge first ("edge deletion") to provide a better edge seal.

Since aluminum is an excellent conductor of heat, the aluminum spacer used in most standard edge systems represented a significant thermal "short circuit" at the edge of the IGU, which reduces the benefits of improved glazings. As the industry has switched from standard double-glazed IGUs to units with Low-E coatings and gas fills, the effect of this edge loss becomes even more pronounced. Under winter conditions, the typical aluminum spacer would increase the U-factor of a Low-E, gas fill unit slightly more than it would increase the U-factor of a standard double-glazed IGU. The smaller the glass area, the larger the effect of the edge on the overall product properties. In addition to the increased heat loss, the colder edge is more prone to condensation.

Fenestration product manufacturers have developed a series of innovative edge systems to address these problems, including solutions that depend on material substitutions as well as radically new designs. One approach to reducing heat loss has been to replace the aluminum spacer with a metal that is less conductive, e.g., stainless steel, and change the cross-sectional shape of the spacer. Another approach is to replace the metal with a design that uses materials that are better insulating. The most commonly used design incorporates spacer, sealer, and desiccant in a single tape element. The tape includes a solid, extruded thermoplastic compound that contains a blend of desiccant materials and incorporates a thin, fluted metal shim of aluminum or stainless steel. Another approach uses an insulating silicone foam spacer that incorporates a desiccant and has a high-strength adhesive at its edges to bond to glass. The foam is backed with a secondary sealant. Both extruded vinyl and pultruded fiberglass spacers have also been used in place of metal designs.

There are several hybrid designs that incorporate thermal breaks in metal spacers or use one or more of the elements described above. Some of these are specifically designed to accommodate three- and four-layer glazings or IGUs incorporating stretched plastic films. All are designed to interrupt the heat transfer pathway at the glazing edge between two or more glazing layers.

Warm edge spacers have become increasingly important as manufacturers switch from conventional double glazing to higher-performance glazing. For purposes of determining the overall fenestration product U-factor, the edge spacer has an effect that extends beyond the physical size of the spacer to a band about 63.5 mm (2.5 inches) wide. The contribution of this 63.5 mm (2.5-inch) wide "glass edge" to the total fenestration product U-factor depends on the size of the product. Glass edge effects are more important for smaller fenestration products, which have a proportionately larger glass edge area. For a typical residential-size window (0.8 by 1.2 meters , 3 by 4 feet), changing from a standard aluminum edge to a good-quality warm edge will reduce the overall fenestration product U-factor by 0.01 to 0.02 Btu/hr- ft<sup>2</sup>-°F.

# 4.8 Shading Systems

Window coverings are elements added to existing windows to improve energy performance, reduce glare, provide privacy, or enhance the appearance or comfort of a home. Examples of window coverings include: interior shades and drapes, exterior shades, shutters, and awnings. More examples are shown below in Figure 4-4.

WINDOW and THERM are designed to simulate the thermal performance of many of these shade types. WINDOW and THERM do not currently simulate non-coplanar systems, such as awnings. Shades may be places on the room-side, exterior-side, or between glass panes. Many of these shading types are operable, meaning they may be placed in two or more positions. The overall thermal performance of a shading system is highly dependent on the operation.



Interior louvered blind



Interior solar screen



Exterior solar screen



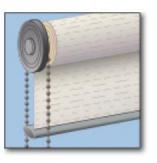
Interior cellular shade



Interior pleated shade



Interior roller shade



Exterior roller shade



Interior window quilt



Exterior roller shutter

Figure 4-4. Shading systems that can be modeled in THERM and WINDOW.

# 5.1. Overview

Much of the information in this chapter is taken from the book *Residential Windows: A Guide to New Technologies and Energy Performance* by John Carmody, Stephen Selkowitz, and Lisa Heschong. Additional information can also be found in the ASHRAE *Handbook of Fundamentals*.

## 5.2 Energy Flow Mechanisms

Overall energy flow through a fenestration product is a function of:

- Temperature Driven Heat Transfer: When there is a temperature difference between inside and outside, heat is lost or gained through the fenestration product frame and glazing by the combined effects of conduction, convection, and radiation. This is indicated in terms of the U-factor of a fenestration assembly.
- Solar Gain: Regardless of outside temperature, heat can be gained through fenestration products by direct or indirect solar radiation. The amount of heat gain through products is measured in terms of the solar heat gain coefficient (SHGC) of the glazing.
- Infiltration: Heat loss and gain also occur by infiltration through cracks in the fenestration assembly. This effect is measured in terms of the amount of air (cubic feet or meters per minute) that passes through a unit area of fenestration product (square foot or meter) under given pressure conditions. In reality, infiltration varies with wind-driven and temperature-driven pressure changes. Infiltration also contributes to summer cooling loads in some climates by raising the interior humidity level.

The 2001 ASHRAE Handbook of Fundamentals contains the following equation for calculating the energy flow through a fenestration product (assuming no humidity difference and excluding air infiltration):

$$q = U_t * A_{pf}(t_{out} - t_{in}) + (SHGC_t * A_{pf} * E_t)$$

[5-1]

Where:

- *q* = instantaneous energy flow, W (Btu/h)
- $U_t$  = overall coefficient of heat transfer (U-factor), W/m<sup>2</sup>-<sup>o</sup>K (Btu/h-ft<sup>2</sup>-<sup>o</sup>F)
- $t_{in}$  = interior air temperature, °C (°F)
- $t_{out}$  = exterior air temperature, °C (°F)
- $A_{pf}$  = Total projected area of fenestration, m<sup>2</sup> (ft<sup>2</sup>)

*SHGC*<sub>t</sub> = overall solar heat gain coefficient, non-dimensional

 $E_t$  = incident total irradiance, W/m<sup>2</sup> (Btu/h-ft<sup>2</sup>)

This equation shows that the properties of U-factor, SHGC, and infiltration are major factors which determine the energy flow through a fenestration product.

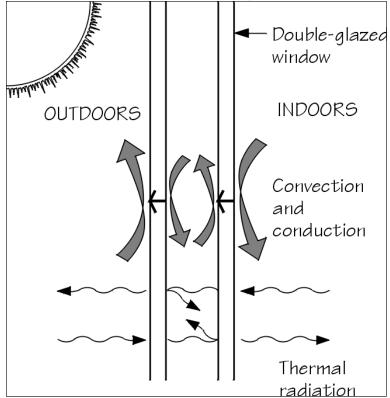
# 5.3 Temperature Driven Heat Transfer

Fenestration product heat loss/gain due to temperature is a combination of three modes of heat transfer:

- 1. Conduction (heat traveling through a solid material, the way a frying pan warms up) through glazing, spacer, and frame elements
- 2. Convection (the transfer of heat by the movement of gases or liquids, like warm air rising from a candle flame) through air layers on the exterior and interior fenestration product surfaces and between glazing layers
- 3. Radiative heat transfer (the movement of heat energy through space without relying on conduction through the air or by movement of the air, the way you feel the heat of a fire) between glazing layers, or between IG units and interior or exterior spaces.

Solar radiation absorbed by glazing layers will contribute to the temperature driven heat transfer, while solar radiation transmitted by the glazing system will be independent of the temperature driven heat transfer. Absorbed solar radiation will partially be transmitted into the conditioned space and will be included in SHGC. These three modes of heat transfer are shown schematically in Figure 5-1. Heat flows from warmer to cooler bodies, thus from inside to outside in winter, and reverses direction in summer during periods when the outside temperature is greater than indoors.

The amount of heat transfer due to these three processes is quantified by its U-factor ( $W/m^2-\circ C$  or  $Btu/h-ft^2-\circ F$ ). The inverse of heat flow, or resistance to heat transfer, is expressed as an R-value.



*Figure 5-1. Mechanisms of heat transfer in a fenestration product.* 

### 5.3.1. Conduction

Compared to a well-insulated wall, heat transfer through a typical older fenestration product is generally much higher. A single-glazed fenestration product has roughly the same insulating qualities as a sheet of

metal – most of the insulating value comes from the air layer on each surface of the glass. Such a product can be considered a thermal hole in a wall and typically has a heat loss rate ten to twenty times that of the wall. A product with such a poor insulating value allows heat to flow out of a space almost unimpeded. If the temperature inside is  $21^{\circ}$ C ( $70^{\circ}$ F) and outside is  $-18^{\circ}$ C ( $0^{\circ}$ F), the glass surface of a single-glazed product would be about  $-8^{\circ}$ C ( $17^{\circ}$ F) – cold enough to form frost on the inside of the glass.

### 5.3.2. Convection

Convection affects the heat transfer in many places in the assembly: the inside glazing surface, the outside glazing surface, inside frame cavities, and inside any air spaces between glazings. A cold interior glazing surface cools the air adjacent to it. This denser cold air then falls to the floor, starting a convection current which is typically perceived as a "draft" caused by leaky fenestration products. One remedy for this situation is to install a product with lower heat loss rates that provides a warmer glass surface.

On the exterior, a component of the heat transfer rate of a fenestration product is the air film against the glazing surface. As wind blows across the product (causing convection), and the insulating value of this air film diminishes which contributes to a higher rate of heat loss. Finally, when there is an air space between layers of glazing, convection currents can facilitate heat transfer through this air layer. By adjusting the space between the panes of glass, as well as choosing a gas fill that insulates better than air, double-glazed fenestration products can be designed to minimize this effect.

#### 5.3.3. Radiation

All objects emit invisible thermal radiation, with warmer objects emitting more than colder ones. Hold your hand in front of an oven window and you will feel the radiant energy emitted by that warm surface. Your hand also radiates heat to the oven window, but since the window is warmer than your hand, the net balance of radiant flow is toward your hand and it is warmed. Now imagine holding your hand close to a single-glazed window in winter. The window surface is much colder than your hand. Each surface emits radiant energy, but since your hand is warmer, it emits more toward the window than it gains and you feel a cooling effect. Thus, a cold glazing surface in a room chills everything else around it.

#### 5.3.4. U-factor

The U-factor is the standard way to quantify insulating value. It indicates the rate of heat flow through the fenestration product. The U-factor is the total heat transfer coefficient of the fenestration system, in W/m<sup>2</sup>-°C (Btu/hr-ft<sup>2</sup>-°F), which includes conductive, convective, and radiative heat transfer for a given set of environmental conditions. It therefore represents the heat flow per hour, in Watts (Btu per hour) through each square meter (square foot) of fenestration product for a 1°C (1°F) temperature difference between the indoor and outdoor air temperature. The smaller the U-factor of a material, the lower the rate of heat flow. The total R-value, which measures thermal resistance, is the reciprocal of the total U-factor (R=1/U).

The U-factor depends on the thermal properties of the materials in the fenestration product assembly, as well as the weather conditions, such as the temperature differential between indoors and outside, and wind speed. NFRC has standardized the exterior conditions (called environmental conditions) for U-factor calculations for product ratings using the following temperatures and wind speeds:

- Wind Speed: 5.5 m/s (12.3 mph)
- Indoor air temperature: 21°C (70°F)
- Outdoor air temperature: -18°C (0°F).

Skylights and roof fenestration products are simulated at a 20 degree slope from horizontal.

### 5.3.4.1. Total Product U-factor

The U-factor of a total fenestration assembly is a combination of the insulating values of the glazing assembly itself, the edge effects that occur in the insulated glazing unit, and the insulating value of the frame and sash.

### 5.3.4.2. Center-of-Glazing U-factor

The U-factor of the glazing portion of the fenestration unit is affected primarily by the total number of glazing layers, the dimension separating the various layers of glazing, the type of gas that fills the separation, and the characteristics of coatings on the various surfaces. The U-factor for the glazing alone is referred to as the center-of-glass U-factor.

### 5.3.4.3. Edge Effects

A U-factor calculation assumes that heat flows perpendicular to the plane of the fenestration product. However, fenestration products are complex three-dimensional assemblies, in which materials and cross sections change in a relatively short space.

For example, metal spacers at the edge of an insulating glass unit have much higher heat flow than the center of the insulating glazing, which causes increased heat loss along the outer edge of the glazing. The relative impact of these "edge effects" becomes more important as the insulating value of the rest of the assembly increases.

### 5.3.4.4. Frames and Sashes

The heat loss through a fenestration product frame can be quite significant: in a typical 1.2 by 0.9 m (4' by 3') double-hung wood frame product, the frame and sash can occupy approximately 30 percent of the product area.

In a frame with a cross section made of one uniform, solid material, the U-factor is based on the conduction of heat through the material. However, hollow frames and composite frames with various reinforcing or cladding materials are more complex. Here, conduction through materials must be combined with convection of the air next to the glazing and radiant exchange between the various surfaces.

Furthermore, frames rarely follow the same cross section around a fenestration product. For example, a horizontal slider has seven different frame cross sections, each with its own rate of heat flow.

#### 5.3.4.5. Overall U-factor

Since the U-factors are different for the glazing, edge-of-glazing zone, and frame, it can be misleading to compare U-factors if they are not carefully described. In order to address this problem, the concept of a total fenestration product U-factor can be calculated in WINDOW and is utilized by many code orgainzations as well as the National Fenestration Rating Council (NFRC), an organization that administers a window certification program in the United States. The default values in WINDOW to calculate the overall U-factor of a fenestration unit are based on the NFRC methodology. In most cases, the overall U-factor is higher than the U-factor for the glazing alone, since the glazing remains superior to the frame in insulating value.

The U-factor of a product is calculated with the product in a vertical position. A change in mounting angle can affect its U-factor.

## 5.4 Solar Heat Gain and Visible Transmittance

The second major energy performance characteristic of fenestration products is the ability to control solar heat gain through the glazing. Solar heat gain through fenestration products tends to be the single most

significant factor in determining the air-conditioning load of a residential building. The intensity of heat gain from solar radiation can greatly surpass heat gain from other sources, such as outdoor air temperature or humidity.

Visible transmittance (VT) is an optical property that indicates the amount of visible light transmitted through the glazing. Although VT does not directly affect heating and cooling energy use, it is used in the evaluation of energy-efficient fenestration products and therefore is discussed following the solar heat gain section.

The origin of solar heat gain is the direct and diffuse radiation coming directly from the sun and the sky or reflected from the ground and other surfaces. Some radiation is directly transmitted through the glazing to the space, and some may be absorbed in the glazing and then indirectly admitted to the space. Sunlight is composed of electromagnetic radiation of many wavelengths, ranging from short-wave invisible ultraviolet, to the visible spectrum, to the longer, invisible near-infrared waves. About half of the sun's energy is visible light; the remainder is largely infrared with a small amount of ultraviolet. This characteristic of sunlight makes it possible to selectively admit or reject different portions of the solar spectrum. While reducing solar radiation through fenestration products is a benefit in some climates and during some seasons, maximizing solar heat gain can be a significant energy benefit under winter conditions. These often conflicting directives can make selection of the "best" product a challenging task. See Section 2.6.9 for a more detailed discussion of these properties of fenestration products.

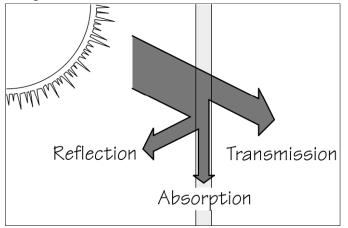


Figure 5-2. A glazing system's properties of reflection, transmission and absorption determine what happens to solar gain.

#### 5.4.1. Determining Solar Heat Gain

There are two means of indicating the amount of solar radiation that passes through a fenestration product. These are solar heat gain coefficient (SHGC) and shading coefficient (SC). In both cases, the solar heat gain is the combination of directly transmitted radiation and the inward-flowing portion of absorbed radiation (Figure 5-3). However, SHGC and SC have a different basis for comparison or reference. SHGC replaces SC because it more correctly accounts for angle-dependent effects. SC represents the ratio of solar heat gain through the system relative to that through 3 mm (1/8-inch) clear glass at normal incidence.

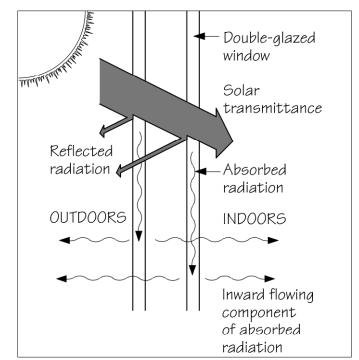


Figure 5-3. A glazing system's properties of reflection, transmission and absorption determine what happens to solar gain.

# 5.4.2. Solar Heat Gain Coefficient (SHGC)

The solar heat gain coefficient (SHGC) represents the solar heat gain through the fenestration system relative to the incident solar radiation. Although SHGC can be determined for any angle of incidence, the default and most commonly used reference is normal incidence solar radiation. The default calculations in WINDOW (which is also required by\_NFRC ratings) for SHGC is at 0° incidence. The SHGC refers to total fenestration product system performance and is an accurate indication of solar gain under a wide range of conditions. SHGC is expressed as a dimensionless number from 0 to 1.0. A high SHGC value signifies high heat gain, while a low value means low heat gain.

### 5.4.3. Visible Transmittance

Visible transmittance is the amount of light in the visible portion of the spectrum that passes through a glazing material. This property does not directly affect heating and cooling loads in a building, but it is an important factor in evaluating energy-efficient fenestration products. Transmittance is influenced by the glazing type, the number of layers, and any coatings that might be applied to the glazings. These effects are discussed in more detail later in this chapter in conjunction with a review of various glazing and coating technologies. Visible transmittance of glazings ranges from above 90 percent for water-white clear glass to less than 10 percent for highly reflective coatings on tinted glass.

Visible transmittance is an important factor in providing daylight, views, and privacy, as well as in controlling glare and fading of interior furnishings. These are often contradictory effects: a high light transmittance is desired for view out at night, but this may create glare at times. These opposing needs are often met by providing glazing that has high visible transmittance and then adding attachments such as shades or blinds to modulate the transmittance to meet changing needs.

When comparing transmittance values between products, it is important to know whether the values becing compared represent the transmittance of the whole product, which include the effect of both glazing and frame (as in the NFRC certification) or of the glazing alone. In the past, products that reduced solar gain (with

tints and coatings) also reduced visible transmittance. However, new spectrally selective tinted glasses and selective coatings have made it possible to reduce solar heat gain with little reduction in visible transmittance.

## 5.5 Condensation Resistance

Condensation has been a persistent and often misunderstood problem associated with windows. In cold climates, single-glazed windows characteristically suffer from water condensation and the formation of frost on the inside surface of the glass in winter. The surface temperature of the glass drops below either the dew point or frost point of the inside room air.

Excessive condensation can contribute to the growth of mold or mildew, damage painted surfaces, and eventually rot wood trim. Since the interior humidity level is a contributing factor, reducing interior humidity is an important component of controlling condensation.

Condensation can also be a problem on the interior surfaces of window frames. Metal frames, in particular, conduct heat very quickly, and will "sweat" or frost up in cool weather. Solving this condensation problem was a major motivation for the development of thermal breaks for aluminum windows.

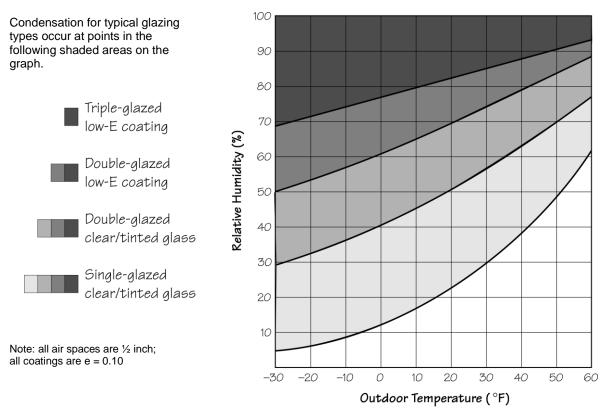
Infiltration effects can also combine with condensation to create problems. If a path exists for warm, moisture-laden air to move through or around the window frames, the moisture will condense wherever it hits its dew point temperature, often inside the building wall. This condensation can contribute to the growth of mold in frames or wall cavities, causing health problems for some people, and it encourages the rotting or rusting of window frames. Frames must be properly sealed within the wall opening to prevent this potential problem. In some instances, the infiltration air will be dry, such as on cold winter days, and it will thus help eliminate condensation on the window surfaces.

Condensation can cause problems in skylights and roof windows as well as typical windows. "Leaky" skylights are frequently misdiagnosed. What are perceived to be drops of water from a leak are more often drops of water condensing on the cold skylight surfaces. A skylight is usually the first place condensation will occur indicating too much moisture in the interior air. Insulating the skylight well and providing adequate air movement assists in reducing condensation. Also, the use of more highly insulating glazing with a well-designed frame can help solve this problem. In many systems, a small "gutter" is formed into the interior frame of the skylight where condensate can collect harmlessly until it evaporates back into the room air.

### 5.5.1. Impact of Glazing Type and Spacers on Condensation

Figure 5-4 indicates condensation potential for four glazing types at various outdoor temperature and indoor relative humidity conditions. Condensation can occur at any points that fall on or above the curves. As the U-factor of windows improves, there is a much smaller range of conditions where condensation will occur. Figure 5-4 must be used with caution, since it shows condensation potential for the center of glazing area only (the area at least 63.5 mm (2.5 inches) from the frame/glazing edge). Usually condensation will first occur at the lower edge of the product where glazing temperatures are lower than in the center.

As Figure 5-4 shows, double-glazed products create a warmer interior glazing surface than single-glazing, reducing frost and condensation. The addition of low-E coatings and argon gas fill further reduce condensation potential. The triple-glazed product with low-E coatings has such a warm interior surface that condensation on any interior surfaces may be eliminated if humidity levels are maintained at reasonable levels.



*Figure 5-4. Condensation potential on glazing (center of glazing) at various outdoor temperature and indoor relative humidity conditions.* 

Condensation forms at the coldest locations, such as the lower corners or edges of an insulated product even when the center of glazing is above the limit for condensation. Generally, as the insulating value of the glazing is improved, the area where condensation can occur is diminished. Condensation potential increases as the outdoor temperature is lowered and the indoor relative humidity increases.

#### 5.5.2. Condensation Resistance

NFRC has developed a Condensation Resistance (CR) value for rating for how well a fenestration product can resist the formation of condensation on the interior surface of the product at a specific set of environmental conditions. The CR calculation method is defined in the *NFRC 500: Procedure for Determining Fenestration Product Condensation Resistance Values.* WINDOW calculates the CR value based on the NFRC assumptions.

#### 5.5.3. Outdoor Condensation

Under some climate conditions, condensation may occur on the exterior glazing surface of a window. This is more likely to occur on higher-performance windows with low-E coatings or films, and low-conductance gas fills that create very low U-factors. By preventing heat from escaping from the interior, the exterior surfaces of the window approach outside air temperature. These exterior temperatures may be below the exterior dew point causing condensation on the exterior glazing surfaces. This is most likely to happen when there is a clear night sky, still air, and high relative humidity, in addition to the right temperature conditions. Like other dew formed at night, exterior window condensation will disappear as surfaces are warmed by the sun. It is the excellent thermal performance of well-insulated glazing that creates the condition where the outer glazing surface can be cold enough to cause condensation to form.

#### 5.5.4. Condensation Between Glazings

A more annoying problem can arise with double-pane windows, which is condensation between the panes. Moisture can migrate into the space between the panes of glass and condense on the colder surface of the exterior pane. This condensation is annoying not only because it clouds the view and stains the interior surfaces, but because it may mean that the glazing unit must be replaced if it is a sealed insulating glazing unit. In a non-sealed unit, simpler remedies may correct the situation.

Factory-sealed insulated glazing utilizes a permanent seal to prevent the introduction of moisture. The void may be filled with air or dry gases, such as argon. A desiccant material in the edge spacer between the panes is used to absorb any residual moisture in the unit when it is fabricated or any small amount that might migrate into the unit over many years. These windows will fog up when moisture leaking into the air space through the seals overwhelms the ability of the desiccant to absorb it. This could happen early in the window's life (the first few years) if there is a manufacturing defect, or many decades later because of diffusion through the sealant. Quality control in manufacture, sealant selection, window design, and even installation can influence the rate of failure. Once a sealed window unit fails, it is not generally possible to fix it, and the sealed unit must be replaced. Moisture in the unit is also likely to reduce the effectiveness of low-E coatings and suggests that gas fills may be leaking out. Most manufacturers offer a warranty against sealed-glazing failure which varies from a limited period to the lifetime of the window.

When condensation occurs between glazings in a non-sealed unit, there are several possible remedies. Most manufacturers who offer non-sealed double glazing include a small tube connecting the air space to the outside air, which tends to be dry during winter months. Check to be sure that the inner glazing seals tightly to the sash, and clear the air tube if it has become obstructed. In some cases, reducing interior room humidity levels may help alleviate the problem.

# 5.6 Infiltration

Infiltration is the leakage of air through cracks in the building envelope. Infiltration leads to increased heating or cooling loads when the outdoor air entering the building needs to be heated or cooled. Fenestration products and doors are typically responsible for a significant amount of the infiltration in homes. In extreme conditions, depending on the type and quality, infiltration can be responsible for as much heat loss or gain as the rest of the product. The level of infiltration depends upon local climate conditions, particularly wind conditions and microclimates surrounding the house. Typically, U-factor and SHCG effects far outweigh infiltration effects. Tight sealing and weatherstripping of the fenestration product, including sash, and frames is of paramount importance in controlling infiltration.

High quality fixed fenestration products help to reduce infiltration because they are easier to seal and keep tight. Operable fenestration products are necessary for ventilation, but they are also more susceptible to air leakage. Operable units with low air leakage rates are characterized by good design and high-quality construction and weatherstripping. They also feature mechanical closures that positively clamp the product shut against the wind. For this reason, compression-seal products such as awning, hopper, and casement designs are generally more effectively weatherstripped than are sliding-seal products. Sliding products rely on wiper-type weatherstripping, which is more subject to wear over time and can be bypassed when it flexes under wind pressure.

# 5.7 Solar Properties of Glazing Materials

Three things happen to solar radiation as it passes through a glazing material. Some is transmitted, some is reflected, and the rest is absorbed. These are the three components of solar that determine many of the other energy performance properties of a glazing material, such as the solar heat gain coefficient and shading. Manipulating the proportion of transmittance, reflectance, and absorptance for different wavelengths of solar radiation has been the source of much recent innovation in fenestration energy performance.

Visible light is a small portion of the electromagnetic spectrum. Beyond the blues and purples lie ultraviolet radiation and other higher-energy short wavelengths, from X rays to gamma rays. Beyond red light are the near-infrared, given off by very hot objects, the far-infrared, given off by warm room-temperature objects, and the longer microwaves and radio waves.

Glazing types vary in their transparency to different parts of the spectrum. On the simplest level, a glass that appears to be tinted green as you look through it toward the outside will transmit more sunlight from the green portion of the visible spectrum, and reflect/absorb more of the other colors. Similarly, a bronze-tinted glass will absorb the blues and greens and transmit the warmer colors. Neutral gray tints absorb most colors equally.

This same principle applies outside the visible spectrum. Most glass is partially transparent to at least some ultraviolet radiation, while plastics are commonly more opaque to ultraviolet. Glass is opaque to far-infrared radiation but generally transparent to near-infrared. Strategic utilization of these variations has made for some very useful glazing products.

The basic properties of glazing that affect solar energy transfer are:

- Visible transmittance
- Reflectance
- Absorptance

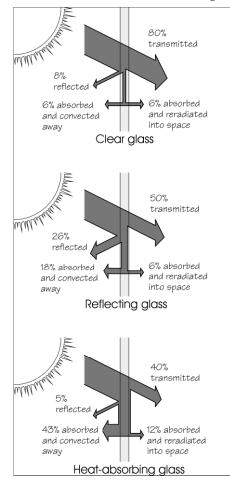
Each is described below.

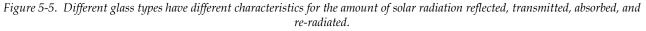
### 5.7.1. Transmittance

Transmittance refers to the percentage of radiation that can pass through glazing. Transmittance can be defined for different types of light or energy, e.g., "visible light transmittance," "UV transmittance," or "total solar energy transmittance." Each describes a different characteristic of the glazing. Visible transmittance (VT) is the total fenestration product system's transmittance across the visible portion of the solar spectrum. Although VT can be determined for any angle of incidence, the default and most commonly used reference is normal incidence solar radiation. Transmission of visible light determines the effectiveness of a type of glass in providing daylight and a clear view through the fenestration product. For example, tinted glass has a lower visible light transmittance than clear glass.

With the recent advances in glazing technology, manufacturers can control how glazing materials behave in these different areas of the spectrum. The basic properties of the substrate material (glass or plastic) can be altered, and coatings can be added to the surfaces of the substrates. For example, a product optimized for daylighting and for reducing heat gains should transmit an adequate amount of light in the visible portion of the spectrum, while excluding unnecessary heat gain from the near-infrared part of the electromagnetic spectrum.

On the other hand, a product optimized for collecting solar heat gain in winter should transmit the maximum amount of visible light as well as the heat from the near-infrared wavelengths in the solar spectrum, while blocking the lower-energy radiant heat in the far-infrared range that is an important heat loss component. These are the strategies of spectrally selective and low-emittance coatings, described later in the chapter.





### 5.7.2. Reflectance

Just as some light reflects off of the surface of water, some light will always be reflected at every glass surface. A specular reflection from a smooth glass surface is a mirror-like reflection similar to when you see an image of yourself in a store window. The natural reflectivity of glass is dependent on the quality of the glass surface, the presence of coatings, and the angle of incidence of the light. Today, virtually all glass manufactured in the United States is float glass and has a very similar quality with respect to reflectance. The sharper the angle at which the light strikes, however, the more the light is reflected rather than transmitted or absorbed . Even clear glass reflects 50 percent or more of the light striking it at incident angles greater than about 70 degrees. (The incident angle is formed with respect to a line perpendicular to the glass surface.)

Coatings can often be detected by careful examination of a reflected bright image, even if the coating is a transparent low-E coating. Hold a match several inches from a fenestration product at night and observe the reflections of the match in the glass. You will see two closely spaced images for each layer of glass, since the match reflects off the front and back surface of each layer of glass. A wider spacing between the two sets of pairs of images occurs with a wider air space between the glass panes. A subtle color shift in one of the reflected images normally indicates the presence of a low-E coating.

The reflectivity of various glass types becomes especially apparent during low light conditions. The surface on the brighter side acts like a mirror because the amount of light passing through the fenestration product from the darker side is less than the amount of light being reflected from the lighter side. This effect can be noticed from the outside during the day and from the inside during the night. For special applications when these surface reflections are undesirable (i.e., viewing merchandise through a store window on a bright day), special coatings can virtually eliminate this reflective effect.

The reflectivity of glass can be increased by applying various metallic coatings to the surface. Early processes used a liquid alloy of mercury and tin to create mirrors. A silvering process developed in 1865 improved the performance of mirrors. Today, mirror-like surfaces can be created by using vacuum-deposited aluminum or silver, or with a durable pyrolytic coating applied directly to the glass as it is manufactured. Thick coatings can be fully reflective and virtually opaque; a thinner coating is partially reflective and partially transmitting.

Most common coatings reflect all portions of the spectrum. However, in the past twenty years, researchers have learned a great deal about the design of coatings that can be applied to glass and plastic to reflect only selected wavelengths of radiant energy. Varying the reflectance of far-infrared and near- infrared energy has formed the basis for low-emittance coatings for cold climates, and for spectrally selective low-emittance coatings for hot climates.

### 5.7.3. Absorptance

Energy that is not transmitted through the glass or reflected off of its surfaces is absorbed. Once glass has absorbed any radiant energy, the energy is transformed into heat, raising the temperature of the glass.

Typical 1/8-inch (3 mm) clear glass absorbs only about 4 percent of incident sunlight. The absorptance of glass is increased by adding to the glass chemicals that absorb solar energy. If they absorb visible light, the glass appears dark. If they absorb ultraviolet radiation or near-infrared, there will be little or no change in visual appearance. Clear glass absorbs very little visible light, while dark tinted glass absorbs a considerable amount. The absorbed energy is converted into heat, warming the glass. Thus, when these "heat-absorbing" glasses are in the sun, they feel much hotter to the touch than clear glass. They are generally gray, bronze, or blue-green and are used primarily to lower the solar heat gain coefficient and to control glare. Since they block some of the sun's energy, they reduce the cooling load placed on the building and its air-conditioning equipment. Absorption is not the most efficient way to reduce cooling loads, as discussed later.

# 5.8 Infrared Properties of Glazing Materials (Emittance)

When heat or light energy is absorbed by glass, it is either convected away by moving air or reradiated by the glass surface. This ability of a material to radiate energy is called its emissivity. Fenestration products, along with all other household objects, typically emit, or radiate, heat in the form of long-wave far-infrared energy. This emission of radiant heat is one of the important heat transfer pathways for a fenestration product. Thus, reducing the product's emission of heat can greatly improve its insulating properties.

Standard glass has an emittance of 0.84 over the long wavelength portion of the spectrum, meaning that it emits 84 percent of the energy possible for an object at its temperature. It also means that for long-wave radiation (where there is no transmittance) striking the surface of the glass, 84 percent is absorbed and only 16 percent is reflected. By comparison, low-E glass coatings have an emittance as low as 0.04. This glazing would emit only 4 percent of the energy possible at its temperature, and thus reflect 96 percent of the incident long-wave infrared radiation.

## 6.1. Overview

WINDOW consists of the following libraries which are described in detail in this manual, with a separate chapter for each library.

- Window Library
- Glazing System Library
- Glass Library
- Gas Library
- Frame Library
- Divider Library
- Environmental Conditions Library
- Shade Material Library
- Shading Layer Library

This chapter explains the features that are common across all the libraries.

## 6.2. Libraries in General

Libraries are the main components of the WINDOW program, and each library contains characteristics necessary for the calculations.

### 6.2.1. List and Detail Views

There is a "List" and a "Detail" view of the data in each library. The List View shows all the records (rows) in the library but only some of the fields (columns with data), and the **Detail View** shows all the data (or fields) for one record. Most changes to the library records are made in the **Detail View**.

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Import       Export         Report       Name:         Print       Delete         Click on the Detailed View button to see the Detail View of the selected record, where the values can be edited.       Save         Alternatively, double click on the highlighted record to go to the Detailed View.       Frame:       0.353387       Btu/ht2:F         Edge of Glass:       0.413889       Btu/ht2:F         Edge of Glass:       0.340714       Btu/ht2:F         Edge of Glass:       0.300000         Center of Glass U-value:       0.340714       Btu/ht2:F         FRAME       Frame Dimension:       1.688       inches         Material Abs:       0.300000       Color:       0.300000         Color:       1.623       inches       Comment:         Library for the selected record, ID #5.       Condensation Resistance based on Them CR simulation       Condensation Resistance based on Them CR simulation		records found.		/ 1	List		ID #	5					
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Image: Copy Delete       Copy Delete         Click on the Detailed View button to see the Detail View of the selected record, where the values can be edited.       Save         Alternatively, double click on the highlighted record to go to the Detailed View.       From the Detailed View, click on the List button to see the List View of the library       Image: Content of Glass U-value: 0.340714 Btu/h-th2-F         The Detailed View of the Frame Library for the selected record, ID #5.       Frame: 1.623 inches       Content of Classed on Them CR simulation					Mou		Name:	sample	head.TH	M			
Print       Delete         Click on the Detailed View button to see the Detail View of the selected record, where the values can be edited.       Save         Alternatively, double click on the highlighted record to go to the Detailed View.       Frame: 0.353387       Btu/h:ft2-F         Edge of Glass: 0.413889       Btu/h:ft2-F         GLAZING SYSTEM       Width: 1.044       inches         Detailed View.       From the Detailed View, click on the List button to see the List View of the library       The Detailed View of the Frame Library for the selected record, ID #5.       FRAME       Frame Dimension: 1.688       inches         Condensation Resistance based on Therm CR simulation       @30%RH @50%RH @70%RH 0_verail       Verail       Frame 0.000 0.013 0.043 98.2		Export			New		Source:	Therm		<ul> <li>Type:</li> </ul>	Head		•
Print       Delete         Click on the Detailed View button to see the Detail View of the selected record, where the values can be edited.       Save         Alternatively, double click on the highlighted record to go to the Detailed View.       Image: Content of Glass: 0.413689         From the Detailed View, click on the List button to see the List View of the library       Image: Content of Glass: 0.300000         The Detailed View of the Frame Library for the selected record, ID #5.       FRAME         Condensation Resistance based on Them CR simulation       Condensation Resistance based on Them CR simulation         @302RH @502RH @502RH @702RH Overall       Frame 0.000         0.000       0.013       0.043       98.2		Report			Сору		Filename	. \Samp	les\sampl	e-bead TH	м	Brown	
Click on the Detailed View button to see the Detail View of the selected record, where the values can be edited. Alternatively, double click on the highlighted record to go to the Detailed View. From the Detailed View, click on the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation Frame 0.000 0.013 0.043 98.2		Print			Delete				ies (sampi	enedu. m	ITI	DIUW	se
Click on the Detailed View button to see the Detail View of the selected record, where the values can be edited. Alternatively, double click on the highlighted record to go to the Detailed View. From the Detailed View, click on the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation @30%RH @50%RH @70%RH @70%RH Overall Frame 0.000 0.013 0.043 98.2	/ l		/	/	C		U-VALU	JES	Fram	e <sup>.</sup> 0.353	387 Bhu/b-	#2-E	
the Detail View of the selected record, where the values can be edited. Alternatively, double click on the highlighted record to go to the Detailed View. From the Detailed View, click on the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation $\frac{@30\%RH}{@50\%RH}$ $\frac{@50\%RH}{@70\%RH}$ $\frac{@70\%RH}{Dverall}$	Click on the Detail	ed View button to	see /		Save			Edaal				1121	
where the values can be edited.       Alternatively, double click on the highlighted record to go to the Detailed View.         From the Detailed View, click on the List button to see the List View of the library       From the Detailed View of the Frame Library for the selected record, ID #5.         Condensation Resistance based on Them CR simulation       ©302RH @502RH @702RH @ro202RH @ro202	the Detail View of	the selected recor	'd, /					-					
Alternatively, double click on the highlighted record to go to the Detailed View. From the Detailed View, click on the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Alternatively, double click on the frame Dimension: 1.004 inches Center of Glass U-value: 0.340714 Btu/h-ft2-F Projected Frame Dimension: 1.688 inches Material Abs: 0.30000 Color: Wetted Length: 1.623 inches Condensation Resistance based on Them CR simulation @30%RH @50%RH @70%RH Overall Frame 0.000 0.013 0.043 98.2	where the values c	an be edited.						Edg	je or Gias	s: 0.413	889 Btu/h-	łt2-F	
highlighted record to go to the Detailed View. From the Detailed View, click on the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation @30%RH @50%RH @70%RH @verall Frame 0.000 0.013 0.043 98.2	Altorn	atively, double clic	/ k on the				GLAZIN	NG SYST	ЕМ				
Detailed View.       Center of Glass U-value: 0.340714       Btu/h-ft2-F         From the Detailed View, click on the List button to see the List View of the library       FRAME       Frame Dimension: 1.688       inches         The Detailed View of the Frame       Color:									Widt	h: 1.	044 inches	:	
From the Detailed View, click on the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation Condensation Resistance based		-					Cent	ter of Gla	ss U-valu	e: 0.340	714 Btu/h-	ft2-F	
From the Detailed View, click on the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation Condensation Resistance based				/			- EDAMO						
the List button to see the List View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation Condensation Resistance based on Them CR simulation Condensatio		From the Detailed	View, cli	ck on				-	Dimensio	n: 1	688 inches		
View of the library The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation Condensation Resistance based on Them CR simulation         @30%RH       @50%RH       @70%RH       Overall         Frame       0.000       0.013       0.043       98.2		the <b>List</b> button to s	see the <b>L</b>	ist			110/0000				=		
The Detailed View of the Frame Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation @30%RH @50%RH @70%RH Overall Frame 0.000 0.013 0.043 98.2	,	View of the library	/					141			•		
The Detailed View of the Frame Library for the selected record, ID #5.								5.7-W			l COO instant		
Library for the selected record, ID #5. Condensation Resistance based on Them CR simulation @30%RH @50%RH @70%RH Overall Frame 0.000 0.013 0.043 98.2			_						tea Lengti	n: I.	623 inches		
Condensation Resistance based on Therm CR simulation       Condensation Resistance based on Therm CR simulation       @30%RH     @50%RH     @70%RH     Overall       Frame     0.000     0.013     0.043     98.2				#5.			Comment						
Image: Constraint of the system         Image: Constand of the system         Image: Constando				- '									
Frame 0.000 0.013 0.043 98.2							Conder	1					
								@30%	(RH @5	50%RH @	270%RH	Overall	
Edge 0.000 0.057 0.177 92.2							Frame	0.	.000	0.013	0.043	98.2	
							Edge	0.	.000	0.057	0.177	92.2	

*Figure 6-1. Switching between the List View and Detail View in a Library.* 

#### 6.2.2. Selecting Records from Libraries

From many of the libraries, it is necessary to select records from other libraries. For example, in the **Window Library Detail View**, in order to define a window, it is necessary to select records from the

- Frame Library
- Glazing System Library
- Divider Library (optional)

From the Glazing System Library Detail View, it is necessary to select records from the

- Glass Library
- Gas Library
- Shading Layer Library (optional)

There are several different options for selecting records from other libraries, as discussed below.

One method is to click on the double arrow icon where it appears. This will open a small dialog box with a listing showing all the records and their associated fields from that library.

It is also possible to type the ID number in the ID field, if that is known, and the program will display the appropriate record.

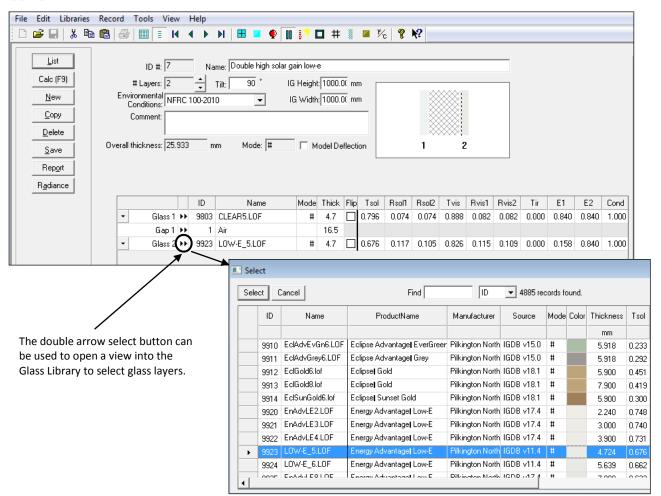


Figure 6-2. Selecting a record from another library.

#### 6.2.3. Moving Between Records in Detail View

There are several ways to move between records in the Library Detail View:

- The Record Menu contains choices for First Record, Previous Record, Next Record, Last Record
- The Toolbar has buttons for first , previous , next , and last record to move between records.

#### 6.2.4. Creating New Records

New records are created in the **List View** of any of the libraries. From the **List View**, there are two methods for creating new records, either:

- Use the **Copy** button to copy an existing record and change the data that is different for the new record.
- Use the **New** button to create a new record, based on a default record that is automatically included in the program for each library.

#### **Creating New Records Using New Button**

New records can be created in the **List View** using the **New** button, which will make a new record based on the values in the WINDOW default record for that Library. Go to the **Detailed View** of the new record and make the desired changes to the input values.

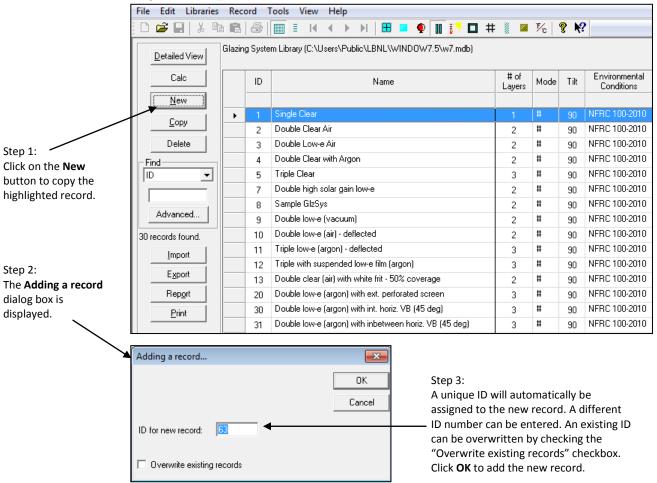
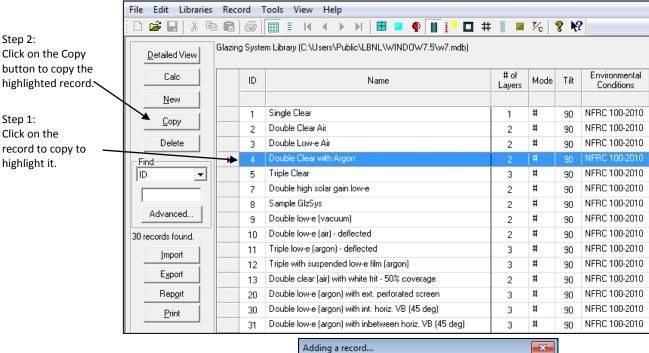


Figure 6-3. Create a new record using the New button.

### **Creating New Records Using the Copy Button**

New records can be created in all the libraries by copying an existing record (by highlighting it and clicking on the **Copy** button in the **List** View) and then editing the new record with the desired values in the **Detailed View**.



#### Step 3:

WINDOW will automatically assign a unique ID for the new record. A different ID number can be typed, as long as it is unique. Or the **Overwrite existing records** box can be checked to replace an existing ID. Click **OK** to add the new record.

	Adding a record	<b>-</b> ×-
		ОК
		Cancel
•	ID for new record: 🔂	
	Overwrite existing records	

Figure 6-4. Create a new record by copying an existing record.

			Step 4: Highlight the newly copied /	record t	o edit	it.						
	File Edit Libraries Record Tools View Help											
Stop Fr	🗋 🖆 🖬 🕹 🖻	D 🚅 🖬   & 🖻 💼   🗁   🏢 🗉 M 🔺 🖌 M   🖽 🛎 🍨 💵 📴 🕂 🖉 🌌 7%   😵 🕺										
Step 5: Click on the <b>Detailed</b> <b>View</b> button or	Detailed View	Glazing Syste	em Library (C:\UserxPublic\LBNL\WINDOW7.5\w7.mdb)									
double click the	Calc	ID	Name	# of Layers	Mode	Tilt	Environmental Conditions					
highlighted record to	New											
open the detailed		55	Thermochromic Gray 12 mm	2		90	NFRC 100-2010					
view.		56	Thermochromic Laminate 7 mm	2		90	NFRC 100-2010					
	Delete	60	Double clear with pleated shade	3	#	90	NFRC 100-2010					
	- Find	61	y <sup>r</sup> iracon Frit	2 #		90	NFRC 100-2010					
	ID 💌	62	62 Double low-e (argon) with int. horiz. VB (45 deg)		#	90	NFRC 100-2010					
		▶ 63	Double Clear with Argon	2	#	90	NFRC 100-2010					

`

#### Step 6:

In the **Detailed View**, edit the fields as needed to define the new record

	<u> </u>																				
File	Edit Li	braries	Reco	rd Too	ols \	liew	H	s p													
Ē	🗳 🖬	μ 🖻	1 🛍	@  <b>I</b>	1	M	∢	N	M	<b>H</b>	<b>4</b>		1 <mark>27</mark>	⊒ #	1	🖉 K	6   <b>?</b>	N?			
	List		ID #: 63 Name: Double Clear with Argon																		
	Calc (F9)			# Layers: 2 🚽 Tilt: 90 * IG Height: 1000.00 mm																	
	<u>N</u> ew			Environmental NFRC 100-2010 IG Width: 1000.0( mm																	
	<u>С</u> ору			Comment																	
	<u>D</u> elete																				
	<u>S</u> ave		0.46	erall thick	ness:	18.79	96	m	n	Mod	le:  #		ШМ	odel De	flect	ion		1	2		
	Rep <u>o</u> rt																				
	R <u>a</u> diance	•																			
								ID		Na	me		Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	R visi
				-	Glas	ss 1 🕨	•	102	CLEA	.R_3.D	)AT		#	3.0		0.834	0.075	0.075	0.899	0.083	0.08
					Ga	p1)	•	6	Air (5	%) / Ai	rgon (95	5%) M		12.7							
				-	Glas	ss 2 🕨	•	102	CLEA	.R_3.D	)AT		#	3.0		0.834	0.075	0.075	0.899	0.083	0.08

Figure 6-5. Edit the newly created record in the Library Detail View.

# 6.3. Standards Files

WINDOW uses "standards files" to calculate the optical properties in many of the libraries, including the Glass Library (for calculating the averaged optical properties), the Glazing System Library (for calculating the optical properties) and the Window Library (for calculating the optical properties of the complete fenestration product).

These standards files are text files and are located in the "LBNL Shared" subdirectory of the "Program Files (x86)" directory, and have the extension "\*.std". The default standards file for WINDOW is called "W5\_NFRC\_2003.std".

OS (C:) ► Program Files (x86) ► LBNL ► LBNL Shared ► Standards					
ary 🔻 Share with 💌 Burn	Compatibility files	New folder			
Name	Date modified	Туре			
NFRC_300_2003.std	1/6/2003 11:53 AM	STD File			
prEN_410.std	9/5/2002 3:54 PM	STD File			
Radiance.std	9/5/2002 3:54 PM	STD File			
W5_NFRC_2003.std	9/5/2002 3:54 PM	STD File			
W7_G173_37Tilt_Direct.std	1/17/2014 6:09 PM	STD File			
W7_G173_37Tilt_Global.std	1/17/2014 6:09 PM	STD File			
W7_G197_20Tilt_Direct.std	1/17/2014 6:10 PM	STD File			
W7_G197_20Tilt_Global.std	1/17/2014 6:10 PM	STD File			
W7_G197_90Tilt_Direct.std	1/17/2014 6:11 PM	STD File			
W7_G197_90Tilt_Global.std	1/17/2014 6:11 PM	STD File			
WINDOW4.std	9/5/2002 3:54 PM	STD File			

Figure 6-6. Standards files are found in the Program Files (x86)/LBNL/LBNLShared/Standards directory.

Each standards file contains information for the optical calculations, and in many cases references other files for spectrum definitions, that are located in that same directory. In the **W5\_NFRC\_2003.std** file, many source spectrum (\*.SSP) files are referenced.

🔚 W5\_NFRC\_2003.std 🔀 Standard Description : Consistent with NFRC 300-2003 - default for WINDOWS Standard Provides Methods: SOLAR, PHOTOPIC, COLOR\_TRISTIMX, COLOR\_TRISTIMY, 4 Name : SOLAR Description : NFRC 300-2003 Solar 5 6 Source Spectrum : ASTM E891 Table 1 Direct AM1\_5.ssp 7 Detector Spectrum : None 8 Wavelength Set : Source Integration Rule : Trapezoidal 9 10 Minimum Wavelength : 0.3 11 Maximum Wavelength : 2.5 12 13 Name : PHOTOPIC 14 Description : NFRC 300-2003 Photopic 15 Source Spectrum : CIE Illuminant D65 1nm.ssp 16 Detector Spectrum : ASTM E308 1931 Y.dsp 17 Wavelength Set : Color 5nm.wvl 18 Integration Rule : Trapezoidal 19 Minimum Wavelength : 0.38 20 Maximum Wavelength : 0.78 21 22 Name : COLOR\_TRISTIMX 23 Description : ASTM E308 Color - not in NFRC 300-2003 24 Source Spectrum : CIE Illuminant D65 1nm.ssp 25 Detector Spectrum : ASTM E308 1964 X.dsp 26 Wavelength Set : Color 5nm.wvl 27 Integration Rule : Trapezoidal (Normalized, k=1.0) 28 Minimum Wavelength : 0.38 29 Maximum Wavelength : 0.78

Figure 6-7. The STD file references other SSP files.

The standards file can be changed from the **File** menu, **Preferences** choice, **Optical Data** tab, and clicking on the **Browse** button in the "Standards File" section.

Options	Thermal Calcs	Optical Calcs	Optical Data	Radiance	Deflection	Updates				
Use t	Use the following database for optical data:									
⊚ IG	DB or IGDB Upd	ate								
C:\U	sers\Public\LBN	L\LBNL Shared	\Glazing.mdb	Browse						
() Op	otics User databa	se								
C:\U	sers\Public\LBN	L\LBNL Shared	\UserGlazing.ı	Browse						
	lards File		CDC 2002 11							
BNL	LBNL shared\Sta	andards\W5_N	FRC_2003.std	Browse						

*Figure 6-8.* The standards file can be specified in the File/Preferences/Optical Data tab.

The Window Library is where the whole product is constructed from each of the components (frames, glazing systems, dividers, environmental conditions). The calculation results will be for the entire product.

# 7.1. Window Library List View

The List View shows all the records in the Window Library.

File Edit Librarie	s Re	cord	Tools View He	lp						
D 🚅 🖬   X 🖻	B	8		N   🖽 🗖	<b>9</b> II		# 🐰 🔳	½   🤋		
Detailed View	Detailed View Window Library (C:\Users\Public\LBNL\WINDOW7.6\w7.mdb)									
Calc		ID	Name	Туре	Width	Height	Ufactor	SHGC	Tvis	CR
New					mm	mm	W/m2-K			
	•		Sample Picture Wini	Fixed (picture)	1200	1500	2.497	0.401	0.534	N/A
Сору		2	Sample Horizontal S	Horizontal Slider	1500	1200	2.707	0.395	0.512	N/A
Delete		3	Sample Vertical Slid	Vertical Slider	1200	1500	2.701	0.394	0.512	N/A
Find		4	Sample Double Cas	Casement - Dou	1200	1500	2.761	0.393	0.506	N/A
ID  Advanced  4 records found. Import Export Report Print										

Figure 7-1. Window Library, List View.

The buttons on the left hand side of the List View have the following functions:

*Detailed* Used to access the detailed view of the record, where the input values can be edited. *View* 

Calc

*c* Click to calculate selected or all records

Calculate		×
Calculate		
OK	Cancel	

Figure 7-2. Calculation options

- *New* Used to make a new record.
- *Copy* Used to copy an existing record (including name and all associated input values) into a new record.
- *Delete* Used to delete the highlighted record(s).
- *Find* Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.



*Figure 7-3. Pulldown list of fields to specify for the Find functionality* 

Advanced: Used to access a more advanced method of searching the list

Find		<b>—</b> ×
Find what:		Find Next
Match entire cell text	Direction	Cancel
Match case	⊂ Up ⊙ Down	

Figure 7-4. Find dialog box

*Import* Used to import records from the Window Library of other WINDOW databases

The Browse button can be used to select the WINDOW database to import from.

Import		×					
Format	WINDOW Database						
Import database	C:\Users\Public\LBNL\LBNL Shared\W7-CG Browse						
✓ Avoid creating for identical re	Avoid creating duplicate records in export database by searching for identical records						
	OK Cancel						

Figure 7-5. Import dialog box

*Export* Used to export Window records to either another WINDOW database or a commaseparated text file of the Window Library list. The Format pulldown list allows selection of these export options.

Export		8
Export: © Selected recor © All records	rd(s)	
Format WINDOV	√ Database 📃 💌	
. ,	\Public\LBNL\WINDOW7.5\lssue1 Browse New	
for identical rec	g duplicate records in export database by searching cords	
	OK Cancel	

Figure 7-6. Export dialog box

*Report* Used to create one of several reports.

Report 🛛 🕅	
Report type:       Library List         Generate report for:         Selected record(s)         All records         Text file options         Use default column widths         Wrap columns         Preview         OK       Cancel	Library List Library List Detailed DOE-2 Energy Plus Energy Plus IDF File Energy Plus BSDF IDF File AERC Energy Plus BSDF IDF

Figure 7-7. Report options.

**Report type:** The following reports are available from the List view (see the section on Reports, which presents the details of each report):

- Library List: A list of the records and all the fields displayed in the List view.
- Detailed: a report listing all the information associated with the record. If multiple records are selected, one file is generated with the detailed report of each appended onto the file.
- DOE-2: a report (text file) that contains input data to be used with the DOE-2 hourly simulation program. Due to restrictions in the DOE2 program, this file can only be created from windows with one light, and with generic frames that are all of the same frame type.
- Energy Plus: a report (text file) that contains input data to be used with the Energy Plus hourly simulation program, in a "non-native" Energy Plus format. In contrast to files for DOE2, Energy Plus files can contain windows with multiple lights, generic or THERM frames, and dividers. This report is not widely used for Energy Plus input. The preferred input file is one of the Energy Plus IDF file formats which contain actual Energy Plus input, rather than the non-native format in this report.

- **Energy Plus IDF File:** a report (text file) that contains the actual Energy Plus input in the "IDF" format. This file can be copied into a whole building Energy Plus IDF file to define the windows in the building.
- Energy Plus BSDF IDF File: a report (text file) that contains the actual Energy Plus input in the "IDF" format, with the addition of the Energy Plus BSDF (Bidirectional Scattering Distribution Function) matrix, that WINDOW generates for "complex" glazing systems, such as those with shading systems.
- AERC Energy Plus BSDF IDF: a report (text file) that contains the actual Energy Plus input in the "IDF" format, with the addition of the Energy Plus BSDF matrix, specifically constructed to be used with the AERCalc software program. This report is generally used to "debug" input to the AERCalc program and is not designed to be used directly with the AERCalc program.

### Generate report for

- Selected record(s): This option generates a report for only selected records, both contiguous and non-contiguous, in the List view.
- All records: This option generates a report for all the records in the List view

### Text file options

In some cases, the best outcome for the report will be to *uncheck both of these boxes*, which results in no data truncation or wrapping

- Use default column widths: a checkbox which will use default column widths for each column. If this option is selected, wrap columns should also be selected – otherwise, the text in the fixed column widths will be truncated.
- Wrap columns: a checkbox which directs the program to wrap the text in columns if it does not fit into the default column width.

ID	Name	Туре	Width inches	Height inches	Ufactor Btu/h-ft2-F
1 2 3 4	Sample Picture Window Sample Horizontal Slider Sample Double Casement Sample Vertical Slider	Fixed (picture) Horizontal Slide Casement - Doubl Vertical Slider	47.24	59.06 47.24 59.05 59.06	0.340 0.359 0.359 0.359 0.357

Figure 7-8. Report preview with both Default column widths and wrap columns unchecked.

Preview: Checking this box will display the report in a separate dialog box.

Save	Print Close						
ID	Name	Туре	Width inches	Height	Ufactor Btu/h-ft2-F	SHGC	Tvis
1	Sample Picture Windo w	Fixed (picture)	47.24	59.06	0.340	0.526	0.56
2	Sample Horizontal Sl ider	Horizontal Slide	59.06	47.24	0.359	0.586	0.62
3	Sample Double Caseme	Casement - Doubl	47.24	59.05	0.359	0.581	0.62
4	Sample Vertical Slid er	Vertical Slider	47.24	59.06	0.357	0.586	0.62

Figure 7-9. Report Preview dialog box.

The preview screeh has three buttons which allow the following options

• Save: This option allows saving the report to a text file, including the option to

browse to a specific directory and give the file a specific name.

- **Print:** This option brings up the standard printer dialog box for installed printers
- **Close:** This option closes the preview screen.
- *Print* Used to print a report which contains a list of all the records in the library.

# 7.2. Window Library Detail View

The Detail View shows details of individual windows in the Window Library. The upper left section of the screen is used to input the window characteristics. The upper right section of the screen shows a graphic representation of the window based on the input values. It is possible to see the selected components for frames, glazing systems, and dividers by clicking on the specific graphic elements; this will cause information about that element to appear in the lower right corner. The lower left section of the screen shows the calculation results for the whole product. These results become "?" when any of the input values change, and can be recalculated by clicking in the **Calc** button. To define the number of dividers in a window, click on the **Dividers** button, and input the correct number of horizontal and vertical dividers.

H W7.5 - Window Library (C:\Users\Public\LBNL\WINDOW7.5\w7.mdb)							
	Record Tools View Help						
0 🖻 🖬 👗 🖻 🛍	🛍   🍜   🏢 🗉 🙌 🔺 🕨 N   🔠 💻 🍨 🖩 🔛 👫 🖉 🎋 🛛 🋠						
<u>N</u> ew <u>D</u> elete <u>S</u> ave Rep <u>o</u> rt	ID # 1 Name Sample Picture Window Mode NFRC Type Fixed (picture) ▼ >> Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 90 Environmental Conditions NFRC 100-2010 ▼						
SHGC/VT Detail CR Detail	Total Window Results       Click on a component to display characteristics below         U-factor       1.932       W/m2-K         SHGC       0.526         VT       0.561         CR       49						
For Help, press F1	Mode: NFRC SI N	UM //					

Figure 7-10. Window Library, Detail View.

The following section describes the input and results fields in the Window Library Detail Screen.

IDThe unique ID associated with each window record. This value is automatically<br/>assigned when a new record is created in List View, and can be changed at that time<br/>by the user as long as the value is unique.NameThe name of the window, input by the userModeCurrently not enabled.TypeThe Type of window product, from the pulldown list. The Type determines the<br/>display to the right and the number of lites and frame sections available for

definition. It also determines the size of the window, as well as the default width and height.

The width and height are not editable for most of the window types except for:

- Custom Dual Vision Horizontal
- Custom Dual Vision Vertical
- Custom Single Vision

When any of these three Types are selected, the Width and Height fields can be input, and the Size field is automatically calculated based on these values.

	ID	Туре	Slze	Width	Height	Layout
				mm	mm	
•		Casement - Double	NFRC 2001	1200.0	1500.0	Horizontal Slider
	2	Casement - Single	NFRC 2001	600.0	1500.0	Single vision area
	3	Door Transom	NFRC 2001	2000.0	600.0	Single vision area
	4	Door	NFRC 2001	960.0	2090.0	Single vision area
	5	Double Door	NFRC 2001	1920.0	2090.0	Horizontal Slider
	6	Fixed (picture)	NFRC 2001	1200.0	1500.0	Single vision area
	7	Garage door	NFRC 2001	3000.0	2400.0	Single vision area
	8	Horizontal Slider	NFRC 2001	1500.0	1200.0	Horizontal Slider
	9	Projecting (Awing-Dual)	NFRC 2001	1500.0	1200.0	Vertical Slider
	10	Projecting (Awning-Single)	NFRC 2001	1500.0	600.0	Single vision area
	11	Sidelite	NFRC 2001	600.0	2000.0	Single vision area
	12	Skylight	NFRC 2001	1200.0	1200.0	Single vision area
	13	Vertical Slider	NFRC 2001	1200.0	1500.0	Vertical Slider
	17	Sliding Glass Door	NFRC 2001	2000.0	2000.0	Horizontal Slider
	18	Glazed Wall System	NFRC 2001	2000.0	2000.0	Horizontal Slider
	100	Custom Dual Vision Horizontal	Custom	1500.0	1200.0	Horizontal Slider
	101	Custom Dual Vision Vertical	Custom	1200.0	1500.0	Vertical Slider
	102	Custom Single Vision	Custom	600.0	1500.0	Single vision area

Figure 7-11. List of choices for the Type field.

Width	Overall width of the product, based on the Type input value. This value is not editable for most of the Type values, with the exception of the "Custom" Types. <b>Units:</b> mm (SI); inches (IP).
Height	Overall height of the product, based on the Type input value. <b>Units:</b> mm (SI); inches (IP)
Area	Overall size of the product, based on the <b>Type</b> input value. This value is not editable by the user; it is calculated by the program based on the Width and Height values.
Tilt	Tilt of the product. Default: 90. Units: Degrees from horizontal
Environmental Conditions	Environmental conditions to be applied to the whole product calculations. The pulldown list shows the records in the Environmental Conditions Library.

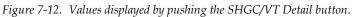
#### **Total Window Results**

U-factor	The whole product U-factor. <b>Units:</b> W/m <sup>2</sup> -K ; (SI); Btu/h-ft <sup>2</sup> -oF (IP).
----------	-------------------------------------------------------------------------------------------------------

- SHGC The whole product Solar Heat Gain Coefficient. Units: unitless
- *VT* The whole product Visible Transmission. **Units:** unitless
- *CR* The whole product Condensation Resistance. **Units:** unitless

SHGC/VT This button displays detailed values for the SHGC/VT calculation Detail

	Actual Dividers	No Dividers	Generic Dividers	Generic Dividers
PDD (inches)	1.0000	N/A	0.7500	1.5000
SHGCO	0.0070	0.0036	0.0065	0.0093
SHGC1	0.7640	0.8790	0.7923	0.7103
VTO	0.0000	0.0000	0.0000	0.0000
VT1	0.7570	0.8755	0.7858	0.7010



CR Detail

This button displays detailed values for the Condensation Index calculation.

Condensation Index Details									
	Close	Close							
*CRg value includes divider and divider edge calculations									
	ID	Area	@30%RH	@50%RH	@70%RH	Overall			
CR		19.38	78.28	49.21	36.37	48.96			
CRg*		13.89	100.00	80.91	47.56	63.06			
CRe		3.07	78.28	49.21	36.37	48.96			
CRf		2.41	87.78	73.86	62.51	71.10			
COG 1	8	3.83	0.0000	0.0070	0.1442	0.0504			
Divider 1	7	2.30	0.0001	0.0126	0.0428	0.0185			
Div. Edge 1	7	7.76	0.0004	0.0568	0.1772	0.0781			
Header	5	0.53	0.0017	0.0177	0.0527	0.0241			
Header Edge	5	0.67	0.0073	0.1321	0.2634	0.1343			
Left Jamb	6	0.67	0.0017	0.0177	0.0527	0.0241			
Left Jamb Edge	6	0.87	0.0073	0.1321	0.2634	0.1343			
Right Jamb	6	0.67	0.0038	0.0234	0.0625	0.0299			
Right Jamb Edge	6	0.87	0.0278	0.2023	0.3230	0.1844			
Sill			37.2	50.5	59.7				

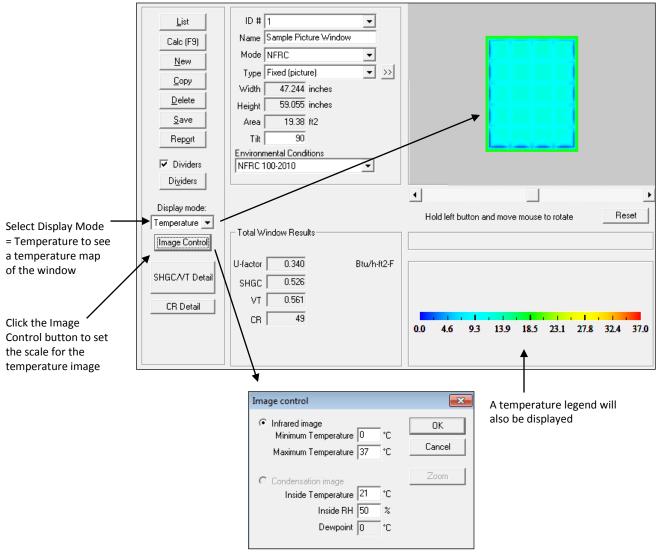
Figure 7-13. Values displayed by pushing the CR Detail button

#### **Display Mode**

*Normal* Normal display of the product, showing the geometry

*Temperature* Temperature map display of the product. This will only be displayed if the frame cross sections were calculated with THERM.

When Temperature is selected, an additional button appears called Image Control which allows control of the temperature range displayed.



*Figure 7-14. Display mode = Temperature* 

# 7.3. Creating a New Window

#### 7.3.1. Select the Glazing System for the Window

To view the characteristics of the glazing system of the window, click on the glazing system component and the information is displayed in the lower right group box, as shown below. This information is from the Glazing System Library.

To select a new glazing system for this window, click on the glazing system to be changed, and either use the pulldown list to see the names of all the records in the Glazing System Library, or click on the double arrow button, and another window will open which displays all the values from the Glazing System Library.

Step 2: The characteristics of the currently selected glazing system are displayed in the lower

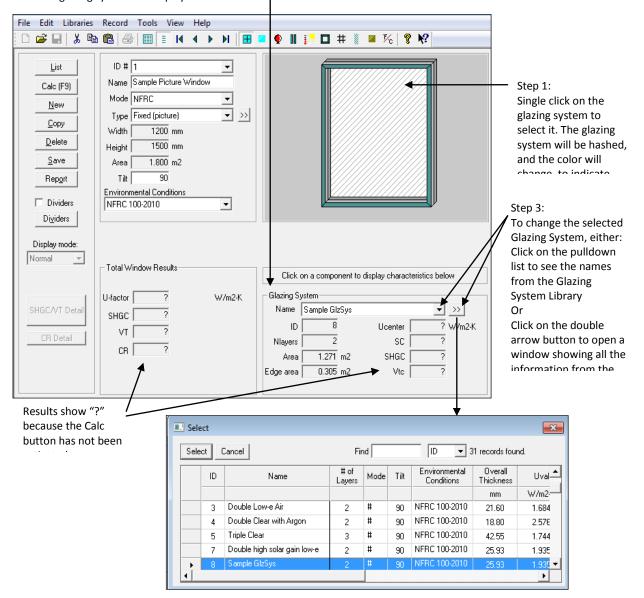
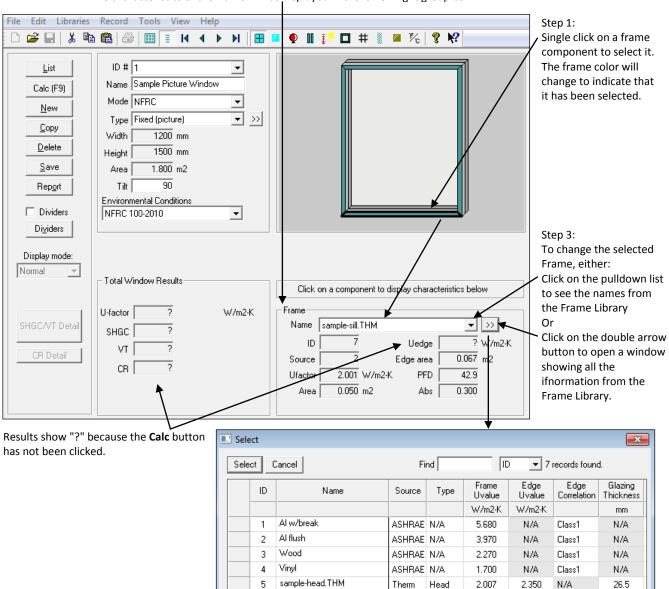


Figure 7-15. Select a Glazing System for the window.

#### 7.3.2. Select the Frame for the Window

To view the characteristics of the frame of the window, click on a frame component and the information is displayed in the lower right group box, as shown below. This information is from the Frame Library.

To select a new frame for this window, click on the frame component to be changed, and either use the pulldown list to see the names of all the frames in the Frame Library, or click on the double arrow button, and another window will open which displays all the values from the Frame Library.



Step 2: The characteristics of the frame will be displayed in the lower right group box.

Figure 7-16. Select a Frame for the window.

Therm

[herm

Jamb

1.996

2.343

N/A

26.5

sample-jamb.THM

sample-sill.THM

6

۲

## 7.3.3. Add Dividers to the Window

To add dividers to the window without dividers, click on the Divider button above the Results group box.

	File Edit Libraries Record	Tools View Help			
			🗄 🗖 🍨 🖩 📴	# 🕴 🛛 🏷   🤋	₩?
Step 1: Click on the <b>Dividers</b> button.	Calle (F.G)     Mode N       New     Type Fit       Copy     Width       Delete     Height       Save     Area       Report     Tilt	ample Picture Window FRC   Iteration for the second secon			
	Display mode: Normal Total Wind SHGC/VT Detail CR Detail CR Detail CR	dow Results ? ? ? ? ?	Click on a com	nponent to display charact	eristics below
will appear. Selec	iguration dialog box t the correct number d <b>Vertical Dividers</b> , button.	Divider Configuration # of Horizontal Dividers Aut # of Vertical Dividers Aut Apply to Vision Area All		OK       Cancel       Apply       Automatic       Automatic	

Figure 7-17. Specify the number of dividers for the window.

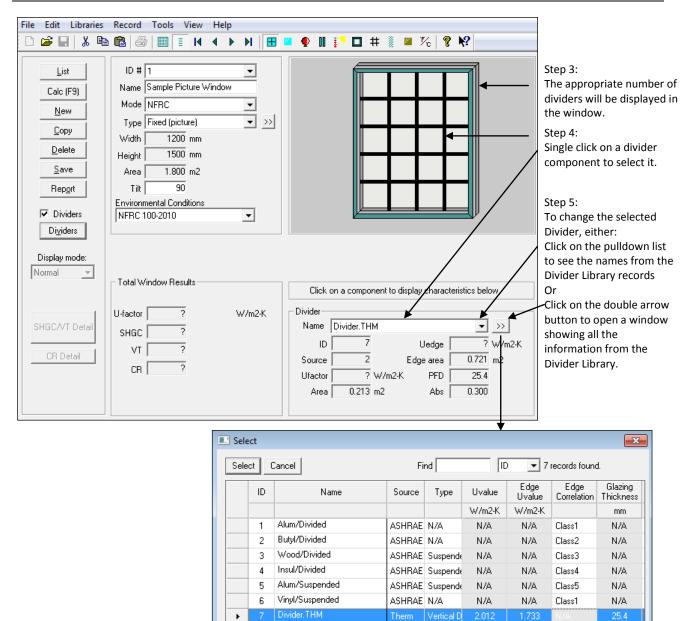


Figure 7-18. Select a Divider for the window.

4

### 7.3.4. Calculate

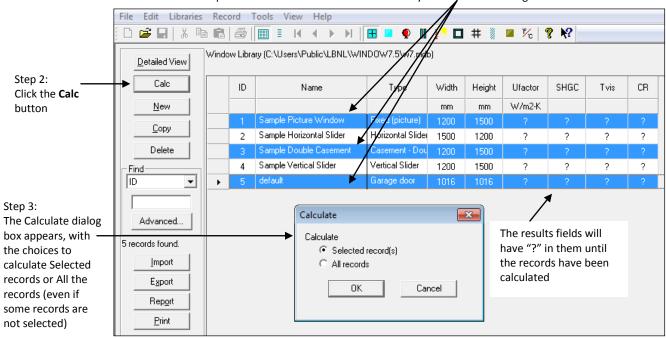
When all the components for the product have been defined, the total product values can be calculated by clicking on the Calc button.

	File Edit Libraries Record Tools View Help	
	🗅 😅 🖬   👗 🗈 🛍   🗁   🏢 \Xi 🙌 🔺 🕨 M   🖪 🖉 🌵 💵 💱 🗖 🕂 🕷 😵 🍢	
Click the <b>Calc</b> button to initiate the calculation of the thermal and optical characteristics of the window.	List       ID # 1         Calc [F3]       Name Sample Picture Window         New       Sample Picture Window         Copy       Mode NFRC         Copy       Vidth 1200 mm         Delete       Height 1500 mm         Save       Area 1.800 m2         Tilt 90       Intrometral Conditions         NFRC 100-2010       ✓	
	Display mode:       Normal       Image: Total Window Results       Click on a component to display characteristics below         SHGC/VT Detail       U-factor       1.932       W/m2-K         SHGC       0.526       ID       Tube Using the second secon	

After clicking the **Calc** button, the "?" in the results sections will be replaced with values.

Figure 7-19. Click the Calc button to calculate the current record in the Detailed view.

Calculating Window Library records can also be initiated from the Window Library List view, where multiple records can be selected to be calculated.



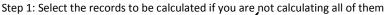


Figure 7-20. Click the Calc button in the List view to calculate just the selected records or all the records.

Before the results are calculated, the results fields will have "?" in them. After the results are calculated, those fields are populated with the calculated values.

File	Edit Librarie	es F	Reco	rd T	ools	View	He	lp										
	🛎 🖬   🐰	Ð.		61	III I	$\mathbb{H}$			▶	<b>H</b>	•	00	P 🗆	# 🐰	🖉 🏹	१ №		
	Detailed View	Wi	indov	v Libra	ry (C:\U:	sers\P	ublic	LBNI	L\WIN	IDOW7	.5\w7.	mdb	)					
	Calc			ID		N	ame			Т	уре		Width	Height	Ufactor	SHGC	Tvis	CR
	New												mm	mm	W/m2-K			
	Сору		۲		Sample	e Pictu	re Wi	ndow		Fixed	picture		1200	1500	1.932	0.526	0.561	49.0
				2	Sample	Horiz	ontal	Slider	r	Horizo	ntal Sli	dei	1500	1200	2.036	0.586	0.629	50.2
	Delete			3	Sample	Doub	le Ca	seme	nt	Casen	nent - D	)ol	1200	1500	2.039	0.581	0.623	49.4
Fir	nd			4	Sample	e Vertic	al Sli	der		Vertica	al Slide	r	1200	1500	2.029	0.586	0.629	50.6
ID	-			5	default					Garag	e door		1016	1016	5.857	0.731	0.708	N/A
	Advanced								Ť									
5 rec	cords found.															r the resu		
	<u>I</u> mport															ulated, th		ls
	Export will display the calculated values																	
	Rep <u>o</u> rt																	
	<u>P</u> rint																	

*Figure 7-21. The calculated results will be displayed after the calculation.* 

# 7.4. Import / Export

#### 7.4.5. Export

The **Import** button in the **Window Library List** view allows import of records from the **Window** libraries of other WINDOW databases. When records are imported, all the associated library records needed to define that record will also be imported.

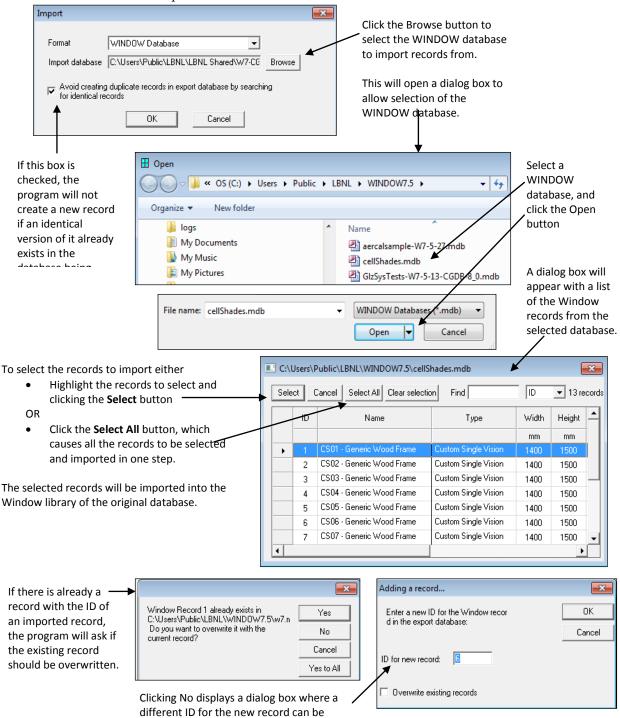


Figure 7-22. Importing record(s) from an existing WINDOW database

#### 7.4.6. Export

The **Export** button can be used to export data in two different formats

- WINDOW Database
- Comma separated value (CSV)

#### Export to a CSV (Text) file

To export selected or all records to a CSV file, do the following:

- From the **Window List** view, click on the **Export** button
- In the Export dialog box, set Format = Comma separated value (CSV)

Export	×
Export:	
Format Comma separated value (CSV)	
Cancel	

• A window will appear allowing you to specify the location and name of the CSV file

🛛 🐌 Conferencing	* Nar	ne Date modified
🛛 📙 Contacts		
🛛 隆 Desktop		No items match your search.
🗼 Downloads		
🛛 🗼 Downloads		
퉬 DropBoxSelectiveSync	=	
Favorites		
🛛 🝌 Google Drive		
🛛 퉲 InstallAnywhere		
D 📗 lib		III
File name: WINDOW	Window Li	brary Export 🔹
Save as type: CSV files (*	.csv)	

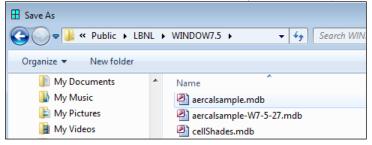
#### Export to WINDOW database

To export selected records from the Window Library of the current WINDOW database into another WINDOW database, do the following

• From the Window List view, click on the Export button

Export		×
Export: Sele All re	cted record(s) ecords	
Format	WINDOW Database	
Export	C:\Users\Public\LBNL\WINDOW7.5\Issue 1 Browse New	
✓ Avoi for ic	d creating duplicate records in export database by searching lentical records	
	OK Cancel	

- In the **Export** dialog box, set **Format = Window Database**
- To add the records to an existing WINDOW database, click on the Browse button to select the database to export the records to
- To add the records to a completely new WINDOW database, click on the New button, and a Save As dialog box will appear, where you can browse to the desired directory and enter the desired database filename. Click on the Save button when you have completed that.

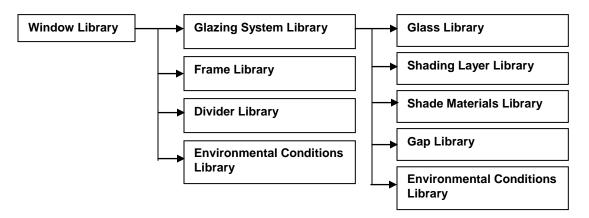


• Then back in the Export dialog box, click the OK button, and the records will be written into the new database, with all the necessary associated records.

When records from the **Window Library** are exported to another WINDOW database, the records referenced in those exported records in all the other libraries that are used either directly or indirectly from those libraries will be included in the exported database:

- Glazing System Library: All the glazing systems referenced in the Window Library entries
- Frame Library: All the frames referenced in the Window Library entries
- **Divider Library:** All the dividers referenced in the Window Library entries, if dividers are modeled.
- **Glass Library:** All the glass layers referenced from the glazing systems used in the Window Library entries
- Shading Layer Library: All the shading layers referenced from the glazing systems used in the Window library entries
- Shade Material Library: All the shade materials referenced from the glazing systems used in the Window Library entries
- Gas Library: All the gases referenced from the glazing systems used in the Window Library entries

• **Environmental Conditions Library:** All the environmental conditions referenced from the glazing systems and the Window Library entries.



# 7.5. Reports

The Window Library has multiple report options, with an additional report in the List view called "Library List". The report options are as follows:

Report 🗾	
Report type: Library List Generate re O Selecte O All reco All reco Energy Plus BSDF IDF File Energy Plus BSDF IDF File AERC Energy Plus BSDF IDF	
Text file options Use default column widths Wrap columns	
Preview	
OK Cancel	

- Library List: A list of the records and all the fields displayed in the List view.
- **Detailed:** a report listing all the information associated with the record.
  - If the report is generated from the List view, and multiple records are selected, one file is generated with the detailed report of each appended onto the file.
  - If the report is generated from the Detail view, the report will only contain the data for the current record.
- **DOE-2:** a report (text file) that contains input data to be used with the DOE-2 hourly simulation program. Due to restrictions in the DOE2 program, this file can only be created from windows with one light, and with generic frames that are all of the same frame type.
- Energy Plus: a report (text file) that contains input data to be used with the Energy Plus hourly simulation program. In contrast to files for DOE2, Energy Plus files can contain windows with multiple lights, generic or THERM frames, and dividers.
- Energy Plus IDF File: a report (text file) that contains input in the native format (IDF) for the Energy Plus hourly simulation program. This file can be inserted directly into a whole building Energy Plus IDF file.
- Energy Plus BSDF IDF File: a report (text file) similar to the standard Energy Plus IDF file except that it also contains a BSDF (Bi-directional Scattering Distribution Function) matrix for modeling optically complex glazing and shading systems.
- **AERC Energy Plus BSDF IDF:** a report (text file) similar to the Energy Plus BSDF IDF file except that it is specifically tied to the input requirements for the AERCalc program.



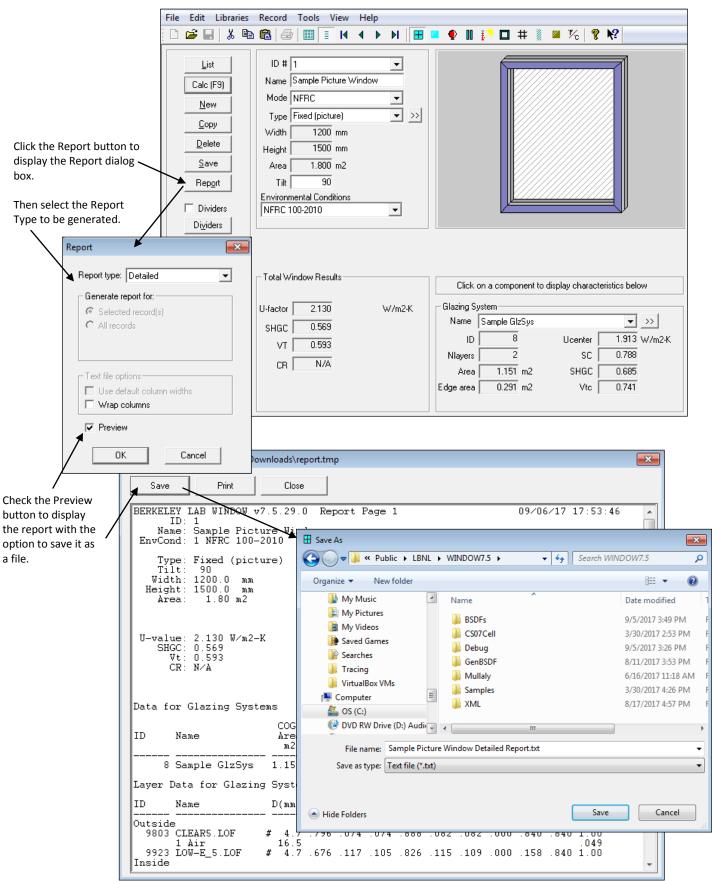


Figure 7-23. Window Library Detailed report from the Window Library Detail screen.

#### Library List Report

The Library List report, generated from the Window Library List view, produces a text file of the selected records and all their results.

Report 💽	
Report type: Library List	
Text file options Use default column widths Vrap columns	
✓ Preview	
OK Cancel	

*Figure 7-24. Report dialog box with settings for generating the Library List report.* 

mpon	mdb)								
	ID	Name	Туре	pe Width Height		Ufactor	SHGC	Tivis	CR
				mm	mm	W/m2-K			
	1	Sample Picture Window	Fixed (picture)	1200	1500	2.130	0.569	0.593	N/A
•	2	Sample Horizontal Slider	Horizontal Slider	1500	1200	?	?	?	?
	3	Sample Double Casement	Casement - Dou	1200	1500	2.039	0.581	0.623	49.4
	4	Sample Vertical Slider	Vertical Slider	1200	1500	2.029	0.586	0.629	50.6
	5	default	Garage door	1016	1016	5.857	0.731	0.708	N/A
	6	CS01 - Generic Wood Frame	Custom Single V	1400	1500	2.102	0.632	0.616	N/A

Figure 7-25. Window Library List View.

Save	Print Close					
[D	Name	Туре	Width	Height	Ufactor	SHGC
	Maile	Type	mm	mm	V∕m2-K	5000
L	Sample Picture Window	Fixed (picture)	1200	1500	2.130	0.569
2	Sample Horizontal Slider	Horizontal Slide	1500	1200	?	?
3	Sample Double Casement	Casement - Doubl	1200	1500	2.039	0.581
4	Sample Vertical Slider	Vertical Slider	1200	1500	2.029	0.586
5	default	Garage door	1016	1016	5.857	0.731
6	CS01 - Generic Wood Frame	Custom Single Vi	1400	1500	2.102	0.632

*Figure 7-26. Window Library List report, which contains the results for all the records.* 

#### **Detailed Report**

The Detailed Report contains all relevant information about the total window results and component details.

```
BERKELEY LAB WINDOW v7.7.4.0 Report Page 1
                                                                   01/29/19 15:28:01
      ID: 1
 Name: Picture
EnvCond: 1 NFRC 100-2010
    Type: Fixed (picture)
    Tilt: 90
   Width: 1200.0
                   mm
  Height: 1500.0 mm
            1.80 m2
    Area:
U-value: 3.261 W/m2-K
SHGC: 0.628
Vt: 0.657
      CR: N⁄A
Data for Glazing Systems
                         COG
ID
                                                Uc
                                                                               RHG
       Name
                         Area #Lay
                                     Tilt
                                                         SCc
                                                               SHGCc
                                                                        Vtc
                          m2
                                               W∕m2
     2 Double Clear Ai 1.207
                                      90
                                                        0.808
                                                               0.703
                                                                       0.786
                                                                                532
                                 2
                                               2.664
Layer Data for Glazing System '2 Double Clear Air'
ID
                        D(mm) Tsol 1 Rsol 2 Tvis 1 Rvis 2 Tir 1 Emis 2 Keff
       Name
Outside
                              .771 .070 .070 .884 .080 .080 .000 .840 .840 1.00
   103 CLEAR_6.DAT
                       #
                          5.7
                         12.0
       1 Air
                                                                                .064
   103 CLEAR_6.DAT
                       # 5.7 .771 .070 .070 .884 .080 .080 .000 .840 .840 1.00
Inside
Frame Data
                                                         Frame
                                                                 Edge
                  ID
                          Name
                                                                                   Uedge
Location
                                          Source
                                                         Area
                                                                 Area
                                                                          Uframe
                                                          m2
                                                                  m2
                                                                             W∕m2-K
                                                         0.065
                          Al w/break
                                          ASHRAE/LBL
                                                                 0.065
                                                                          5.6800
                                                                                  3.2825
Header
                       1
                                                                                  3.2825
Left Jamb
                       1
                          Al w⁄break
                                          ASHRAE/LBL
                                                         0.082
                                                                 0.084
                                                                          5.6800
                                          ASHRAE/LBL
                                                         0.082
                                                                 0.084
                                                                          5.6800
                                                                                  3.2825
Right Jamb
                       1
                          Al w/break
Sill
                                          ASHRAE/LBL
                                                                 0.065
                                                                          5.6800
                          Al w/break
                                                         0.065
                                                                                  3.2825
                       1
Gas Data
ID
        Name
                                    Type
                                            Cond
                                                    Visc
                                                             Ср
                                                                    Dens
                                                                             Pran
                                                    x e-6
     1
                                           0.0241
                                                    17.22 1006.10 1.2925 0.7197
        Air
                                    Pure
```

Figure 7-27. Window Library Detailed Report sample, Page 1.

BERKELEY LAB WINDOW v7.7.4.0 Report Page 2 01/29/19 15:28:01 Environmental Conditions: 1 NFRC 100-2010 Tin WndSpd Solar Tsky Tout Wnd Dir Esky (C) (C) (V∕m2) (m∕s) (C) 0.0 - 18.0-18.021.0 5.50 Windward 1.00 Uvalue 24.0 2.75 Windward 783.0 32.0 Solar 32.0 1.00 Frame Library Data U-value Edge GlzSys GlzSys Width ID Name Source Frame Edge Corr Width Uc (PFD) Abs 1 Al w/break ASHRAE/LBL 5.6800 N⁄A 1 N⁄A N/A 57.15 0.90 Divider Library Data U-value Edge GlzSys GlzSys Width ID Name Source Div Edge Corr Width Uc (PFD) Abs No Dividers for this Glazing System Optical Properties for Glazing System '2 Double Clear Air' Angle 0 10 20 30 40 50 60 70 80 90 Hemis Vtc . : 0.786 0.786 0.784 0.779 0.766 0.735 0.663 0.510 0.253 0.000 0.683 : 0.144 0.144 0.144 0.147 0.157 0.185 0.253 0.403 0.662 1.000 0.229 Rf : 0.144 0.144 0.144 0.147 0.157 0.185 0.253 0.403 0.662 1.000 0.229 RЬ Tsol : 0.607 0.606 0.601 0.593 0.577 0.546 0.483 0.362 0.165 0.000 0.510  $: 0.114 \ 0.114 \ 0.114 \ 0.115 \ 0.123 \ 0.145 \ 0.201 \ 0.328 \ 0.566 \ 1.000 \ 0.184$ Rf RЪ  $: 0.114 \ 0.114 \ 0.114 \ 0.115 \ 0.123 \ 0.145 \ 0.201 \ 0.328 \ 0.566 \ 1.000 \ 0.184$ Abs1 : 0.167 0.168 0.170 0.175 0.182 0.190 0.200 0.209 0.202 0.000 0.185 Abs2 : 0.113 0.113 0.115 0.116 0.118 0.119 0.115 0.101 0.067 0.000 0.111 SHGCc: 0.703 0.702 0.699 0.693 0.679 0.650 0.586 0.457 0.238 0.000 0.608 Tdw-K : 0.524 Tdw-ISO: 0.690 : 0.463 Tuv BERKELEY LAB WINDOW v7.7.4.0 Report Page 3 01/29/19 15:28:01 Temperature Distribution (degrees C) Winter Summer Out In Out In Lay1 -14.4 -13.9 Lay2 5.7 6.3 37.9 38.2 36.9 36.6

Figure 7-28. Window Library Detailed Report sample, Page 2.

#### **DOE2** Report

The DOE2 report contains data that the DOE-2.1E hourly simulation program can use for window modeling. The report is saved as a text file from WINDOW5, and then used as a text file with the DOE-2.1E program.

The file can contain data for one or more windows. In the case of a file containing data for more than one window, the information for each window follows the previous window in succession.

BERKELEY LAB WINDOW v7.7.4.0 DOE-2 Data File : Multi Band Calculation
Unit System : SI Name : DOE-2 WINDOW LIB Desc : Picture Window ID : 1 Tilt : 90.0 Glazings : 2 Frame : 1 Ål w/break 5.680 Spacer : 1 Class1 2.330 -0.010 0.138 Total Height: 1500.0 mm Total Height: 1500.0 mm Glass Height: 1385.7 mm Glass Width : 1085.7 mm
$\begin{array}{lllllion & : \ None \\ Gap & Thick & Cond & dCond & Vis & dVis & Dens & dDens & Pr & dPr \\ 1 & Air & 12.0 & 0.02407 & 7.760 & 1.722 & 4.940 & 1.292 & -0.0046 & 0.720 & -0.0002 \\ 2 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 4 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 5 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ Angle & 0 & 10 & 20 & 30 & 40 & 50 & 60 & 70 & 80 & 90 & Hemis \\ Tsol & 0.607 & 0.606 & 0.601 & 0.593 & 0.577 & 0.546 & 0.483 & 0.362 & 0.165 & 0.000 & 0.510 \\ Abs1 & 0.167 & 0.168 & 0.170 & 0.175 & 0.182 & 0.190 & 0.200 & 0.209 & 0.202 & 0.000 & 0.185 \\ Abs2 & 0.113 & 0.115 & 0.116 & 0.118 & 0.119 & 0.115 & 0.101 & 0.067 & 0.000 & 0.111 \\ Abs3 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & $
Layer ID# 103 103 0 0 0 0 Tir 0.000 0.000 0 0 0 0 Emis F 0.840 0.840 0 0 0 0 Emis B 0.840 0.840 0 0 0 Thickness(mm) 5.7 5.7 0 0 0 0 Cond(V/m2-K )175.0 175.0 0 0 0 0 Spectral File CLEAR_6.DAT CLEAR_6.DAT None None None
$ \begin{array}{c ccccccccccccccccccccccccccccccccccc$

Figure 7-29. Window Library DOE2 Report sample.

### **Energy Plus Report**

The Energy Plus report contains data that the Energy Plus hourly simulation program can use for window modeling. The report is saved as a text file, and then used as a text file with the Energy Plus program.

The file can contain data for one or more windows. In the case of a file containing data for more than one window, the information for each window follows the previous window in succession.

Window5 Data File for EnergyPlus BERKELEY LAB WINDOW v7.7.4.0 Date : Tue Jan 29 15:35:09 2019 Window name : 1 Picture Description : Fixed (picture) Date : Vindow name : 1 Picture Description : Fixed (picture) # Glazing Systems 1 GLAZING SYSTEM DATA: Height Width nPanes Uval-center SC-center SHGC-center Twis-center System1 : 1386 1086 2 2.664 0.808 0.703 0.786 FRAME/MULLION DATA: Width OutsideProj InsideProj Cond EdgeCondRatio SolAbs VisAbs Emiss I Sill : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 I Head : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 R Head : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Top I Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Top R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Bot I Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 0.900 0.900 Dest R Jamb : 57.2 25.4 25.4 56.424 1.484 0.900 Orient'n (mull) 

 57.2
 23.4
 -- 

 None
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 25.4
 56.424
 1.484
 0.900
 0.900
 0.90

 Width OutsideProj InsideProj Cond EdgeCondRatio SolAbs VisAbs Emiss Type
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 0.000 Average frame DIVIDER DATA #Hor #Vert 0 0 EmissB Spect System1 GLASS DATA SpectralDataFile CLEAR\_6.DAT EmissF System1 0.840 0 .840 0.840 CLEAR 6.DAT GAP DATA System1 GAS DATA GasName System1 Gap1 Air GLAZING SYSTEM OPTICAL DATA Angle 0 10 20 30 104 0.601 0.593 0 175 Gap# Thick nGasses 1 12.00 1 1 Fraction MWeight ACond BCond CCond AVisc BVisc CVisc ASpHeat BS 0000 28.97 0.002873 7.76e-05 0 3.723e-06 4.94e-08 0 1002.74 0.012324 BSpHeat CSpHea 1.0000 4050 60 70 80 90 Hemis 
 Angle
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 10
 20
 30
 40
 50
 60
 70
 80
 90
 Hemis

 System1
 Tsol
 0.607
 0.606
 0.601
 0.593
 0.577
 0.546
 0.483
 0.362
 0.165
 0.000
 0.510

 Abs1
 0.167
 0.168
 0.170
 0.175
 0.182
 0.90
 0.200
 0.209
 0.202
 0.000
 0.181

 Abs2
 0.113
 0.113
 0.115
 0.116
 0.118
 0.119
 0.115
 0.101
 0.067
 0.000
 0.181

 Rbs01
 0.114
 0.114
 0.115
 0.123
 0.144
 0.201
 0.328
 0.566
 1.000
 0.184

 Rbs01
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 0.114
 0.115
 0.123
 0.145
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 0.328
 0.566
 1.000
 0.184

 Tvis
 0.786
 0.784
 0.779
 0.766
 0.735
 0.663
 0.510
 0.523
 0.000
 0.683

 Rfvis
 0.144

Figure 7-30. Window Library Energy Plus Report sample.

#### Energy Plus IDF Report

Two different IDF files are created with this report selection. One has spectral data for the glass layers and the other has averaged spectral data. The name of the files contains the name of the window with either "Avg" or "Spec" added to the end of the filename.

Energy Plus IDF Report with averaged spectral data for glass layers

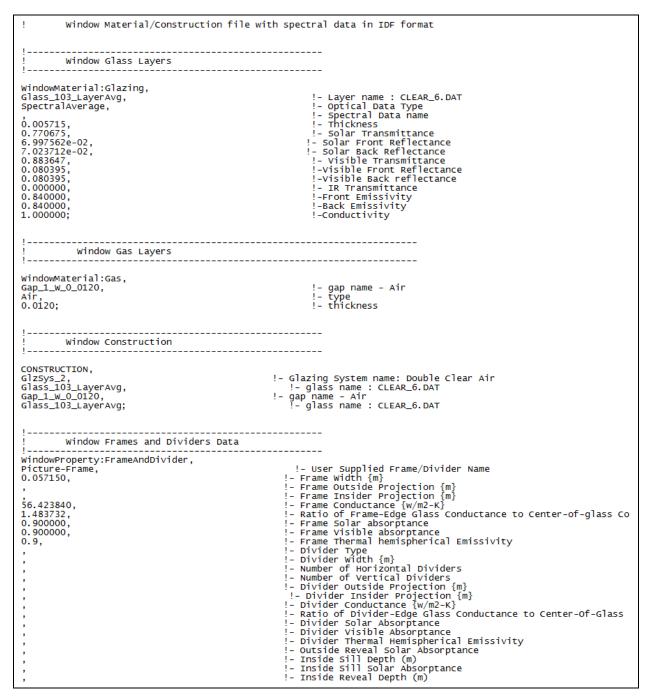


Figure 7-31. Window Library Energy Plus IDF file with averaged spectral data example.

! Window Material/Construction file wi ! Generated by BERKELEY LAB WINDOW v7.	
! Window Glass Layers	
WindowMaterial:Glazing, Glass_103_Layer, Spectral, Glass_103_Layer_SpecDat, 0.005715, , , , , , , , , , , , , , , , , , ,	<pre>!- Layer name : CLEAR_6.DAT !- Optical Data Type !- Spectral Data name !- Thickness !- Solar Transmittance !- Solar Front Reflectance !- Solar Back Reflectance !- Visible Transmittance !- Visible Front Reflectance !- Visible Back reflectance !- IR Transmittance !-Front Emissivity !-Back Emissivity !-Conductivity</pre>
Window Gas Layers	
windowMaterial:Gas, Gap_1_W_0_0120, Air, 0.0120;	!- gap name - Air !- type !- thickness
! ! Window Construction	
CONSTRUCTION, GlzSys_2, Glass_103_Layer, Gap_1_W_0_0120, Glass_103_Layer;	!- Glazing System name: Double Clear Air !- glass name : CLEAR_6.DAT !- gap name - Air !- glass name : CLEAR_6.DAT

# Energy Plus IDF Report with detailed spectral data for glass layers

Figure 7-32. Window Library Energy Plus IDF file with detailed spectral data example (continued).

!			
!			
	- Spectral	Data	Name
0.300000,0.000000,0.047000,0.049000, 0.305000,0.005000,0.047000,0.049000,			
0.310000,0.000000,0.047000,0.048000, 0.315000,0.003000,0.046000,0.048000,			
0.320000,0.019000,0.046000,0.048000,			
0.325000,0.066000,0.045000,0.046000, 0.330000,0.160000,0.045000,0.047000,			
0.335000,0.294000,0.049000,0.050000, 0.340000,0.437000,0.055000,0.056000,			
0.345000,0.566000,0.062000,0.062000,			
0.350000,0.671000,0.069000,0.069000, 0.355000,0.744000,0.074000,0.074000,			
0.360000,0.793000,0.078000,0.078000,			
0.365000,0.822000,0.080000,0.080000, 0.370000,0.832000,0.081000,0.081000,			
0.375000,0.819000,0.080000,0.080000, 0.380000,0.809000,0.079000,0.079000,			
0.385000,0.829000,0.080000,0.080000,			
0.390000,0.853000,0.082000,0.082000, 0.395000,0.868000,0.083000,0.083000,			
0.400000,0.875000,0.083000,0.083000, 0.410000,0.875000,0.083000,0.083000,			
0.420000,0.873000,0.083000,0.083000,			
0.430000,0.873000,0.082000,0.082000, 0.440000,0.873000,0.082000,0.082000,			
0.450000,0.880000,0.082000,0.082000, 0.460000,0.887000,0.082000,0.082000,			
0.470000,0.890000,0.082000,0.082000,			
0.480000,0.892000,0.083000,0.083000, 0.490000,0.893000,0.082000,0.082000,			
0.500000,0.894000,0.082000,0.082000,			
0.510000,0.895000,0.082000,0.082000, 0.520000,0.895000,0.082000,0.082000,			
0.530000,0.894000,0.082000,0.082000, 0.540000,0.893000,0.081000,0.081000,			
0.550000,0.891000,0.081000,0.081000,			
0.560000,0.888000,0.081000,0.081000, 0.570000,0.884000,0.080000,0.080000,			
0.580000,0.881000,0.080000,0.080000, 0.590000,0.876000,0.079000,0.079000,			
0.600000,0.871000,0.079000,0.079000,			
0.610000,0.865000,0.078000,0.078000, 0.620000,0.859000,0.077000,0.077000,			
0.630000,0.853000,0.077000,0.077000, 0.640000,0.847000,0.076000,0.076000,			
0.650000,0.840000,0.075000,0.075000,			
0.660000,0.833000,0.075000,0.075000, 0.670000,0.826000,0.074000,0.074000,			
0.680000,0.818000,0.073000,0.073000, 0.690000,0.810000,0.073000,0.073000,			
0.700000,0.802000,0.072000,0.072000,			
0.710000,0.794000,0.071000,0.072000, 0.720000,0.786000,0.071000,0.071000,			
0.730000,0.777000,0.070000,0.070000, 0.740000,0.769000,0.069000,0.070000,			
0.750000,0.761000,0.069000,0.069000,			
0.760000,0.752000,0.068000,0.068000, 0.770000,0.744000,0.067000,0.068000,			
0.780000,0.736000,0.067000,0.067000, 0.790000,0.729000,0.066000,0.066000,			

Figure 7-33. Window Library Energy Plus IDF file with detailed spectral data example (continued).

```
Window Frames and Dividers Data
                                                                                                                                                                                                                                   !- User Supplied Frame/Divider Name
!- Frame Width {m}
!- Frame Outside Projection {m}
!- Frame Insider Projection {m}
!- Frame Conductance {w/m2-k}
!- Ratio of Frame-Edge Glass Conductance to Center-of-glass Co
!- Frame Solar absorptance
!- Frame Thermal hemispherical Emissivity
!- Divider Type
!- Divider Width {m}
!- Number of Horizontal Dividers
!- Number of Horizontal Dividers
!- Number of Vertical Dividers
!- Divider Outside Projection {m}
!- Divider Insider Projection {m}
!- Divider Conductance {w/m2-K}
!- Ratio of Divider-Edge Glass Conductance to Center-Of-Glass
!- Divider Solar Absorptance
!- Divider Visible Absorptance
!- Divider Thermal Hemispherical Emissivity
!- Outside Reveal Solar Absorptance
!- Inside Sill Depth (m)
!- Inside Sill Solar Absorptance
WindowProperty:FrameAndDivider,
Picture-Frame,
0.057150,
,
56.423840,
1.483732,
0.900000,
0.900000,
0.9,
 ,
 ,
 ,
 ,
```

Figure 7-34. Window Library Energy Plus IDF file with detailed spectral data example (continued).

# 7.6. Condensation Resistance (CR) Calculation

WINDOW includes a feature which calculates the whole product Condensation Resistance (CR) using the methodology presented in NFRC 500. This process involves importing files from THERM5 into the Frame and Divider library that have been modeled in THERM with the Condensation Resistance feature. See the THERM5 User's Manual for the specifics of modeling these THERM files. The modeling procedures for CI are slightly different from those for U-factor, and will mostly likely mean that different THERM files must be created for the CR and U-factor calculations. This will also mean that in WINDOW, separate surface temperatures from THERM for each cross-section; surface temperatures are then area weighted in accordance with NFRC 500 which considers the areas covered with condensation at three different relative humidities. The resulting total product CR value is presented on the Total Window Results section of the Window Library Detail button to the right of the CR value on the Window Library Detail View shows intermediate component specific values used in the CR calculation.

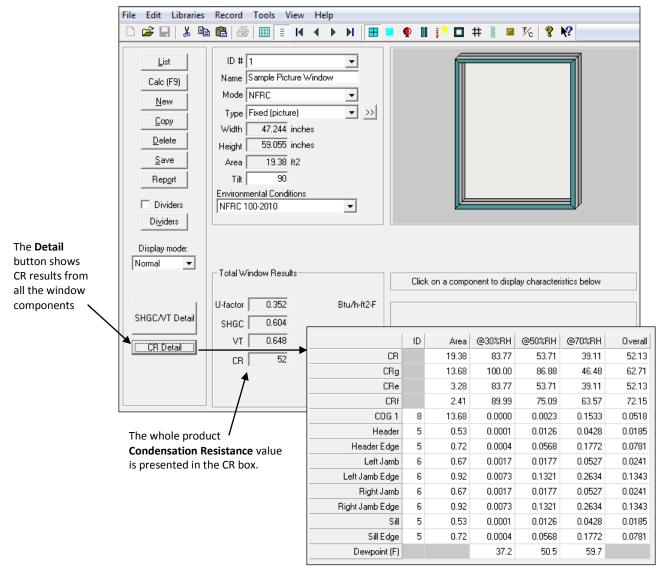


Figure 7-35. Condensation Index results for the whole window product.

This chapter discusses the Glazing System Library in detail.

# 8.1. Glazing System Library List View

The List View shows all the records in the Glazing System Library and some of the characteristics of the glazing system from the Detailed View.

The list can be sorted by any column by double clicking on the desired column.

File Edit Librari	es R	ecord	Tools View Help									
D 🚅 🖬   % 🖣	a 🖪	6	= K < ≻ >   = = ♥ 🖩 🗗 #	2	K   9	2						
Datalation	Glazin	g Syste	m Library (C:\Users\Public\LBNL\WINDOW7.6\w7.mdb)		_	_						
Detailed View												
Calc		ID	Name	# of Layers	Mode	Tilt	Environmental Conditions	Overall Thickness	Uval	SHGC	Tvis	Tdw-ISO
New								mm	W/m2-K			
	•	1	Single Clear	1	#	90	NFRC 100-2010	3.05	5.913	0.861	0.899	0.842
Сору		2	Double Clear Air	2	#	90	NFRC 100-2010	23.43	2.703	0.704	0.786	0.690
Delete		3	Double Low-e Air	2	#	90	NFRC 100-2010	21.60	1.684	0.431	0.639	0.487
Find		4	Double Clear with Argon	2	#	90	NFRC 100-2010	18.80	2.576	0.764	0.814	0.738
ID 👻		5	Triple Clear	3	#	90	NFRC 100-2010	42.55	1.744	0.617	0.703	0.601
		7	Double high solar gain low-e	2	#	90	NFRC 100-2010	25.93	1.935	0.686	0.741	0.635
		8	Sample GizSys	2	#	90	NFRC 100-2010	25.93	1.935	0.686	0.741	0.635
Advanced		9	Double low-e (vacuum)	2	#	90	NFRC 100-2010	8.06	0.634	0.354	0.691	0.517
26 records found.		10	Double low-e (air) - deflected	2	#	90	NFRC 100-2010	21.75	1.663	0.362	0.685	0.512
Import		11	Triple low-e (argon) - deflected	3	#	90	NFRC 100-2010	43.12	0.700	0.298	0.515	0.349
		13	Double clear (air) with white frit - 50% coverage	2	#	90	NFRC 100-2010	24.13	2.689	0.499	0.528	0.423
Export		20	Double low-e (argon) with ext. perforated screen	3	#	90	NFRC 100-2010	37.33	1.050	0.056	0.062	-1.000
Report		30	Double low-e (argon) with int. horiz. VB (45 deg)	3	#	90	NFRC 100-2010	54.69	1.243	0.264	0.147	0.092
Print		31	Double low-e (argon) with inbetween horiz. VB (45 deg)	3	#	90	NFRC 100-2010	21.15	3.379	0.295	0.159	0.104
Find		32	Double low-e (argon) with ext. horiz. VB (45 deg)	3	#	90	NFRC 100-2010	90.61	1.082	0.086	0.112	0.072

Figure 8-1. Glazing System Library, List View.

### 8.1.1. Buttons

The buttons on the left hand side of the List View have the following functions:

Detailed View	Used to access the detailed view of the record, where the input values can be edited.
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s).
Find	Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.

	Advanced: Used to access a more advanced method of searching the list
Import	Currently disabled.
Export	Used to create a Window 4.1 file of glazing system records, called glzsys.w4. This file can then be imported into THERM or Window 4.1.
Report	Currently disabled.
Print	Used to print a report which contains a list of all the records in the library.

#### 8.1.2. Column Headings

The List view contains columns with selected results (from the Detail view) for each record, as described below.

ID	The unique ID associated with each glazing system record.
Name	The name of the glazing system. This is defined by the user.
# of Layers	The number of layers for the glazing system. The layers are increased or decreased using the up and down arrows to the right of this field. The program will automatically adjust the number of layers in the layers detail section of the screen based on this number
Mode	The mode value will depend on the layers. If one layer has a # in the Mode field, then the entire glazing system will have a # designation. Used by NFRC for their approved certification models.
Tilt	The tilt of the glazing system.
Environmental Conditions	The name of the appropriate environmental condition from the Environmental Condition Library, selected using the arrow to the right of the field. <b>Default:</b> ASHRAE/NFRC.
Overall Thickness	The overall thickness of the glazing system. <b>Units:</b> mm (SI); inches (IP).
Uval	Center of glass U-factor. By default this value assumes a one meter high glazing system. When the glazing system is used in a window (in the Window Library) the actual window height is used to calculate the U-factor, and therefore, if the window height is not equal to one meter, the center of glass U-factors will be different in the Glazing System results and the Window Library results. <b>Units:</b> W/m <sup>2</sup> -K (SI); Btu/h-ft <sup>2</sup> -°F (IP)
SHGC	Center of glass Solar Heat Gain Coefficient. Unitless.
Tvis	Center of glass visible transmittance
Tdw-ISO	Damage-weighted transmittance of the glazing system, based on the ISO 15099 calculation method. See detailed description under the section "Glazing System

Detail View".

## 8.2. Glazing System Library Detail View

The Glazing System Library is used to construct glazing systems to determine the center of glass U-factor, which can be used in the Window library to construct a whole product. Glazing Systems consist of glass layers selected from the Glass Library (which are from the Optics database), an optional shading layer selected from the Shading Layer Library, and definitions of the gaps between the glass layers, which are defined by a thickness and selections from the Gap Library. When the glass layers, shading layers, and gaps have been defined, the results are calculated using the **Calc** button.

The Detail View shows details of individual glazing systems in the Glazing System Library.

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List Calc (F3) New Copy Delete Save Report	ID #: 31 # Layers: 3 Environmental Conditions: NFRC Comment Overall thickness: 21.154	Name: [	Double low-e (argon) 90 Â* IG Heij 🚽 IG Wie	with inb	etween 000.00 000.00	horiz. mm mm	. VB (45		1	2 3										
Radiance		ID	Name		n	-r_	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond	Di()	Dhat (area)	Diduteral	Di-9 (corr)
	✓ Glass 1 ►►		AR 6.DAT	Mode ' #					HISOI2	0.884	0.080		0.000	0.840	E2 0.840		Dtop (mm)	D Dot (mm)	Dright (mm)	Diert (mm)
	Gap 1 🕨		10%) / Argon (90%) ł		1.3	-		0.010	0.010	0.004	0.000	0.000	0.000	0.040	0.040	1.000				
	<ul> <li>Shade 2 &gt;&gt;</li> </ul>		'inbetween VB (whit		7.2												0.0	0.0	0.0	0.0
	Gap 2 🔸	9 Air (1	10%) / Argon (90%) I		1.3															
	Glass 3      →	103 CLE.	AR_6.DAT	#	5.7 [	] 0	).771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000				
	•						11													4
	Center of Glass Results	Temperature	Data Optical Data	Angu	ar Data	Col	lor Prop	erties	Radiano	e Resul	s									
	Ufactor	SC	SHGC	Rel. H	lt. Gain		Tvi	is		Keff	L	ayer 1 K	eff	Gap 1	Keff	Layer	2 Keff	Gap 2 Keff	Layer	3 Keff
	W/m2-K			W	/m2				V	//m-K		W/m-K		W/m	-K	W.	/m-K	W/m-K	W	′m∙K
	3.379	0.339	0.295	2	40		0.15	59	0	1109		1.0000		0.021	16	3.2	549	0.0224	1.0	000

Figure 8-2. Glazing System Library, Detail View.

### 8.2.1. Buttons

The buttons on the left hand side of the Detail View have the following functions:

List	Used to access the List view of the Glazing System Library, which shows all the records in the library
Calc (F9)	Used to calculate the current record
New	Used to make a new record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the current record.
Save	Used to save the current record.
Pmort	Used to greate a report of the surrent record. The following dialog has apone when this

*Report* Used to create a report of the current record. The following dialog box opens when this button is clicked.

Report 🛛 🕅
Report type: Detailed
Generate report for:
Selected record(s)
C All records
Text file options Use default column widths Wrap columns
Preview
OK Cancel

Figure 8-3. Glazing System Report dialog box

**Report Type:** A pulldown list with three report options

- Detailed
- Energy Plus IDF File
- Energy Plus BSDF IDF File

**Generate report for:** In the Detail view, this is always set to "Selected record(s)", i.e., the current record.

**Text file options:** Checking the Wrap Columns box will cause the program to include all the text in long fields by wrapping it to the next line. Without this box checked, that

text will be truncated.

With Wrap Text unchecked, the Name of the Glass layer is truncated to

Layer Data for Glazing	System '50 Sage Green'
ID Name	D(mm) Tsol 1 Rsol 2 Tvis
Outside 8915 SageGlass_9_Grea 1 Air	# 8.7 .208 .047 .124 .550 12.7

Figure 8-4. Glazing System Report, no text wrapping

With Wrap Text checked, the full name of the Glass layer is displayed by wrapping it to the next line or lines as needed.

Layer I	Data for Glazing	System	ι '50	Sage	Green	1'
ID	Name	D(mm)	Tsol	1 Ra	sol 2	Tvis
Outside 8915	= SageGlass_9_Gre# en_49clr.SAG	≠ 8.7	. 208	.047	.124	. 550

Figure 8-5. Glazing System Report, with text wrapping

Preview: Checking the Preview box allows you to view the report before saving it.

Report C:\Users\Public\LBNL\WIN	NDOW7.5\report.tmp	8
Save Print	Close	
BERKELEY LAB WINDOW v7.	5.29.0 Glazing System Thermal and Optical Properties (	)9/2 🔺
ID : 50 Name : Sage Green Tilt : 90.0 Glazings: 2 KEFF : 0.0657 Width : 24.448 Uvalue : 1.83 SHGCc : 0.27 SCc : 0.31 Vtc : 0.50 RHG : 211.85		E
Layer Data for Glazing	System '50 Sage Green'	
ID Name	D(mm) Tsol 1 Rsol 2 Tvis 1 Rvis 2 Tir 1 Emis 2 Kef	f
1 Air	* 8.7 .208 .047 .124 .550 .052 .035 .000 .840 .140 .72 12.7 .03 * 3.0 .834 .075 .075 .899 .083 .083 .000 .840 .840 1.0	36

Figure 8-6. Glazing System Report preview

*Radiance* Used to initiate a Radiance calculation for the current record. Clicking this button brings up the following dialog box

Radiance		×
Sun Position		
Oate/time	Month Jun V Day 21 V Time 12:00	
	Latitude 38.0 🔺 Longitude 122.0 🔺	
🔘 Manual	Altitude 42.5 Azimuth 0.0	
Room geometry	SimpleRoom 💌	
Calculation detail	Low	
View	Fisheye 💌	Close
Sky specification	+s sunny sky, with sun 💌	
Comment		

Figure 8-7. Glazing System Radiance button options

Sun Position: The settings that Radiance will use to generate the rendering

**Date/time:** selecting this sun position option allows input of date, time, latitude and longitude

**Manual:** selecting this sun position option allows the input of an exact altitude and azimuth for the Radiance model

Room Geometry: There is currently only the option of "SimpleRoom"

Calculation detail: There is currently only the option of "Low"

**Sky specification:** This pulldown has several options which determine what type of sky conditions are used for the Radiance model

Sky specification	+s sunny sky, with sun	-
	+s sunny sky, with sun	
	-s sunny sky, no sun -c cloudy sky	
	+i intermediate sky, with sun -i intermediate sky, no sun -u uniform cloudy sky	

*Figure 8-8. Glazing System Radiance button, Sky specification options.* 

Comment: A user editable comment

**Calc:** The calc button will initiate the Radiance calculation. If a message appears asking about detailed angular data, click the Yes button to produce a more accurate Radiance

rendering. A "calculating" dialog box will appear, showing the different angular calculations being performed.

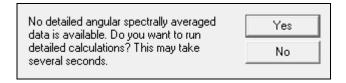


Figure 8-9. Message presented before Angular calculations are performed

When the detailed angular calculations are complete, the program will display this dialog box (click the OK button to start the Radiance calculations)

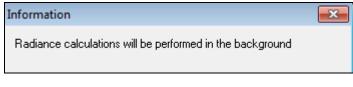


Figure 8-10. Message indicating Radiance will run in the background and other work can be performed in the program

A DOS window will appear which is where the Radiance calculation is running

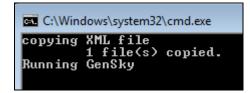


Figure 8-11. Radiance DOS window displays during Radiance calculation

When the run is finished, the program will display a dialog box indicating it is complete.



Figure 8-12. Message indicating Radiance run is completed.

#### 8.2.2. Overall Glazing System

The following section describes the input fields for the overall glazing system.

ID #: 3	31 Name:	Double low-e (	(argon) with i	nbetween horiz. Vł	B (45 deg)
# Layers: 🕄		90 Â*	IG Height:	1000.00 mm	
Environmental Conditions:	NFRC 100-2010	•	IG Width:	1000.00 mm	
Comment:					
Overall thickness: 2	21.154 mm	Mode: #	M	odel Deflection	1 2 3

Figure 8-13. Glazing System Detail View, general information

ID The	unique ID associated w	ith each glazing system record.
--------	------------------------	---------------------------------

- *Name* The name of the glazing system, input by the user. Legal values: up to 256 characters.
- #Layers The number of layers for the glazing system. The layers are increased or decreased using the up and down arrows to the right of this field. The program will automatically adjust the number of layers in the layers detail section of the screen based on this number
- *Tilt* The tilt of the glazing system. **Default:** 90°
- *IG Height* The height of the glazing system to be modeled. The default value is based on the value input in the **Preferences/Options** "Glazing system height" input box. This value can be overridden by the user for each record by changing the value in this input box. **Default:** 1000 mm.
- *IG Width* The width of the glazing system to be modeled. The default value can be overridden by the user for each record by changing the value in this input box. **Default:** 1000 mm
- EnvironmenThe name of the appropriate environmental condition from the Environmental<br/>condition Library, selected using the arrow to the right of the field. Default:<br/>ASHRAE/NFRC.
- *Comment* A user entered comment.

Thickness

- *Overall* The overall thickness of the glazing system. **Units:** mm (SI); inches (IP).
- *Mode* The mode value will depend on the layers. If one layer has a # in the Mode field, then the entire glazing system will have a # designation. Used by NFRC for their approved certification models.

ModelA checkbox which, when checked, will cause the program to model the glazing systemDeflectionin both a deflected and non-deflected state. If "Model Deflection" is checked, an<br/>additional set of input values are displayed. Also, a second line will appear in red in<br/>the Center of Glass Results tab at the bottom of the screen to show the deflected<br/>properties of the glazing system.

**Input:** There are two options for defining the deflection in a glazing system, selected from this pulldown list:

Input:	Pressure/Temp	]
	Pressure/Temp Deflected Gan Width	
	Deflected Gap Width	

Figure 8-14. Deflection input options.

**Pressure/Temp:** This selection allows input of the temperature and pressure for calculating the glazing system deflection.

Deflection		
Input:	Pressure/Temp	-
Temp (initial):	25.0	С
Pressure (initial):	101325	Pa
Pressure (atmospheric):	75000	Pa

Figure 8-15. Deflection options if Input = Pressure/Temp

**Temp (initial):** The temperature the glazing system was originally manufactured under

**Pressure (initial):** The pressure the glazing system was originally manufacturerd under

**Pressure (atmospheric):** The current outside pressure that the glazing system is experiencing

• **Deflected Gap Width:** This selection allows input of the actual measured deflection of each gap width in the glazing system. Based on this information, the program will determine the deflection of each glass layer as well as the thermal characteristics of the glazing system in the deflected state.

– Deflection –	Input: Deflected G	iap Width 💌
Gap #	Gap Width	mm

Figure 8-16. Deflection options if Input = Deflected Gap Width

**Gap #:** This pulldown will have a different selection for each gap in the current glazing system. Select the gap being defined

**Gap Width:** For the Gap # selected in the pulldown, input the value of the actual measured deflection of the gap.

#### 8.2.3. Glazing System Layers

The following section describes the input fields for the layers in the glazing system.

The layer order is from outside to inside, so Glass (or Shade) 1 is the outermost layer in the glazing system.

			ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond	Dtop (mm)	Dbot (mm)	Dright (mm)	Dieft (mm)
-	Glass 1	••	103	CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000				
	Gap 1	••	9	Air (10%) / Argon (90%) I		1.3															
-	Shade 2	••	32	0.4" inbetween VB (whit		7.2												0.0	0.0	0.0	0.0
	Gap 2	••	9	Air (10%) / Argon (90%) I		1.3															
-	Glass 3	••	103	CLEAR 6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000				

Figure 8-17. Glazing Systems Detail View, Layers section

*Column 1* A pulldown list to define the type of layer, from the following options:

- **Glass:** Select this option for modeling the layer as a glass layer. If this option is selected, the list of layers to select will be from the Glass Library
- Shade or Frit: Select this option for modeling the layer as a Shading Layer or Fritted Glass. If this option is selected, the list of layers to select will be from the Shading Layer Library
- **Gap:** The program automatically assigns the layer between two glass or shade layers to be Gap. In this layer, the records to select are from the Gap Library

••

The double arrow "selection button" opens a separate dialog box to show the records from the appropriate library (Glass, Shading Library or Gap).

Sele	elect		Find	▼ 4886 records found.				
	ID	Name	ProductName	Manufacturer	Source	Mode	Color	Th
	100	BRONZE_3.DAT	Generic Bronze Glass	Generic	IGDB v11.4	#		
	101	BRONZE_6.DAT	Generic Bronze Glass	Generic	IGDB v11.4	#		Ę
	102	CLEAR_3.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		:
•	103	CLEAR_6.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		
	104	GRAY_3.DAT	Generic Grey Glass	Generic	IGDB v11.4	#		1

*Figure 8-18.* Double arrow selection button opens a Select dialog box showing the Glass Library records.

ID

The unique ID associated with each layer, from the appropriate library (Glass, Shading

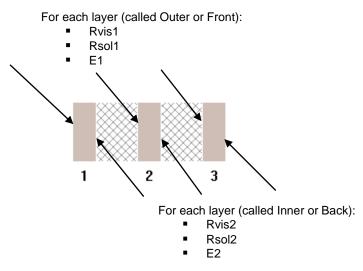
Layer or Gap). This value can be typed into this field, and the program will automatically fill in the name from that library record.

Name The name of the layer, from the name of the record selected from the appropriate library (Glass, Shading Layer or Gap). This is not editable by the user.
 Mode An identifier to determine the glass layer approval status. At this time, the only approval mode implemented is NFRC, indicated by "#", and only records with "#" in this field can be used for NFRC simulations
 Thick Layer thickness. Units: mm (SI); inches (IP).
 Flip A checkbox to indicate whether or not the layer is flipped (this currently only applies to "Glass" layer types). Click the box to put an 'x' in it, which indicates that the layer is flipped. This will cause the values for emissivities on the 1 and 2 surfaces to be interchanged.

## **Solar and Optical Layer Properties**

The next set of values in the Glazing System Library layer table are the averaged solar and thermal properties for each layer.

The naming convention for the case where there are two values, one for each "side", "1" represents the outer or front side, and "2" represents the inner or back side.



- *Tsol* Solar transmittance of the glazing layer.
- *Rsol1* Solar reflectance of the glazing layer, exterior-facing side.
- *Rsol2* Solar reflectance of the glazing layer, interior-facing side.
- *Tvis* Visible transmittance of the glazing layer.
- *Rvis1* Visible reflectance of the glazing layer, exterior-facing side

- *Rvis2* Visible reflectance of the glazing layer, interior-facing side.
- *Tir* Thermal infrared (longwave) transmittance of the glazing layer.
- *E1* Infrared (longwave) emittance of the glazing layer, exterior-facing side
- *E2* Infrared (longwave) emittance of the glazing layer, interior-facing side
- *Cond* Conductance of glass. **Units:** W/m-K (SI); Btu/h-ft-°F (IP)

#### **Shading Layer Mounting Nomenclature**

- DtopThe distance from the top of the shading layer to the top of the glass/frame<br/>intersection (for interior and exterior blinds) or spacer line (blindsbetween glass<br/>blinds), depending on the type of shading device.
- DbotThe distance from the bottom of the shading layer to the bottom of the glass/frame<br/>intersection (for interior and exterior blinds ) or the bottom spacer line (blindsbetween<br/>glass blinds), depending on the type of shading device.
- DrightThe distance from the right side of the shading layer to the right glass/frame<br/>intersection (for interior and exterior blinds) or the right spacer line (for between glass<br/>blinds)
- DleftThe distance from the left side of the shading layer to the left glass/frame intersection<br/>(for interior and exterior blinds) or the left spacer line (for between glass blinds)

🖁 Window Library (C:\Program Files\LBNL\WINDOW6\w6.mdb)																					
Eile Edit Libraries Record Tools View Help																					
D 😂 🖬   🕹 📾 🕲   🥪   🎟 🗉   4 🕨 🕨   🖽 💷 🍨 🔳 👬 🗖 🕂 🖏   76   🤋 ஜ																					
Glazing System Library													<u> </u>								
										tian	blin	d (Lave	r 2)								
Calc (F9)	Calc (F9) ID #: 10 Name: Sample GizSys - Integral Venetian A, 45 d is betwee																				
New #Lay	vers: 3		Tile 90 *	IG He	eight:	100	0 mm			////	5								0.0,		
New         # Layers:         3         Tilt:         90         1G Height:         1000 mm         or "integral" w         or "integral" w         glazing system           Lopy         Condition:         NFRC 100-2001         ▼         IG Width:         1000 mm         glazing system																					
Delete Comm	ient:							$\boldsymbol{\mathcal{A}}$	/	- 2	э										
Save Overall thickn	iess: 25.9	944 m	m Mode: #		/																
Report		ID	Name	Hode	Thiek	Flip	Isol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond	Dtop (n	nm) Dbot (mm)	Dright (mr	) Dieft (i	mm)
- Glas	ss 1 🕨	9803	CLEAR5.LOF	/	47		0.796	0.074	0.074	0.888	0.082	0.082	0.000	0.840	0.840	1.000					
🖌 🖌 🖌 Ga	p1 🕨	1	Air		2.6			Vent													
- Shad	le 2 🕨	2	Venetian A45		11.3								0.000	0.900	0.900	160.000	3.0	7.0	1.0	)	1.0
🗶 🖉 Ga	p 2 🕨	1	Air 🖊		2.6			Vent									•				4
Glas	ss 3 🕨	9923	LOW-E_5.LOF	#	4.7		0.676	0.117	0.105	0.826	0.115	0.109	0.000	0.158	0.840	1.000					-
For Help, press F1																		Mode: NFRC	SI	NUM	

Gaps 1 and 2 define the distance of the venetian blind from the interior surfaces of the enclosing glass layers.

# Dtop, Dbot, Dright, Dleft define the venetian blind relative to the *spacer line* for integral venetian blinds.

Figure 8-19. Glazing layer nomenclature.

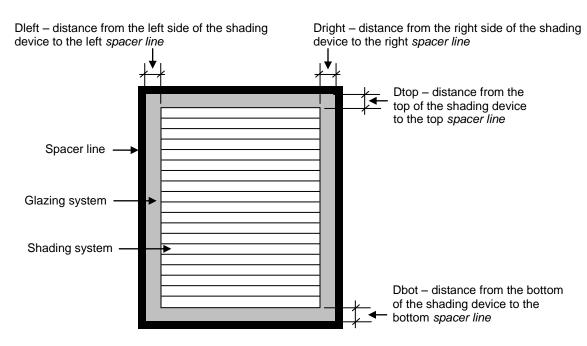
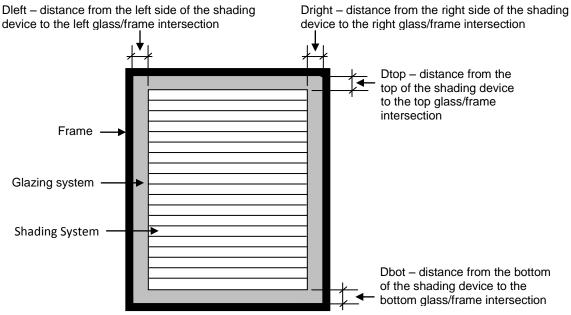
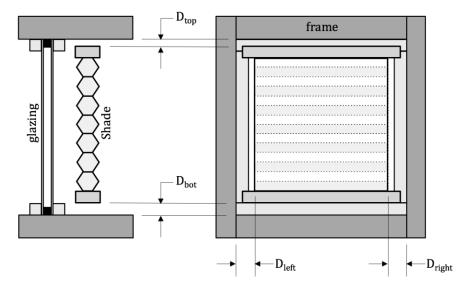


Figure 8-20. Define a glazing system with an integral venetian blind.



*Figure 8-21. Define a Dtop, Dbot, Dleft and Dright defined for an exterior venetian blind.* 



*Figure 8-22. Perimeter gap widths between frame and shade with continuous hardware. The figure illustrates a roomside shading system, but the defined gap distances apply to all shade locations (roomside, outside, and between-glass).* 

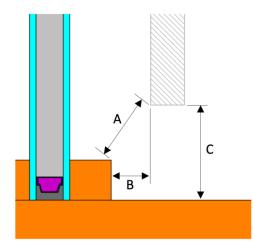


Figure 8-23. Perimeter gap is the minimum distance (A, B, or C) from end of shade (continuous hardware included) to frame

## 8.2.4. Glazing System Results

The following section describes the results that are available for the glazing system. There are multiple tabs in the results section:

- Center of Glass Results
- Temperature Data
- Optical Data
- Angular Data
- Color Properties
- Radiance Results

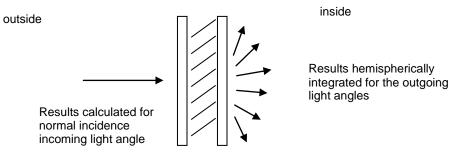
The following sections discuss each of these results in detail.

#### 8.2.4.1. Calculation Methods

WINDOW produces two different sets of results for the glazing system:

- Results calculated at normal incidence: these are the results displayed in the Glazing System Library Center of Glass Results tab
- Results calculated for many incoming and outgoing angles: these are the results displayed in the Angular Data results tab, as well as in the Matrix Reader spreadsheet that is distributed with WINDOW.

For a glazing system with a shading device, the optical properties of complex glazing systems are calculated at normal incidence for the incoming angle (horizontal to the glazing system) and hemispherically integrated on the outgoing side. This is what is displayed in the "Center of Glass Results" tab in the lower section of the **Glazing System Library** for SC, SHGC, Tvis as well as the results in the **Optical Data** tab in that same section. The thermal results (U-value) are calculated using the ISO 15099 method for shading systems.



*Figure 8-24. The results in the Glazing System Library are calculated at normal incidence for incoming light and hemispherically integrated for the outgoing light angles.* 

## 8.2.4.2. Matrix Calculation Results

If the "Generate full spectrally-averaged matrix for Solar Band and Visible Band" checkboxes are checked in Preferences, WINDOW will generate results for glazing systems with shading devices that include results at all the incoming and outgoing angles defined in the basis.

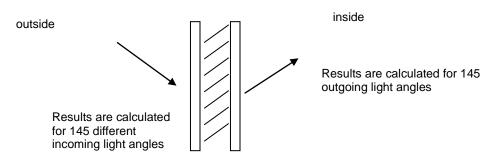


Figure 8-25. The full set of results that WINDOW 6 can calculate are for 145 incoming angles which result in values for 145 outgoing angles. This complete set of results (21,015 values) can be read by the MatrixReader spreadsheet for viewing.

The files containing the matrix results are CSV (comma separated value) text files and are created for every calculated glazing system, with the name of the glazing system and a CSV extension. The files are located in the program working directory in the BSDFs subdirectory. The contents of these files can be displayed in the "MatrixReader.xls" spreadsheet provided with the program (and explained in detail later in this section).

## 8.2.4.3. Center of Glass Results

Click on the Center of Glass Results tab (after clicking the Calc button) to see those results for the glazing system.

nter of Glass Resul	ts Temperature	Data Optical Dat	a Angular Data	Color Properties	Radiance Results			
Ufactor	SC	SHGC	Rel. Ht. Gain	Tvis	Keff	Layer 1 Keff	Gap 1 Keff	Layer 2 Keff
W/m2-K			W/m2		W/m-K	W/m-K	W/m-K	W/m-K
3.379	0.339	0.295	240	0.159	0.1109	1.0000	0.0216	3.2549

#### Figure 8-26. Center of Glass Results tab.

The following section describes the glazing system Center of Glass Results.

U-factor	Center of glass U-factor. By default this value assumes a one meter high glazing system. When the glazing system is used in a window (in the Window Library) the actual window height is used to calculate the U-factor, and therefore, if the window height is not equal to one meter, the center of glass U-factors will be different in the Glazing System results and the Window Library results. <b>Units:</b> W/m <sup>2</sup> -K (SI); Btu/h-ft <sup>2</sup> - $^{\circ}F$ (IP)
SC	Center of glass Shading Coefficient
SHGC	Center of glass Solar Heat Gain Coefficient. Unitless.
Rel. Ht. Gain	Center of glass Relative Heat Gain. <b>Units:</b> W/m <sup>2</sup> (SI); Btu/h-ft <sup>2</sup> (IP)
Tvis	Center of glass visible transmittance
Keff	Center of Glass effective conductivity. <b>Units:</b> W/m-K (SI); Btu/h-ft-°F (IP)
Layer <n> Keff</n>	Center of Glass effective conductivity of each layer in the glazing system. Units: W/m-K (SI); Btu/h-ft- $^{\circ}$ F (IP)
Gap <n> Keff</n>	Center of Glass effective conductivity of each gap (if applicable) in the glazing system. <b>Units:</b> W/m-K (SI); Btu/h-ft- °F (IP)

## 8.2.4.4. Temperature Data Results

Click on the Temperature Data tab (after clicking the Calc button) to see the results for the glazing system.

С	Center of Glass Results Temperature Data Optical Data Angular Data Color Properties Radiance Results										
[			Lay	er 1	Lau	er 2	Lay				
		Outside Air	Outer Surface	Inner Surface	Outer Surface	Inner Surface	Outer Surface	Inner Surface	Inside Air		
	Ufactor	-18.0	-13.5	-12.7	-5.0	-5.0	2.5	3.2	21.0		
	SHGC	32.0	45.5	46.7	52.6	52.6	45.1	44.1	24.0		

Figure 8-27. Center of Glass Temperature Data tab.

The following section describes the glazing system Temperature Data results. There will be temperature results for as many layers as have been defined in the glazing system.

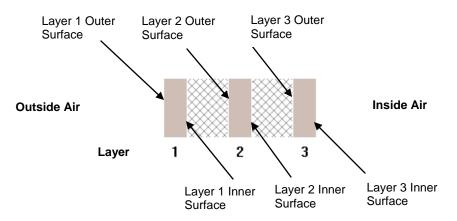


Figure 8-28.Glazing layer nomenclature for surfaces.

## **U-factor**

Outside Air	Temperature of the outside air, based on the U-factor environmental conditions.
Layer <n> Outer Surface</n>	Temperature of the outer surface of each layer, calculated at the U-factor environmental conditions. See the figure above. There will be temperature results for each layer defined in the glazing system.
Layer <n> Inner Surface</n>	Temperature of the outer surface of each layer, calculated at the U-factor environmental conditions. See the figure above. There will be temperature results for each layer defined in the glazing system.
Inside Air	Temperature of the inside air, based on the U-factor environmental conditions
SHGC	
Outside Air	Temperature of the outside air, based on the SHGC environmental conditions.
Layer <n> Outer Surface</n>	Temperature of the outer surface of each layer, calculated at the SHGC environmental conditions. See the figure above. There will be temperature results for each layer defined in the glazing system.

Layer <n> Inner Surface</n>	Temperature of the outer surface of each layer, calculated at the SHGC environmental conditions. See the figure above. There will be temperature results for each layer defined in the glazing system.
Inside Air	Temperature of the inside air, based on the SHGC environmental conditions.

### 8.2.4.5. Optical Data Results

Click on the Optical Data tab (after clicking the Calc button) to see detailed optical and solar property results, calculated at normal incidence, for the glazing system. These properties are also calculated based on incidence angle in the Angular Data tab (see below).

0	Center of Glass Resu	lts Temperature	Data Optical Dat	Angular Data	Color Properties	Radiance Results						
		Visible				UV						
	Tvis	Rfvis	Rbvis	Tsol	Rfsol	Rbsol	Abs1	Abs2	Abs3	Tdw-K	Tdw-ISO	Tuv
	0.1589	0.4222	0.4155	0.1088	0.3111	0.3063	0.2067	0.3497	0.0231	0.0566	0.1039	0.0292

*Figure 8-29. Center of Glass Optical Data tab.* 

The following section describes the glazing system Optical Data results.

Visible
---------

Tvis	Visible light transmission of the glazing system.
Rfvis	Front surface reflectance of the glazing system.
Rbvis	Back surface reflectivity of the glazing system.
Solar	
Tsol	Solar transmission of the glazing system.
Rfsol	Front surface solar reflectance of the glazing system.
Rbsol	Back surface solar reflectance of the glazing system.
Abs1 AbsN	Solar absorptance for each of the glazing system layers, starting with surface 1.
UV	
Tdw-K	Damage-weighted transmittance of the glazing system, based on the Krochmann calculation method. Measured between 300 and 500 microns. <b>From BFRC Glossary:</b>
	a measure of total solar transmittance which is damaging to surface finishes, fabrics, etc, including ultraviolet and visible-light effects, for wavelengths between 280 and 500nm. Weighted according to the Krochmann Damage Function.
	From the WINDOW Default Standards File:

Description : Old-style Krochmann damage weighted average - not in NFRC

300-2003 Source Spectrum : ASTM E891 Table 1 Direct AM1\_5.ssp Detector Spectrum : Krochmann Wavelength Set : Source Integration Rule : Trapezoidal Minimum Wavelength : 0.3 Maximum Wavelength : 0.5

*Tdw-ISO* Damage-weighted transmittance of the glazing system, based on the ISO 15099 calculation method.

Measured between 300 and 700 microns

#### From the WINDOW Default Standards File:

Description : NFRC 300-2003 UV Damage Weighted Transmittance based on CIE 89/3 Source Spectrum : ASTM E891 Table 1 Direct AM1\_5.ssp Detector Spectrum : UV Action (a=3.6, b=12.0) Wavelength Set : Source Integration Rule : Trapezoidal Minimum Wavelength : 0.3 Maximum Wavelength : 0.7

*Tuv* Unwieghted UV transmission of the glazing system.

Measured between 310 and 380 microns.

#### From the WINDOW Default Standards File:

Description : Unweighted UV average - not in NFRC 300-2003 Source Spectrum : ASTM E891 Table 1 Direct AM1\_5.ssp Detector Spectrum : None Wavelength Set : Source Integration Rule : Trapezoidal Minimum Wavelength : 0.31 Maximum Wavelength : 0.38

### 8.2.4.6. Angular Data Results Tab

Click on the Angular Data tab (after clicking the Calc button) to see detailed optical and solar property results, calculated at incidence angles from 0 ° to 90°, as well as hemispherical, for the glazing system

Center of (	Glass Results	Temperature Dat	a Optical Data	Angular Data	Color Properties	Radiance Results
	Angu	lar Data	Annual Optic	al Graphs		
,		JL				

Figure 8-30. Center of Glass Angular Data tab.

There are two buttons in the Angular Data tab:

- Angular Data
- Annual Optical Graphs

The following section describes each of these results in detail.

#### Angular Data

The Angular Data button will only be "clickable" for glazing systems without shading systems; it will be "grayed out" for glazing systems that include shading systems.

lazing System	Angula	r Proper	ties									
	0	10	20	30	40	50	60	70	80	90	Hemis	
Tsol	0.549	0.549	0.544	0.538	0.528	0.505	0.449	0.336	0.162	0.000	0.468	
Abs1	0.140	0.141	0.143	0.147	0.153	0.160	0.169	0.179	0.176	0.000	0.157	
Abs2	0.158	0.159	0.160	0.160	0.157	0.152	0.142	0.119	0.066	0.000	0.143	
Rfsol	0.153	0.152	0.153	0.155	0.162	0.184	0.240	0.366	0.596	1.000	0.222	
Rbsol	0.142	0.141	0.142	0.145	0.153	0.175	0.232	0.362	0.607	1.000	0.215	
Tvis	0.741	0.740	0.736	0.729	0.719	0.691	0.620	0.470	0.236	0.000	0.640	
Rfvis	0.174	0.173	0.174	0.178	0.187	0.213	0.278	0.424	0.671	1.000	0.255	
Rbvis	0.166	0.165	0.166	0.169	0.178	0.203	0.266	0.404	0.648	1.000	0.244	

Figure 8-31. Center of Glass Angular Data results.

#### Angle

0 - 90Each value calculated at the angle of incidence of solar radiation indicated, i.e., 40<br/>degrees, etc.HemisThe value integrated over all the angles of incidence of solar radiation, hence<br/>hemispherical.ValueSolar transmission of the glazing system calculated at each incidence angle.Abs1 ...Solar absorptance for each of the glazing system layers, starting with surface 1<br/>calculated at each incidence angle.

Rfsol	Front surface solar reflectance of the glazing system calculated at each incidence angle.
Rbsol	Back surface solar reflectance of the glazing system calculated at each incidence angle.
Tvis	Visible light transmission of the glazing system calculated at each incidence angle.
Rfvis	Front surface reflectance of the glazing system calculated at each incidence angle.
Rbvis	Back surface reflectivity of the glazing system calculated at each incidence angle.
SHGC	Solar Heat Gain Coefficient calculated at each incidence angle.

## Annual Optical Graphs

Clicking the Annual Optical Graphs button under the Center of Glass Results tab will display a series of graphs as shown in the figure below. The graphs show the values calculated for every hour of the year and then graphed over a year for different optical properties, latitude, window orientation and window tilt, for the current record in the Glazing System Detail view.

The graph below, showing Transmitted Visible Light on the back side (interior surface) of a Venetian Blind with the slats at a 45 degree tilt, with a south facing window (180 degree window orientation), illustrates that the most light will be transmitted between 10 am and 2 pm during the winter months (October – March).

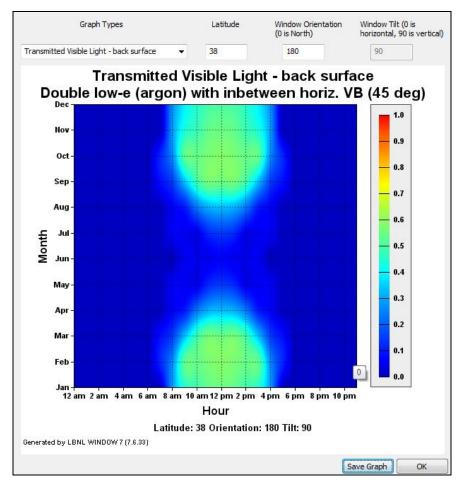


Figure 8-32. Center of Glass Annual Optical graphs.

The options for what data will be displayed are explained below

*Graph Type* A pulldown list of data that can be graphed, from the following selection:

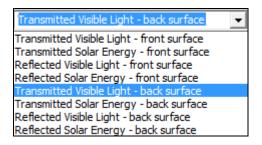


Figure 8-33. Selection of the results to display

- Transmitted Visible Light front surface
- Transmitted Solar Energy front surface
- Reflected Visible Light front surface
- Reflected Solar Energy front surface
- Transmitted Visible Light back surface
- Transmitted Solar Energy back surface
- Reflected Visible Light back surface
- Reflected Solar Energy back surface

Latitude	The latitude used for the hourly calculations. The latitude affects the sun angle at every hour of the year. Set this value to the latitude being studied to see the effect of the shading system at that latitude. <b>Default:</b> 38 degrees. <b>Legal values:</b> -90 to 90 degrees. Minus values will reflect calculations for the Southern hemisphere.
Window Orientation	The orientation of the window for the hourly calculations, based on the standard that 0 is due north, 90 is due east, 180 is due south, and 270 is due west. <b>Default:</b> 0 (due north). <b>Legal values:</b> 0 – 360 degrees.
Window Tilt	The tilt of the window, based on the value input in the Glazing System Detail view; therefore it is not editable in this graph. Legal values: 0 – 90.

### Buttons

*Save* Click the Save button to save the currently displayed graph as a PNG file. A browse window will open to allow saving to any directory with any valid filename.

## 8.2.4.7. Color Properties Results

Click on the Color Properties tab (after clicking the Calc button) to see detailed color properties for the glazing system. These color properties are for normal incidence solar radiation for transmitted radiation and front surface reflected solar radiation and include the CIE 1976 L\*, a\*, and b\* color coordinates, the dominant wavelenght, and percent purity. WINDOW calculates these values for glazing systems if each layer has an associated spectral data file. See the *WINDOW Technical Documentation* chapter on **Glazing System Optical Performance** for more details about these calculations.

Center of Glass Rest	ults Temperature	Data   Optical Da	ta Angular Data	Color Properties	Radiance Results
	Dominant				
	Wavelength	Purity	L×	a×	b*
Transmittance	0.55380	8.4	46.75	-5.03	5.60
Reflectance	0.55372	7.40	70.94	-6.21	6.86

Figure 8-34. Center of Glass Color Properties tab.

The following section describes the glazing system Color Properties results.

#### Transmittance

Dominant Wavelength	A single wavelength between 380-780 nm which best describes the color of the material. Certain colors are represented with the wavelength of the complementary color instead. (Not necessarily the wavelength with highest value.)
Purity	A measure of how close the material color is to being a monochromatic color of the dominant wavelength.
* L*, * a*, * b*	Chromaticity coordinates for the visible part of the spectrum.
$L^*$	Lightness factor (higher is lighter)
a*	Red/green factor (higher is more red, lower is greener)
$b^*$	Yellow/blue factor (higher is more yellow, lower is bluer)
Reflectance	
<b>Reflectance</b> Dominant Wavelength	A single wavelength between 380-780 nm which best describes the color of the material. Certain colors are represented with the wavelength of the complementary color instead. (Not necessarily the wavelength with highest value.)
Dominant	material. Certain colors are represented with the wavelength of the complementary
Dominant Wavelength	material. Certain colors are represented with the wavelength of the complementary color instead. (Not necessarily the wavelength with highest value.) A measure of how close the material color is to being a monochromatic color of the
Dominant Wavelength Purity *L*, *a*, *	<ul><li>material. Certain colors are represented with the wavelength of the complementary color instead. (Not necessarily the wavelength with highest value.)</li><li>A measure of how close the material color is to being a monochromatic color of the dominant wavelength.</li></ul>

*b*\* Yellow/blue factor (higher is more yellow, lower is bluer)

#### 8.2.4.8. Radiance Results

Click on the Radiance Results tab to see detailed Radiance results for the glazing system. In order to produce these Radiance results, it is necessary to do the following:

- Make sure that you have the Radiance for WINDOW installed on your computer (go to the LBNL WINDOW software download page)
- Click the Radiance button on the left side of the Glazing System Library Detail view this will cause the Radiance dialog box to appear to enter values and start the calculation
- The Radiance calculation will happen in the background, and when it is finished the program will produce a dialog box saying the calculation is complete.

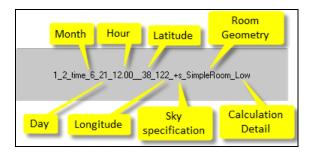
Once all these steps have been completed, the Radiance Results tab will show the results from the Radiance calculation, including two images, one a black and white image, and the other a false color image.

Center of	Center of Glass Results   Temperature Data   Optical Data   Angular Data   Color Properties   Radiance Results										
RunID	File	Month	Day	Hour	Latitude	Longitude	Detail	Room	View	Standard Color	False Color
					mm	mm					
1	31_1_time_6_21_12.0038_122_+s_SimpleRoom_Low	June	21	12.0	38.0	122.0	Low	SimpleRoom	Fisheye		

Figure 8-35. Center of Glass Radiance Results tab.

The following section describes the glazing system Color Properties results.

- *Run ID* An auto-incrementing ID number for each Radiance run that is calculated for a glazing system.
- *File* The name of the file created by Radiance to perform the calculation. The name contains information about the settings used for the calculation, including the date and time, latitude, longitude, room type and fidelity.



Radiance creates several results files for one calculation and they can be found in

C:\Users\Public\LBNL\WINDOW7\RADIANCE\Results

The program creates a Radiance HDR file for both the black and white and false color image, as well as BMP files for each (these are full size renderings) and thumbnail BMP files which are displayed in this results row.

OS (C:) ► Users ► Public ► LBNL ► WINDOW7 ► RADIANCE ► Results Share with ▼ Slide show Print E-mail Burn New for	Full size BMP for black and white image
Name         Da           I_2_time_6_21_12.00_38_122_+s_SimpleRoom_Low.bmp         9/2           1_2_time_6_21_12.00_38_122_+s_SimpleRoom_Low.hdr         9/2	Radiance HDR file for black and white image
I_2_time_6_21_12.00_38_122_+s_SimpleRoom_Low_f.bmp         0/7           I_2_time_6_21_12.00_38_122_+s_SimpleRoom_Low_f.hdr         9/2           I_2_time_6_21_12.00_38_122_+s_SimpleRoom_Low_f.thumb.bmp         9/2	Full size BMP for false
I_2_time_6_21_12.00_38_122_+s_SimpleRoom_Low_thumb.bmp	Radiance HDR file for false color image
Thumbnail BMP for black and white image	Thumbnail BMP for false color image

*Month* The month defined for the Radiance calculation.

*Day* The day of the month defined for the Radiance calculation.

*Hour* The hour of the day defined for the Radiance calculation.

*Latitude* The latitude defined for the Radiance calculation.

*Longitude* The longitude defined for the Radiance calculation.

*Detail* The Calculation Detail defined for the Radiance calculation.

*Room* The Room Geometry defined for the Radiance calculation.

*View* The View defined for the Radiance calculation.

*Standard* The gray scale image from the Radiance calculation.

*False Color* The false color image from the Radiance calculation.

Color

## 8.2.4.9. Dynamic Properties Results

For glazing systems where chromogenic glass layers are modeled, a special results tab is displayed called "Dynamic Properties".

Below are Dynamic Properties results for a thermochromic glazing system, where the glass properties are based on glass temperature.

nter of Glass Results	Temperature Data	Optical Data Ar	ngular Data 🛛 Color I	Properties Radian	ce Results Dynar	nic Properties								
Switching Paramater	System Properties													
Layer Temp	Tsol	Abs1	Abs2	Rfsol	Rbsol	Tvis	Rfvis	Rbvis	SHGC					
24.000	0.203	0.893	0.005	0.054	0.113	0.493	0.080	0.135	0.337					
34.000	0.169	0.773	0.008	0.050	0.112	0.396	0.068	0.132	0.310					
48.000	0.102	0.848	0.006	0.044	0.110	0.206	0.049	0.125	0.256					
64.000	0.048	0.906	0.004	0.042	0.109	0.064	0.043	0.122	0.212					
76.000	0.029	0.926	0.003	0.042	0.108	0.021	0.042	0.121	0.196					
59.423	0.060	0.893	0.005	0.042	0.109	0.094	0.044	0.123	0.222					

Figure 8-36. Dynamic	Properties tab	for a thermochormic	olazino sustem
i igure 0-30. Dynumie	1 Toperties tuo	jor a mermoenormie	<i>guuzing sysiem</i>

Below are Dynamic Properties results for an electrochromic glazing system, where the glass properties are based on the visible *transmittance of the chromogenic layer, which can change state*.

enter of Glass Results	Temperature Data	Optical Data	Angular Data 🛛 Col	or Properties Radia	ance Results Dyna	mic Properties						
Switching Paramater System Properties												
Layer Tvis	Tsol	Abs1	Abs2	Rfsol	Rbsol	Tvis	Rfvis	Rbvis	SHGC			
0.550	0.185	0.754	0.007	0.055	0.160	0.496	0.078	0.111	0.273			
0.231	0.073	0.879	0.002	0.046	0.153	0.209	0.052	0.096	0.172			
0.160	0.050	0.903	0.001	0.045	0.153	0.144	0.050	0.094	0.152			
0.079	0.026	0.931	0.001	0.043	0.143	0.071	0.046	0.091	0.130			
0.008	0.003	0.953	0.000	0.045	0.139	0.007	0.048	0.091	0.109			

Figure 8-37. Dynamic Properties tab for an electrochromic glazing system

## 8.2.4.10. Matrix Reader Spreadsheet

As explained earlier in this section, when WINDOW calculates a matrix (such as for a glazing system with a shading system), the files containing the matrix results are CSV (comma separated value) text file and are created for every calculated glazing system, and have the name of the glazing system with a CSV extension. The files are located in the program working directory in the BSDFs subdirectory. The contents of these files can be displayed in the "MatrixReader.xls" spreadsheet provided with the program (and explained in detail later in this section).

To view the detailed angular results in the CSV files, do the following:

- Open the W6MatrixReader.xls spreadsheet with the Microsoft Excel program
- Click on the Load Matrix button, open the file with the desired glazing system name (such as "Venetian 90 degrees.csv"

The data will be displayed as shown below.

The results shown below are from a glazing system constructed of a double glazed IG (clear 3 mm glass) with a Venetian blind between the panes, with the blind slat tilt set to 40 degrees.

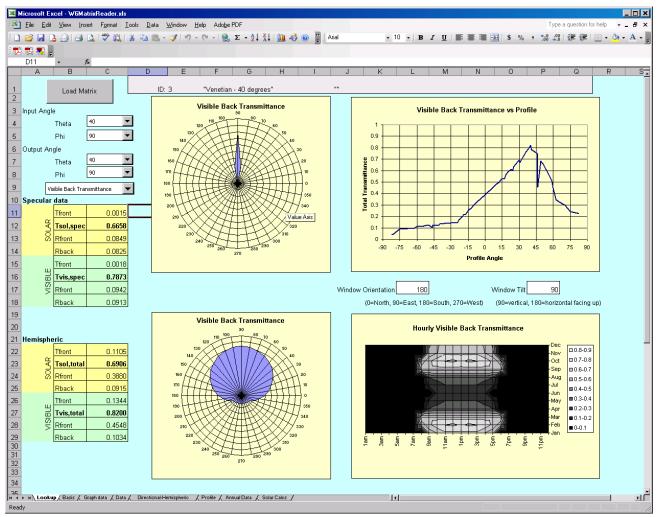


Figure 8-38. The results displayed by the W6MatricReader.xls file.

Each section of the results spreadsheet is explained in the following section.

#### **Tabular Results**

Input An	gle	9	
		Theta	40
		Phi	90
Output A	۱.	gle	
		Theta	40
		Phi	90
Γ	Vis	ible Back Tran	nsmittance 🗖
Specula	Г	data	
		Tfront	0.0015
		Tsol,spec	0.6658
C G	5	Rfront	0.0849
		Rback	0.0825
		Tfront	0.0018
ū	VISIBLE	Tvis,spec	0.7873
Ū S		Rfront	0.0942
		Rback	0.0913
Hemispl		ric Tfront	0.1105
	Ľ.	Tsol,total	0.6906
۲. ا	SOLAR		
	500	Rfront	0.3880
14	500	Rfront Rback	0.3880 0.0915
·			
·		Rback	0.0915
·		<mark>Rback</mark> Tfront	0.0915 0.1344

*Figure 8-39. The tabular results from the complex glazing calculation.* 

The combination of Theta and Phi represents an angle of a ray of light relative to the glazing system. One way to visualize these angles is to think of an arrow shot through the glazing system. When you are rotating the shaft of the arrow, you are varying the Phi component. Therefore Phi varies between 0 and 360 degrees. Theta is the angle between the arrow and the plane of the glass, and ranges between 0 and 90 degrees. 90 degrees is perpendicular to the plane of the glass, and 0 is parallel to the plane of glass. In the standard wavelength set, there are 145 combinations of theta and phi for both incoming and outgoing light ray angles.

The pulldown list listing the front and back transmittance and reflectance for solar and visible wavelengths controls the display of the "polar" graphs. "Front" represents what is being reflected or transmitted into the room. "Back" represents what is being reflected or transmitted on the outside. (Back transmittance is not a very useful piece of data).

#### **Specular Data**

This represents the component of the transmission that is direct, ie, the rays that go directly through the shading system, such as the rays that go directly through a partially open Venetian blind. These results are calculated for both the solar and visible wavelengths for front and back reflectance and transmittance.

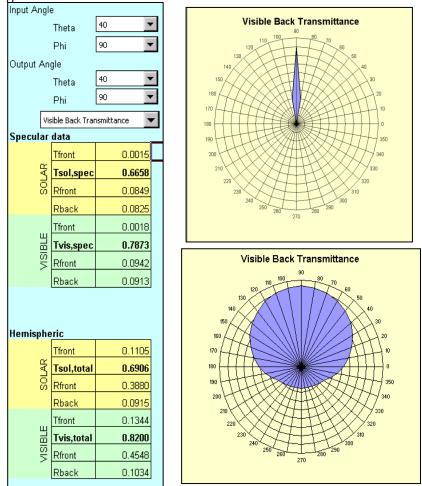
#### Hemispheric

This represents the all the solar radiation, both direct and diffuse, that is either reflected or transmitted for the front and the back of the glazing system.

#### **Solar Front Transmittance**

The top graph shows specular transmittance or reflectance for a specific incoming theta and phi combination. It shows all the transmittance or reflectance for all the outgoing phi's for a certain outgoing theta. So it's a fixed incoming theta/phi and outgoing theta. The outside circle represents 100% reflectance or transmittance, and the inner circle represents 0% reflectance or transmittance. It shows the transmission or reflectance as a function of outgoing phi angle (0-360).

The bottom graph shows the hemispheric transmittance or reflectance as a function of incoming phi for a given incoming theta.



*Figure 8-40.* The visible front transmittance results from the complex glazing calculation.

## Solar Front Transmittance vs Profile Angle

The spreadsheet translates the incoming thetas and phis into profile angles, and this graph plots hemispheric transmittance or reflectance for front or back, against the profile angle.

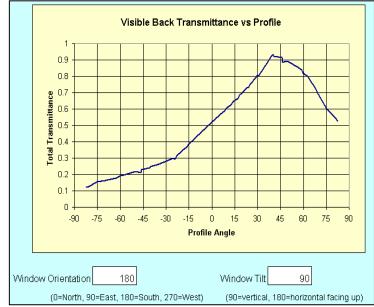


Figure 8-41. The solar front transmittance plotted against the profile angle of the system from the complex glazing calculation.

## Hourly Solar Front Transmittance

The spreadsheet calculates a combination of theta and phi for each hour of the day and day of the year for the sun position of a given latitude (in this case Berkeley, CA), against hemispheric transmittance or reflectance for front or back.

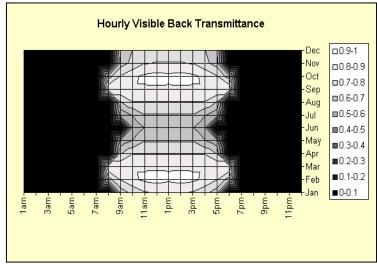


Figure 8-42. The hourly solar front transmittance for each hour of the day over each month of the year.

## 8.3. Create a New Glazing System

There are several methods for making a new glazing system

From the List view:

- Click the New button to make a new record with the name Default, and all the values based on the default settings
- Highlight and existing record and click the Copy button to make a copy of that record with the same name but a new ID

From the **Detail** view:

- Click the New button to make a new record with the name Default, and all the values based on the default settings
- Move to the desired record (either from the List view or using the record navigation buttons) and click the Copy button to make a copy of the current record.

#### 8.3.1. Create a Glazing System using Copy from the List View

To create a new glazing system from the List view using the **Copy** button, follow these steps:

Step 3:

- In the **Glazing System Library List View**, copy an existing record by highlighting the record to be copied and clicking on the **Copy** button.
- Click on the **Detailed View** button to edit the glazing system information as needed, including the **Name**.
- Save the record using the Record/Save menu (or Alt-S).

Step 1: Highlight the record to be copied

**F**11

by clicking on the record.

WINDOW5 will automatically assign a unique ID for the new Glazing system. A different ID number can be typed, as long as it is unique.

	File Edit Libraries	Reco	ord I	ools View Help							
	D 🗳 🖬   🔖 🛍	ß	6		M   🖽 🞽 🍨 📗 i	×þ.	# 🕺 🗖	₹ <mark>∕</mark> c	? N		
Step 2: Click on the	Detailed View	Glazing	g Syste	m Library (C:\Users\Publi	c\LBNL\WINDOW7.5\w7	.mdb)					
Copy button	Calc		ID		Name		# of Layers	Mode	Tilt	Environmental Conditions	T
to copy the	New	$\setminus$									
highlighted		Ā	1	Single Clear			2	#	90	NFRC 100-2010	_
record. —		•	2	Double Clear Air			2	#	90	NFRC 100-2010	
	Delete		3	Double Low-e Air	Adding a record					× 00-2010	
	Find		4	Double Clear with Argor	Adding a record					p0-2010	
	ID 🔹		5	Triple Clear						ок ро-2010	
			7	Double high solar gain lo						00-2010	
	Advanced		8	Sample GlzSys		↓				p0-2010	
	Advanced		9	Double low-e (vacuum)	ID for new record: 15	1	-			0-2010	
	32 records found.		10	Double low-e (air) - defle		-1				0-2010	
	<u>I</u> mport		11	Triple low-e (argon) - del						0-2010	
			12	Triple with suspended lo	Overwrite existing rec	cords				0-2010	
	Export		13	Double clear (air) with w	nite nit - 30% coverage		2	#	90	00-2010 הידאר	
	Rep <u>o</u> rt		20	Double low-e (argon) wit	h ext. perforated screen		3	#	90	NFRC 100-2010	
	<u>P</u> rint	•	30	Double low-e (argon) wit	h int. horiz. VB (45 deg)		3	#	90	NFRC 100-2010	•

Figure 8-43. Use the Copy button to copy an existing record to a new record.

Click on the Detailed View button to copy the highlighted record.

ile <u>E</u> dit <u>L</u> ibraries <u>I</u>	Record T	Tools <u>V</u> iew <u>H</u> elp					
D 😂 🖬   X 🖻 I	6   6	🏢 E K K 🕨 🕨 🗄 🖴 🍨 💵 🗱	‡ 🕺 🜌	$\mathbb{Z}_{c}$	१ №		
◀ <u>D</u> etailed View GI	lazing Syste	m Library (C:\Users\Public\LBNL\WINDOW7.5\w7.mdb)					
Calc	ID	Name	# of Layers	Mode	Tilt	Environmental Conditions	Т
New							
Сору	1	Single Clear	2	#	90	NFRC 100-2010	
	2	Double Clear Air	2	#	90	NFRC 100-2010	
Delete	3	Double Low-e Air	2	#	90	NFRC 100-2010	
-Find	4	Double Clear with Argon	2	#	90	NFRC 100-2010	
ID 👻	5	Triple Clear	3	#	90	NFRC 100-2010	
	7	Double high solar gain low-e	2	#	90	NFRC 100-2010	
	8	Sample GlzSys	2	#	90	NFRC 100-2010	
Advanced	9	Double low-e (vacuum)	2	#	90	NFRC 100-2010	
33 records found.	10	Double low-e (air) - deflected	2	#	90	NFRC 100-2010	
	11	Triple low-e (argon) - deflected	3	#	90	NFRC 100-2010	
	12	Triple with suspended low-e film (argon)	3		90	NFRC 100-2010	
E <u>x</u> port	13	Double clear (air) with white frit - 50% coverage	2	#	90	NFRC 100-2010	
Report	▶ 15	Double Clear Air	2	#	90	NFRC 100-2010	
Print	20	Double low-e (argon) with ext. perforated screen	3	#	90	NFRC 100-2010	•

## Step 4:

Make sure the new record is highlighted, then either click on the Detailed View button to make changes to the new record, or double click on the highlighted record.

*Figure 8-44. Highlight the newly copied record and click on the Detailed View button.* 

When the **Detailed View** is first opened, all the fields will be identical to the copied record.

Type a new name for												
Use the <b>up/down</b> arrows to add or delete glass layers.	ID #: 15 # Layers: 2 Environmental Conditions: NFRC 10 Comment:	÷ T		Height: Width:								
Click on the <b>Select</b> arrows to pick a new glass layer from the <b>Glass Library</b> .	Overall thickness: 23.430	m	Mode: #	□ Mo	odel De	flecti	on		1	2		
		ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	B١
	- Glass T 🕨		CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.
	Gap 1 🕨	<b>\</b>	Air		12.0							
	Glass 2 ▶▶	183	CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.
		Th	e <b>Select</b> screen di	splay	s the	rec	ords fi	rom th	e Glas	s Libra	arv.	
			<b>\</b>	-17							-	
	sired glass library		Select				_			_		×
	ck on the <b>Select</b> butto	on —	Select Cancel				Find		ID	▼ 4886 re	cords found	d.
to use it in the g	glazing system.		ID Nam	e	P	roducti	Name	Manu	facturer	Source	Mode Co	lor 🔺
			6360 VUE840.vir		VUE-40 o	n Euor		Viraco	o. 11	GDB v18.2	#	
			6361 VUE1140.v		VUE-40 o		-	Viraco		GDB v18.2		
			► 6362 VUE140.vir		VUE-40 o		r n OptiWhite	Viraco Viraco		GDB v18.2		
			6363 VRE2438.V 6364 VRE2438-1				n OptiWhite			GDB v21.0 GDB v21.0	#	•
	ID #: 15	N	ame: Double Green Low	E								
	# Layers: 2		Tit: 90 * 1	G Heigh	t: 1000	.0( m	nn 🗆					
	Environmental Conditions: NFRC	100-20	10 -	lG Widt	n: 1000	.0( m	ım		- 8	***		
	Comment:				,		_					
	Overall thickness: 23.375	r	nm Mode: #		1odel D	eflec	tion		1	2		
		ID	Name	Mode	Thick	Flin	o Tsol	Rsol1	Rsol2	Tvis	Rvis1	BN
	Glass 1      →		VUE140.vir	#			0.188			0.449		
	Gap 1 🕨		Air		12.0							
	Glass 2      →	103	CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.

When all the changes have been made to define the new glazing system, click on the Calc button and the results will be updated

Figure 8-45. Editing the Glazing System characteristics in the Detailed View.

## 8.3.2. Create a Glazing System with a Shading System

To model a glazing system with a shading system, specify that the layer is a Shade, which then allows selection for that layer from the Shading Layer Library. The shading layer can be put on the outside or inside of the glazing system, or between two of the glass layers. It is possible to model multiple shading systems in one glazing system.

To add a shading layer to the glazing system, select "Shade or frit" from the pulldown list on the left hand side of the layer table.

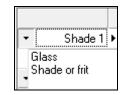


Figure 8-46. To select a fritted layer, select "Shade or frit"

The double arrow to the left of this option will then display all records in the Shading Layer Library

ele	ect Car	ncel	Find	<ul> <li>280 records found.</li> </ul>	
	ID	Name	ProductName	Manufacturer	Туре
	3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian (horizontal)
	3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)
	3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)
	3003	Slim Marine Closed	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)
	3004	Slim Marine 45	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)
	3005	Slim Marine Open	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)
	3500	Dickson Orchestra #0681 Dune	Dickson Orchestra #0681 Dune	Goodearl and Bailey	BSDF
	4000	Uniview Charcoal	Uniview Charcoal	Uniline	BSDF

Figure 8-47. Click the double arrow to the left of the ID column and the records from the Shading Layer Library are displayed.

The desired shading layer can be selected and it will be added as a layer in the glazing system.

ID #: # Layers: Environmental Conditions: Comment: Overall thickness:	3 NFRC	100-201		nn nn	(45 deg		1 2	2 3												
		ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	T vis	Rvis1	Rvis2	Tir	E1	E2	Cond	Dtop (mm)	Dbot (mm)	Dright (mm)	Dleft (mm)
✓ Gla	s1 🕨	103	CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000				
Ga	p1 🕨	9	Air (10%) / Argon (90%) Mix		1.3															
<ul> <li>Shad</li> </ul>	e 2 🕨	21	Dark Blue Blind 24 mm slat at 45 degrees		17.0												0.0	0.0	0.0	0.0
Ga	p 2 🕨	9	Air (10%) / Argon (90%) Mix		1.3															
✓ Gla	s 3 🙌	103	CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000				

Figure 8-48. The selected fritted layer will now be defined for that layer in the Glazing System.

### 8.3.3. Create a Glazing System with a Frit layer

Fritted glass layers are found in the Shading Layer Library. For the layer, select the option for the layer of "Shade or frit".



Figure 8-49. To select a fritted layer, select "Shade or frit"

The double arrow to the left of this option will display all records in the Shading Layer Library, which will include any fritted layers that are defined there.

	Sele	ect				
(	Sele	ct Can				
		ID	Name	ProductName	Manufacturer	Туре
		5000	Viraspan(TM) Medium Gray (V-948) 30%	Viraspan(TM) Ceramic Frit, Medium Gray (V-948) 30% Coverage	Viracon	Fritted glass
		5001	Simulated Sandblast (V-1086) 70%	Translucent Frit, Simulated Sandblast (V-1086) 70% Coverage	Viracon	Fritted glass

*Figure 8-50. Click the double arrow to the left of the ID column and the records from the Shading Layer Library are displayed, which include any layers defined as fritted glass.* 

The desired fritted layer can be selected and it will be added as a layer in the glazing system.

ID #: 61	Nar	me: Viracon Frit													
	# Layers: 2 → Tilt: 90 Å* IG Height: 1000.00 mm Environmental NFRC 100-2010 V IG Width: 1000.00 mm Conditions:														
Comment: Overall thickness: 23.114 mm Mode: # Model Deflection 1 2															
	ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
<ul> <li>Fritted glass 1 IM</li> </ul>	5000	Viraspan(TM) Medium Gray (V-948) 30%		4.7		0.796	0.062	0.063	0.888	0.065	0.066	0.000	0.840	0.840	1.000
Gap 1 🕨	1	Air		12.7											
Glass 2	103	CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000

Figure 8-51. The selected fritted layer will now be defined for that layer in the Glazing System.

### 8.3.4. Create a Vacuum Glazing System

Modeling a vacuum glazing system requires that a vacuum "gap" be defined in the Gap Library, which can then be selected as a layer between two pieces of glass.

In the example below, the gap for the double glazed system is referencing a record in the Gap Library that has been defined as a vacuum.

	ID #:	9		Na	me: Double low-e (vacuum)													
	# Layers:	2		<b>.</b>	Tilt: 90 Å* IG Height: 100	0.00 n	nm <sub>E</sub>						7					
E	nvironmental Conditions:	NFF	RC 1	00-201	0 🔹 IG Width: 100	0.00 n	nm											
	Comment:																	
Dver	erall thickness: 8.062 mm Mode: # 12																	
				ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tivis	Rvis1	Rvis2	Tir	E1	E2	Cond
·	• Gla:	ss 1	H	2027	LoE270-4.CIG	#	4.0		0.370	0.341	0.470	0.765	0.074	0.055	0.000	0.840	0.037	1.000
	Ga	р1	H	300	Vacuum-air P=0.001 (pr-1.5 ps-30)		0.1											
Ŀ	• Glas	ss 2	••	888	CLR_4.AFG	#	4.0		0.845	0.078	0.078	0.899	0.077	0.077	0.000	0.840	0.840	1.000

Figure 8-52. For a vacuum glazing system, the Gap layer is defined in the Gap Library as a vacuum.

Here is the definition in the Gap Library for that vacuum.See Section XX. Gap Library for details about defining a vacuum gap.

Gap Lib	orary				
ID #:	300				
Name: N	Vacuum-air P=0.	001 (pr-1.5 p	is-30)		
				Vacuum	
Mole	ecular Weight:	28.970	Pressure:	0.13332 Pa	0.00100 Torr
Spec	cific heat ratio:	1.400	Pillar Definition:	1 1.5 radius 30 sp	bacing 🔻 >
			Gap Proper	ties at Vacuum	
			Conducta	ince 0.106787 V	//m2-K

*Figure 8-53. An example Gap Library record defined as a vacuum.* 

## 8.3.5. Create a Chromogenic Glazing System

There are several chromogenic glass layers in the Glass Library, both electrochromic and thermochromic.

SAGE Electrochromics is one example of a electrochromic manufacturer, but there are other in the Glass Library. See the WINDOW Knowledge Base website (under Chromogenics) to see the list of chromogenic layers in WINDOW.

Glass	Library (	C:\Users\Public\LBNL\WINDOW7.6\w7.	mdb)					
	ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness
								mm
	8900	SageGlass_Classic_7_64clr.SAG	SageGlass® Classic_7mm lami full clear 64%	SAGE Electrochromics, Inc.	IGDB v33.0	#		6.990
	8905	SageGlass_7_SR2_60clr.SAG	SageGlass® SR2.0_7mm lami full clear 60%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		6.990
•	8910	SageGlass_9_Gray_45clr.SAG	SageGlass® Gray 9mm lami full clear 45%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.830
	8915	SageGlass_9_Green_49clr.SAG	SageGlass® Green 9mm Iami full clear 49%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.700
	8920	SageGlass_9_Blue_40clr.SAG	SageGlass® Blue 9mm lami full clear 40%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.760
	8925	SageGlass_9_GraySVC_24clr.SAG	SageGlass® Gray SVC 9mm lami full clear 24%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.820
	8930	SageGlass_9_GrnSVC_26clr.SAG	SageGlass® Green SVC 9mm Iami full clear 26%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.730

Figure 8-54. Chromogenic glass layers in the WINDOW Glass Library.

Looking at the detail view of the layer, it is possible to see the characteristics of the different states

Glass Library	<b>-</b> 1 · 1	8.8 mm				
ID #: 8910	Thickness	: 0.0 mm				
Name:	SageGlass_9_0	àray_45clr.SAG	ì			
Product Name:	SageGlass® Gr	ay 9mm lami fu	ll c			
Manufacturer:	SAGE Electrock	hromics, Inc.				
Туре:	Electrochromic					
Conductivity:	0.727 w/r	n-K				
Conductivity.						
		Light				Dark
	Tvis	0.512	0.215	0.169	0.071	0.006
	Color:					
Solor						
Tran	ns, Front (Tisol):	0.286	0.091	0.070	0.028	0.003
Trans	, Back (Tsol2):	0.286	0.091	0.070	0.028	0.003
Reflect	, Front (Rsol1):	0.066	0.058	0.057	0.058	0.058
Reflect,	, Back (Rsol2):	0.124	0.113	0.113	0.114	0.116
Visible						
Tran	ns, Front (Tivis):	0.512	0.215	0.169	0.071	0.006
Trans	, Back (Tvis2):	0.512	0.215	0.169	0.071	0.006
Reflect	; Front (Rivis1):	0.052	0.048	0.047	0.047	0.048
Reflect	, Back (Rivis2):	0.032	0.016	0.013	0.013	0.014
IR						
	Trans (Tir):	0.000	0.000	0.000	0.000	0.000
Emis.	, Front (Emis1):	0.840	0.840	0.840	0.840	0.840
Emis.,	, Back (Emis2):	0.142	0.142	0.142	0.142	0.142

Figure 8-55. Detail view of a chromogenic glass layer showing the properties for each "state".

When these layers are then used in a glazing system, WINDOW will report results at different states depending on what type of chromogenic layer it is.

For a thermochromic layer, where the states are determined by glass temperature, the program reports the properties of the glazing system depending on temperature under the Dynamic Properties tab (which only appears when a chromogenic layer is used in a glazing system).

ID #:				chromic Azuria																
# Layers:			1.00	Â* IG Heigh	ht 10	100.00 r	nm		_											
Environmental Conditions:	NFRC	100-201	0	<ul> <li>IG Widt</li> </ul>	th: 10	100.00 r	nm				× -									
Comment:																				
verall thickness:			nm Moo	e: [	🗌 Mode	el Deflec	tion		_	1	2									
Use switching	) Param	eter																		
		ID	N	ame	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond	Com	nment	
				mic2_24.LBL		12.0		0.229	0.045	0.054	0.545	0.055	0.065	0.000	0.840	0.840	1.000			
	ap 1 🕨		Air			12.7														
🔹 Glas	ss 2 🕨	102	CLEAR_3.0	AT	#	3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	1.000			
			022111_0.2				-													
				Optical Data	Angula	r Data	Colo		ties Ra				c Propert	ies						
	esults				Angula	r Data	Colo		ties Ra	diance F		Dynami	c Propert	ies						
inter of Glass R	esults amater				Angula	r Data Abs2			ties Ra Rfsol	diance F	lesults	Dynami	c Propert		F	Ifvis		Rbvis		SHGC
nter of Glass R	esults amater np	Tempe	rature Data	Optical Data	Angula		2			diance F	tesults	Dynami perties		is		Ifvis 080		Rbvis 0.135		SHGC 0.337
nter of Glass R Switching Para Layer Terr	esults amater np	Tempe	rature Data	Optical Data	Angula	Abs2	2		Rfsol	diance F	tesults tem Proj Rbsol	Dynami perties	Tvi	is 03	0.					
nter of Glass R Switching Para Layer Terr 24.000	esults amater np	Tempe	rature Data Tsol 0,203	Optical Data Abs1 0.893	Angula	Abs2	2 5		Rfsol 0.054	diance F	tesults tem Proj Rbsol 0.113	Dynami perties	Tvi 0.49	is 93 96	0. 0.	080		0.135		0.337
enter of Glass R Switching Para Layer Tem 24.000 34.000	esults amater np	Tempe	Tsol 0.203 0.169	Optical Data Abs1 0.893 0.773	Angula	Abs2 0.005 0.008	2 5 3 6		Rfsol 0.054 0.050	diance F	tesults tem Prop Rbsol 0.113 0.112	Dynami perties	T vi 0.49 0.39	is 93 96 06	0. 0. 0.	080 068		0.135 0.132		0.337 0.310
enter of Glass Ri Switching Para Layer Tem 24.000 34.000 48.000	esults amater np	Tempe	rature Data Tsol 0.203 0.169 0.102	Optical Data Abs1 0.893 0.773 0.848	Angula	Abs2 0.005 0.008 0.008	2 5 3 6 4		Rfsol 0.054 0.050 0.044	diance F	tesults tem Proj Rbsol 0.113 0.112 0.110	Dynami perties	T vi 0.49 0.39 0.20	is 33 36 36 36 36	0. 0. 0. 0.	080 068 049		0.135 0.132 0.125		0.337 0.310 0.256

Figure 8-56. The glazing system results show the properties of the glazing system in the different "states" based on the chromogenic layer.

## 9.1. Overview

The Glass Library contains the thermal and optical properties of glazing materials. The total solar, visible, and thermal infrared optical properties of a glazing as well as the thickness and thermal conductivity are displayed.

In general, the records in this library are from the International Glazing Database (IGDB), which contains records submitted by manufacturers of glazing layers. These submittals are reviewed for technical accuracy as well as being subjected to a Peer Review before being added to the IGDB.

## 9.2. Glass Library List View

The List View shows all the records in the Glass Library.

File Edit Librarie	es Re	ecord	Tools View He	lp															
E 🖻 🚅 🖬   % 🖻	B			- H   🗄 🚾 🍨 💵 👔	🛛 # 🐰 🛛	1 Vc   💡													
Detailed View	Glass	Library I	(C:\Users\Public\LBN	IL\WINDOW7.6\w7.mdb)							-								
Calc		ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	emis1	emis2	Cond
New									mm										W/m-K
Сору	•	100	BRONZE_3.DAT	Generic Bronze Glass	Generic	IGDB v11.4			3.124	0.646	0.062	0.063	0.680	0.065	0.066	0.000	0.840	0.840	1.000
Сору		101	BRONZE_6.DAT	Generic Bronze Glass	Generic	IGDB v11.4	#		5.740	0.486	0.053	0.053	0.533	0.056	0.056	0.000	0.840	0.840	1.000
Delete		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	0.000	0.840	0.840	1.000
Find		103	CLEAR_6.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		5.715	0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000
ID 🔹		104	GRAY_3.DAT	Generic Grey Glass	Generic	IGDB v11.4	#		3.124	0.609	0.060	0.061	0.617	0.062	0.063	0.000	0.840	0.840	1.000
		105	THIN_06.DAT	Generic thin glass 0.6 mm	Generic	IGDB v54.0			0.600	0.906	0.083	0.083	0.914	0.085	0.085	0.000	0.840	0.840	1.000
		106	THIN_075.DAT	Generic thin glass 0.75 mm	Generic	IGDB v54.0			0.750	0.906	0.083	0.083	0.914	0.085	0.086	0.000	0.840	0.840	1.000
Advanced		107	THIN_11.DAT	Generic thin glass 1.1 mm	Generic	IGDB v54.0			1.100	0.901	0.082	0.082	0.913	0.086	0.086	0.000	0.840	0.840	1.000
5121 records found.		200	SilAg25LE_3ww.bsf	Silver AG 25 Low-E	Saint-Gobain So	IGDB v16.3	#		3.023	0.156	0.546	0.616	0.222	0.417	0.476	0.000	0.840	0.330	0.942
Import		201	AutBr30_3ww.bsf	Autumn Bronze 30	Saint-Gobain So	IGDB v17.0	#		3.023	0.244	0.467	0.318	0.343	0.238	0.156	0.000	0.840	0.770	0.942
		202	H70_3.bsf	Hilite 70	Saint-Gobain So	IGDB v16.3	#		3.277	0.368	0.353	0.415	0.721	0.088	0.088	0.000	0.840	0.770	0.950
Export		203	H70-8_3.bsf	8 Mil Hilite 70	Saint-Gobain So	IGDB v16.3	#		3.404	0.381	0.316	0.403	0.722	0.095	0.096	0.000	0.840	0.790	0.878
Report		204	NS20_3.bsf	NightSky 20	Saint-Gobain So	IGDB v17.4	#		3.251	0.238	0.113	0.108	0.201	0.132	0.116	0.000	0.840	0.860	0.966
Print		205	NS30_3.bsf	NightSky 30	Saint-Gobain So	IGDB v17.4	#		3.251	0.354	0.089	0.092	0.316	0.098	0.088	0.000	0.840	0.880	0.966
Update IGDB		206	H40_3.bsf	Hilite 40	Saint-Gobain So	IGDB v17.4	#		3.276	0.274	0.299	0.394	0.420	0.059	0.066	0.000	0.840	0.750	0.950
		207	SBr20_3ww.bsf	Solar Bronze 20	Saint-Gobain So	IGDB v16.3	#		3.023	0.130	0.612	0.610	0.223	0.383	0.361	0.000	0.840	0.660	0.942
NFRC only		208	SPSX800SW.bsf	Sentinel Plus SX 80 OSW	Saint-Gobain So	IGDB v47.0	#		3.251	0.422	0.064	0.063	0.784	0.084	0.084	0.000	0.844	0.840	0.966

Figure 9-1. Glass Library, List View.

#### 9.2.1. Buttons

The buttons on the left hand side of the List View have the following functions:

*Detailed* Used to access the detailed view of the record, where the input values can be edited. *View* 

- *Calc* Not used in the Glass Library. Grayed out.
- *New* Used to make a new record, based on a default record.

*Copy* Used to copy an existing record (including name and all associated input values) into a new

record.

If the original record came from the IGDB, it contains detailed spectral data for many wavelengths. If that record is copied, the spectral data is NOT copied into the new record. The program will display a message indicating this when the record is copied.

Information	×
The copied record will not include detailed spectral data, which result in incorrect results for optical properties such as SHGC an TVIS. Custom layers with detailed spectral data can be created Optics and imported into the Window Library.	id É

The results will be less accurate for a record that does not have spectral data, particularly if the layer has properties that are wavelength dependent, such as Low-E coatings.

In addition, copied records cannot be "protected" and are therefore displayed with a white background.

- *Delete* Used to delete the highlighted record(s). The program allows deleting even protected records, which have a gray background.
- *Find* Used to find a record based on the field selected from the pulldown list, and a value typed into the input box

F	ind D	•
	Advanced	

**Find:** A pulldown list that allows selecting the field to search the database. The values in the pulldown list are all the values that are displayed in the list view

E: 1
Find
ID 👻
ID
Name
ProductName
Manufacturer
Source
Mode
Color
Thickness
Tsol
Rsol1
Rsol2
Tvis
Rvis1
Rvis2
Tir
emis1
emis2
Cond

9-2

**Input box:** Once a field has been selected from the Find pulldown list, the value to be searched is entered into the blank input box. In the example below, the field specific is ID, and the ID to be searched is entered into the input box.

Find	
ID	•
1572	

Advanced: Used to access a more advanced method of searching the list

Find		8
Find what:		Find Next
Match entire cell text	Direction	Cancel

*Import* Used to import records from various sources.

Import		×
Format	WINDOW Database	
Import database	Browse	
Avoid creating for identical re	duplicate records in export database by searching cords	
	OK Cancel	

Format: Select from one of the following database formats

- WINDOW database: Import from another WINDOW database
- IGDB or Optics User Database: Import from an Optics database, either the IGDB or an Optics User Database, depending on the settings in the File/Preferences, Optical Data tab.
- Frit from IGDB or Optics User Database: Import records from an Optics database, either the IGDB or an Optics User Database, depending on the settings in the File/Preferences, Optical Data tab, that contains "frit" records

**Import Database:** If the format is set to "WINDOW database" this option appears, allowing the user to select the desired WINDOW database to import records from.

**Avoid Creating Duplicate records** ... : A checkbox, which when checked, will cause the program to ask for new IDs if the IDs of the imported records conflict with existing records in the Library.

*Export* Used to export records from this database into either an existing WINDOW database, or a new WINDOW database.

Export	×
Export:	sted record(s) cords
Format	WINDOW Database 🔹
Export	Browse
Void for id	d creating duplicate records in export database by searching entical records
	OK Cancel

Export: Radio buttons that allow export of selected (highlighted in the List) or all records

Format: The export format options are:

- WINDOW database: This option causes an Export field to be displayed which allows browsing to an existing database to export the records into by clicking the Browse button, or a creating a new database to export the records into by clicking the New button.
- Comma separated value (CSV): Selecting this option and clicking the OK button opens a Save As window which allows the user to specify the name of the CSV file and the directory location.

**Avoid Creating Duplicate records** ... : A checkbox, which when checked, will cause the program to ask for new IDs if the IDs of the imported records conflict with existing records in the Library.

*Report* Allows creating a report containing a list of the records in the Glass Library.

Report 🛛
Report type: Library List 🔹
Generate report for:
Selected record(s)
All records
Text file options
🔽 Use default column widths
✓ Wrap columns
V Preview
OK Cancel

Report Type: There is only one option, which is a Library List

**Generate report for:** Radio buttons which specify whether the report will contain only the selected (highlighted) records or all the records in the Library

**Text file options:** 

- Use default column widths: this option causes long names to be truncated
- Wrap columns: this option allows long names to be wrapped to another line or lines

Preview: check this box shows a preview of the report before it is saved or printed

Report C:\Users\Public\LBNL\WINDOW7.6\report.tmp				
Save	Print	Close		
ID	Name	ProductName	Manufacturer	Source
100 101 102 103 104 105 106 107	BRONZE_3.DAT BRONZE_6.DAT CLEAR_3.DAT CLEAR_6.DAT GRAY_3.DAT THIN_06.DAT THIN_075.DAT THIN_075.DAT THIN_11.DAT	Generic Bronze Glass Generic Bronze Glass Generic Clear Glass Generic Clear Glass Generic Grey Glass Generic thin glass 0.6 mm Generic thin glass 0.75 mm Generic thin glass 1.1 mm	Generic Generic Generic Generic Generic Generic Generic	IGDB v11.4 IGDB v11.4 IGDB v11.4 IGDB v11.4 IGDB v11.4 IGDB v54.0 IGDB v54.0 IGDB v54.0

*Print* Used to print a report which contains a list of all the records in the library.

UpdateUsed to update the Glass Library to the latest version of the International Glazing DatabaseIGDB(IGDB), after that IGDB version has been downloaded and installed. See the<br/>windows.lbl.gov/software website for information about installing the latest IGDB.

*NFRC* Checking this box will filter the records in the Glass Library to only display records that have the *only* "#" symbol in the **Mode** column. These are records that can be used for NFRC certification calculations.

#### 9.2.2. Column Headings

The List view contains columns with selected results (from the Detail view) for each record, as described below.

ID	The unique ID associated with each record.
Name	The name of the glazing layer. This name is supplied by the manufacturer who submits the data to the IGDB.
Product Name	The Product Name of the record. This name is supplied by the manufacturer who submits the data to the IGDB.
Manufacturer	The Manufacturer associated with the record. This name comes from the IGDB.
	There are several records with "Generic" in this field. This indicates that they are example records created by LBNL and were not submitted by a manufacturer to the IGDB.
Source	This field indicates where the data originated. If the record was imported from the IGDB, the program will display "IGDB v <nn.n>", where <nn.n> is the IGDB version number of the data.</nn.n></nn.n>

	If this record was copied from another record in this library, or imported from an Optics User Databse, the Source field will say "User".
Mode	This is used to indicate records that can be used for NFRC approved calculations. If this field has a "#" value in it, it is an approved NFRC record.
	The exception to this is if the record was created in Optics as a laminate or applied film, and then imported into this library. In that case, this Mode field will be blank, but the imported record can still potentially be used for NFRC approved calculations, although it is subject to verification by the NFRC approval process.
Color	This is a color rendering of the layer, based on the spectral data.
Thickness	The thickness of the layer. <b>Units:</b> mm (SI); inches (IP).
Tsol	Solar transmittance of the glazing layer.
Rsol1	Solar reflectance of the glazing layer, exterior-facing side.
Rsol2	Solar reflectance of the glazing layer, interior-facing side.
Tvis	Visible transmittance of the glazing layer.
Rvis1	Visible reflectance of the glazing layer, exterior-facing side
Rvis2	Visible reflectance of the glazing layer, interior-facing side.
Tir	Thermal infrared (longwave) transmittance of the glazing layer.
Emiss1	Infrared (longwave) emittance of the glazing layer, exterior-facing side
Emiss2	Infrared (longwave) emittance of the glazing layer, interior-facing side
Cond	Conductance of layer. <b>Units:</b> W/m-K (SI); Btu/h-ft-°F (IP)

# 9.3. Glass Library Detail View

The Detail View shows details of individual layers in the Glass Library

File Edit Libraries	
List Optics 5 New Copy Delete Save	Image: Solar Solar Solar Trans, Front (Tsol):       0.646         Reflect., Front (Rsol1):       0.062         Reflect., Back (Rsol2):       0.063
	Visible       0.680         Trans, Front (Tvis):       0.680         Trans, Back (Tvis2):       0.680         Reflect., Front (Rvis1):       0.065         Reflect., Back (Rvis2):       0.066         IR       Trans (Tir):       0.000         Emis., Front (Emis1)       0.840         Emis., Back (Emis2)       0.840
	Color: Diffusing

Figure 9-2. Glass Library, DetailView.

## 9.3.1. Buttons

The buttons on the left hand side of the Detail View have the following functions:

- *List* Used to access the List view of the Glass Library, which shows all the records in the library
- *Optics* 5 Use this to open the Optics program.

New	Used to make a new record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the current record.
Save	Used to save the current record.
Update IGDB	Used to automatically update the Glass Library from the latest installed International Glazing Database, which can be downloaded from the windows.lbl.gov/software website.

## 9.3.2. Field Descriptions

The following describes the fields in the Glass Library Detail View.

The values in this section of the Glass Detail View are provided by the manufacturer if the layer is from the IGDB, or the user if the layer is user-defined. If the record was imported from the Optics database, this name will automatically come from that database. Values in records from the IGDB will be protected from editing (they will be "grayed" and the Protected checkbox will be checked). Values in records that are user defined or imported from Optics are not protected and can be edited.

## **General Information**

Glass L ID #:	ibrary 100	Thickness: 3.1 mm					
Name:		BRONZE_3.DAT					
		Generic Bronze Glass					
Manufacturer:		Generic					
	Туре:	Monolithic					
Conduc	ctivity:	1.000 W/m·K					

Figure 9-3. Glass Library: General Information section in the Detail View.

ID	The unique ID associated with this record. For records whose <b>Source</b> is "IGDB v <nn.n>", this ID is automatically assigned. For records whose <b>Source</b> is "User", this ID is assigned automatically by WINDOW but can be overwritten by the user at the time the entry is created, as long as it is unique.</nn.n>
Thickness	Glass thickness. Units: mm (SI); inches (IP).
Name	The name of the glass layer, provided

- *Product*The product name, provided by the manufacturer if the layer is from the IGDB, or the<br/>user if the layer is user-defined.
- *Manufacturer* The name of the glass manufacturer.

*Type* For records from the IGDB or Optics, these values are predetermined from those sources. Options include:

- Monolithic
- Coated
- Film
- Applied Film
- Laminate
- Interlayer
- Electrochromic
- Thermochromic
- Unknown: This can be the case for records that are created in WINDOW by the user using the New button.

Conductivity Conductivity of the layer. Units: W/m-K (SI); Btu/h-ft-oF (IP)

### Solar

Optical properties of the layer in the Solar spectrum

Solar Trans, Front (Tsol):	0.646
Trans, Back (Tsol2):	0.646
Reflect., Front (Rsol1):	0.062
Reflect., Back (Rsol2):	0.063

Figure 9-4. Glass Library: Solar section in the Detail View.

*Trans. Front* Solar transmittance of the glazing layer, exterior-facing side. *(Tsol)* 

*Trans. Back* Solar transmittance of the glazing layer, interior-facing side. *(Tsol2)* 

*Reflect.,* Solar reflectance of the glazing layer, exterior-facing side. *Front (Rsol1)* 

*Reflect., Back* Solar reflectance of the glazing layer, interior-facing side. *(Rsol2)* 

### Visible

Optical properties of the layer in the Visible spectrum

- Visible	
Trans, Front (Tvis):	0.680
Trans, Back (Tvis2):	0.680
Reflect., Front (Rvis1):	0.065
Reflect., Back (Rvis2):	0.066

Figure 9-5. Glass Library: Visible section in the Detail View.

Trans. Front (Tvis)	Visible transmittance of the glazing layer, exterior-facing side
Trans. Back (Tvis2)	Visible transmittance of the glazing layer, interior-facing side
Reflect., Front (Rvis1)	Visible reflectance of the glazing layer, exterior-facing side.
Reflect., Back (Rvis2)	Visible reflectance of the glazing layer, interior-facing side.

## **IR (Infrared)**

Optical properties of the layer in the Infrared spectrum

_ ⊢IB −		
	Trans (Tir):	0.000
	Emis., Front (Emis1)	0.840
	Emis., Back (Emis2)	0.840

Figure 9-6. Glass Library: Iinfrared (IR) section in the Detail View.

*Trans (Tir)* Thermal infrared (longwave) transmittance of the glazing layer.

*Emis., Front* Infrared (longwave) emittance of the glazing layer, exterior-facing side (*Emis1*)

*Emis., Back* Infrared (longwave) emittance of the glazing layer, interior-facing side (*Emis2*)

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Fields at the bottom of the screen

	Color:
	🔲 Diffusing
	🔽 Spectral data
Comment:	
Protected	

*Figure 9-7. Glass Library: Fields at the bottom of the screen.* 

*Color* This is a color rendering of the layer, based on the spectral data.

- *Diffusing* This checkbox indicates whether the layer is specular (unchecked) or diffusing (checked).
- Spectral DataThis checkbox is always grayed out, and indicates whether the layer includes spectral<br/>data. All the records from the IGDB should have this box checked. Any records<br/>created by users in WINDOW in this Library (using the New or Copy buttons) will<br/>not have this box checked, because by definition, they do not have spectral data.
- *Comment* A comment field editable by the user.
- *Protected* This box is always grayed out so it can never be edited by the user. However, if the record came from the IGDB, the box will be checked, indicating that it is protected from editing.

# 9.4. The International Glazing Database and Optics

The primary source of data in the WINDOW Glass Library is the International Glazing Database (IGDB). This data is submitted to LBNL by manufacturers of glazing layers who want their data to be used in WINDOW calculations. LBNL performs a technical review of the submitted data, and then distributes it for a Peer Review. Once the data has passed the Peer Review, it is included in the next public version of the IGDB, which can be found on the LBNL software download page at windows.lbl.gov/software.

When the IGDB data is updated in the WINDOW Glass Library, the Source field indicates that the records are from the IGDB and includes the version number. Additionally, all these records are protected from editing (they have a gray background in the list view, and cannot be edited in the detailed view, although they can be deleted). All data that comes from the IGDB has detailed spectral data associated with it. The optical properties displayed (transmittance, reflectance, emittance) in the Glass Library are average values calculated from the IGDB spectral data, based on the Optical data standard defined in File/Preferences/Optical Data tab, the default standard being "W5\_NFRC\_2003.std".

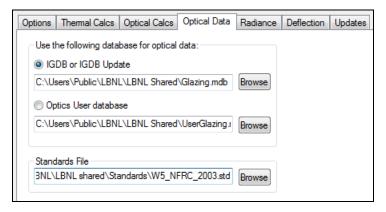


Figure 9-8. Set the Preferences for the IGDB update in the File/Preferences/Optical Data tab.

The file called **Glazing.mdb** is the IGDB database, which is password protected. In order to update the Glass Library, the "IGDB or IGDB Update" radio button should be selected in the File/Preferences/Optical Data tab..

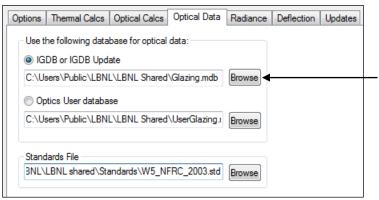
# 9.5. Updating the Glass Library from the IGDB

New versions of the IGDB are released on a regular basis, and are available on the LBNL Windows and Daylighting Software download page.

http://windows.lbl.gov

In order to update the WINDOW Glass Library with the latest IGDB version, follow these steps:

- Download the IGDB installation file from the LBNL website
- Install the IGDB (by "running" the installation file)
- This causes a new version of the "Glazing.mdb" file to be installed in the LBNL Shared directory
  - C:\Users\Public\LBNL\LBNL Shared
- In the **File/Preferences** menu, **Optical Data** tab, use the **Browse** button to select the "IGDB or IGDB Update" database, which will then be the default database that WINDOW will use for updating the Glass Library records. In general, the default database name and path should be
  - o C:\Users\Public\LBNL\LBNL Shared\Glazing.mdb



Click on the Browse button to specify the IGDB database. Then click on the radio button to set that database as the default for WINDOW to use when updating the Glass Library from the latest IGDB version.

*Figure 9-9. Set the Preferences for the IGDB update.* 

Detailed View Calc New Dopy Delete Find ID Advanced	Glass Library	(C:\Users\Public\LBNL\WIN	DOW7.5\w7.mdb)
Calc       ID       Name       ProductName         New       233       SS35-8_3ww.bsf       8 Mil Stainless Steel 35         Copy       234       SS50_3ww.bsf       8 Mil Stainless Steel 50         Delete       235       SS50-4_3ww.bsf       4 Mil Stainless Steel 50         Find       236       SS50-8_3ww.bsf       8 Mil Stainless Steel 50         ID       236       SS50-8_3ww.bsf       8 Mil Stainless Steel 50         236       SS50-8_3ww.bsf       8 Mil Stainless Steel 50         1D       237       TV30_3.bsf       TrueVue 30         238       LX40_3.bsf       LX40         239       St20_3ww.bsf       Sterling 20         Advanced       240       St40_3ww.bsf       Sterling 40		ProductName	
New			
Carry	233	SS35-8_3ww.bsf	8 Mil Stainless Steel 35
	234	SS50_3ww.bsf	Stainless Steel 50
Delete	235	SS50-4_3ww.bsf	4 Mil Stainless Steel 50
Find	236	SS50-8_3ww.bsf	8 Mil Stainless Steel 50
ID 💌	237	TV30_3.bsf	TrueVue 30
	238	LX40_3.bsf	LX40
	239	St20_3ww.bsf	Sterling 20
Advanced	240	St40_3ww.bsf	e ProductName sf 8 Mil Stainless Steel 35 Stainless Steel 50 Stainless Steel 50 Stainless Steel 50 Stainless Steel 50 TrueVue 30 LX40 Sterling 20 Sterling 20 Sterling 40 Sterling 50 Hilte 80 Sterling 50 Hilte 80 Sterling 60 Sterling 60 Sterling 70 Hilte 55 Slate 50
4887 records found.	241	SPSX500SW.bsf	Sentinel Plus SX 50 OSW
Import	242	St50_3ww.bsf	Sterling 50
	ed View alc ID aw 233 S3 234 S3 235 S3 236 S3 236 S3 237 TV 238 D2 239 S0 239 S0 239 S0 239 S0 239 S0 240 S1 240 S1 241 S1 244 S1 244 S1 245 S1 247 H	H80_3.bsf	Hilite 80
E <u>xport</u>	244	St60_3.bsf	Sterling 60
Rep <u>o</u> rt	245	St60-4_3ww.bsf	4 Mil Sterling 60
Print	246	St70_3.bsf	Sterling 70
Update IGDB	247	H55_3.bsf	Hilite 55
	248	SIGr50_3.bsf	Slate 50
NFRC only	249	H25_3.bsf	Hilite 25

• In the Glass Library List view, click on the Update IGDB button

Figure 9-10. Click the Update IGDB button in the Glass Library List view.

• The program will display a progress bar as it discovers what records in the Glass Library need to be removed, added or updated based on the records in the new glazing.mdb file.

Window
Getting records to update.

Figure 9-11. The program will show a series of progress bars as it checks each record.

• The program will show the results of the update before actually proceeding with the update. Click the OK button to allow the program to proceed with the updates to the Glass Library indicated in this dialog box. If you click the Cancel button, the program will not perform the indicated updates to the Glass Library.

it to	o update	to IGDB version 62.0	).0.																
384	records	will be added																	
		will be updated will be removed																	
eco	rds sche	duled for removal																	
	ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	emis1	emis2	Cond	-
								mm										W/m-K	1
•	1806	015_000000_6_0Ch	Saflex® R series	Eastman Chemi	IGDB v31.0	#		10.380	0.632	0.065	0.065	0.854	0.079	0.079	0.000	0.840	0.840	0.802	L
	1807	030_000000_2_3Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		5.360	0.763	0.071	0.072	0.892	0.080	0.081	0.000	0.840	0.840	0.612	
	1808	030_000000_2_5Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		5.760	0.735	0.070	0.069	0.886	0.080	0.080	0.000	0.840	0.840	0.625	
	1809	030_000000_2_7Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		6.160	0.727	0.069	0.068	0.885	0.079	0.079	0.000	0.840	0.840	0.638	
	1810	030_000000_3_0Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		6.760	0.724	0.069	0.068	0.883	0.079	0.079	0.000	0.840	0.840	0.655	
	1812	030_000000_5_0Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		10.760	0.689	0.076	0.076	0.871	0.089	0.089	0.000	0.840	0.840	0.729	
	1813	030_000000_6_0Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		12.760	0.667	0.069	0.069	0.867	0.082	0.081	0.000	0.840	0.840	0.751	
	1814	045_000000_2_3Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		5.740	0.729	0.069	0.068	0.887	0.079	0.079	0.000	0.840	0.840	0.542	
	1815	045_000000_2_5Ch	Saflex® R series	Eastman Chemi	IGDB v31.0	#		6.140	0.718	0.066	0.067	0.884	0.077	0.077	0.000	0.840	0.840	0.556	
	1816	045_000000_2_7Cl	Saflex® R series	Eastman Chemi	IGDB v31.0	#		6.540	0.716	0.067	0.069	0.884	0.078	0.079	0.000	0.840	0.840	0.570	1,
4	1																	•	

*Figure 9-12. The program will show what the updates will be. Click the OK button to allow the program to proceed with the updates.* 

## 9.6. Special Types of Glass Layers

There are a few special glass layer types in the Glass Library. They include:

- Chromogenic layers
- Fritted layers

## 9.6.1. Chromogenic Layers

Chromogenic glass layers, such as electrochromic and thermochromic layers, are switchable, dynamic coatings on glass or films that have properties that are passively or actively controlled to modulate the admission of light and heat.

The IGDB contains several chromogenic layers. When the manufacturers submit their data to the IGDB, they submit data for several of the different states of the chromogenic layer. Each of these states is shown as a separate record in the IGDB, even though they are all the same product.

Because WINDOW requires just one record for a given chromogenic layer, special WINDOW databases are created for chromogenics and can be downloaded from the Window website (see the Chromogenics section of the WINDOW Knowledge Base on windows.lbl.gov/software).

If the chromogenic layers from those special WINDOW databases are imported into the WINDOW Glass Library, there will be one record in that library for each chromogenic layer, shown in the List View. However, in the detail view the states that were measured will be displayed.

There are currently two types of chromogenics supported by WINDOW:

- Electrochrochromic layers which are switched by an electric current through the glass
- Thermochromic layers which are switched by glass temperature

## Electrochromic Layers

The electrochromic layers are shown as a single layer in the Glass Library List View, such as the Sage Electrochromics layers shown below.

Glass L	ass Library (C:\Users\Public\LBNL\WINDOW7.6\w7.mdb)													
	ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness						
								mm						
	8900	SageGlass_Classic_7_64clr.SAG	SageGlass® Classic_7mm lami full clear 64%	SAGE Electrochromics, Inc.	IGDB v33.0	#		6.990						
	8905	SageGlass_7_SR2_60clr.SAG	SageGlass® SR2.0_7mm lami full clear 60%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		6.990						
	8910	SageGlass_9_Gray_45clr.SAG	SageGlass® Gray 9mm lami full clear 45%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.830						
	8915	SageGlass_9_Green_49clr.SAG	SageGlass® Green 9mm Iami full clear 49%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.700						
	8920	SageGlass_9_Blue_40clr.SAG	SageGlass® Blue 9mm Iami full clear 40%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.760						
	8925	SageGlass_9_GraySVC_24clr.SAG	SageGlass® Gray SVC 9mm lami full clear 24%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.820						
	8930	SageGlass_9_GrnSVC_26clr.SAG	SageGlass® Green SVC 9mm Iami full clear 26%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.730						

Figure 9-13. Electrochromic layers in the Glass Library List View

In the Glass Library Detail View the characteristics of the different states are displayed. The same standard values that are displayed for all the Glass Library records are displayed, but there is a separate column for each of those values for the different states that were measured by the manufacturer and submitted to the IGDB.

The first column labeled "Light" represents the lightest state for the layer, and the last column labeled "Dark" represents the darkest state for the layer. The Switching parameter in this cases is Visible Transmittance (Tvis).

Glass Library	ílass Library									
ID #: 8900	Thickness	: 7.0 mm								
Name:	SageGlass_Cla	assic_7_64clr.SA	AC.							
Product Name:	SageGlass® C	lassic_7mm lami	ft							
Manufacturer:	SAGE Electroc	hromics, Inc.								
Type:	Electrochromic									
Conductivity:	0.679 W/	m-K								
		Light				Dark				
	Tvis	0.728	0.203	0.119	0.063	0.014				
	Color:									
Solor										
Tra	ns, Front (Tisol):	0.436	0.084	0.084 0.048 0.025		0.006				
Trans	s, Back (Tsol2):	0.436	0.084	0.048	0.025	0.006				
Reflec	t, Front (Rsol1):	0.105	0.081	0.079	0.074	0.081				
Reflect	;, Back (Rsol2):	0.139	0.122	0.122	0.112	0.125				
Visible										
Tra	ns, Front (Tivis):	0.728	0.203	0.119	0.063	0.014				
Trans	s, Back (Tvis2):	0.728	0.203	0.119	0.063	0.014				
Reflec	t, Front (Rivis1):	0.064	0.056	0.054	0.053	0.057				
Reflect	;, Back (Rvis2):	0.044	0.013	0.012	0.011	0.012				
IR										
	Trans (Tir):	0.000	0.000	0.000	0.000	0.000				
Emis.	, Front (Emis1):	0.839	0.839	0.839	0.839	0.839				
Emis.	, Back (Emis2):	0.142	0.142	0.142	0.142	0.142				

Figure 9-14. Electrochromic layers in the Glass Library Detail View

## Thermochromic Layers

The thermochromic layers are shown as a single layer in the Glass Library List View, such as the Pleotint layer shown below.

Glass	Glass Library (C:\Users\Public\LBNL\WINDOW7.6\w7.mdb)												
	ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness					
								mm					
	16500	Suntuitive_05C.PLE	Suntuitive∥at 5C	Pleotint	IGDB v38.0	#		12.565					

Figure 9-15. Electrochromic layers in the Glass Library List View

In the Glass Library Detail View the characteristics of the different states are displayed. The same standard values that are displayed for all the Glass Library records are displayed, but there is a separate column for each of those values for the different states that were measured by the manufacturer and submitted to the IGDB.

The first column labeled "Light" represents the lightest state for the layer, and the last column labeled "Dark" represents the darkest state for the layer. The Switching parameter in this cases is temperature (Temp)

Glass Library								
ID #: 16500	Thickness:	12.6 mm						
Name:	Suntuitive_05C.	PLE						
Product Name:	Suntuitive  at 5	С						
Manufacturer:	Pleotint							
Туре:	Thermochromic							
Conductivity:	0.730 W/n	n-K						
		Light						Dark
	Temp	5.000	15.000	25.000	45.000	65.000	85.000	95.000
	Color:							
Solor								
Tran	ns, Front (Tisol):	0.685	0.673	0.641	0.499	0.343	0.256	0.232
Trans	;, Back (Tsol2):	0.685	0.673	0.641	0.499	0.343	0.256	0.232
Reflect	;, Front (Rsol1):	0.064	0.064	0.062	0.055	0.050	0.047	0.046
Reflect	, Back (Rsol2):	0.064	0.064	0.062	0.055	0.050	0.047	0.046
Visible								
Tran	ns, Front (Tivis):	0.719	0.695	0.629	0.357	0.105	0.023	0.012
Trans	;, Back (Tvis2):	0.719	0.695	0.629	0.357	0.105	0.023	0.012
Reflect	;, Front (Rivis1):	0.067	0.065	0.061	0.049	0.043	0.043	0.043
Reflect, Back (Rvis2): 0.067		0.065	0.061	0.049	0.043	0.043	0.043	
IR								
Trans (Tir): 0.000			0.000	0.000	0.000	0.000	0.000	0.000
Emis.	, Front (Emis1):	0.840	0.840	0.840	0.840	0.840	0.840	0.840
Emis.	, Back (Emis2):	0.840	0.840	0.840	0.840	0.840	0.840	0.840

Figure 9-16. Thermochromic layers in the Glass Library Detail View

## 9.6.2. Fritted Layers

There are a few fritted glass layers in the Glass Library, and there will undoubtedly be more in the future. The fritted glass layers have both a specular and diffuse component to them, and that is reflected in the data that is in the Glass Library.

	ID	Nar	me	Produ	ctName		Manufactu	irer	Source	Mode	Color	Thickness
												mm
	30000	) WhiteFritDiffus	eFront.lbl	White Frit Diff	fuse (front)		LBNL		CGDB v.1.00			6.000
	30002	WhiteFritSpecu	ularFront.Ibl	White Frit Sp	ecular (fror	nt)	LBNL		CGDB v.1.00			6.000
	30003	ClearFritDiffuse	Front.Ibl	Clear Frit Diffe	use (front)		LBNL		CGDB v.1.00			6.000
	30004	, ClearFritSpecul	larFront.lbl	Clear Frit Spe	cular (front	:)	LBNL		CGDB v.1.00			6.000
		Glass Library				GI	ass Library					1
		ID #: 30000	Thick	ness: 6.0 m	nm	ID #: 30002			Thickness:	6.0	mm	
		Name:	WhiteFritD	iffuseFront.lbl		Na	ame:	Wh	iteFritSpecularFr	ont.lbl		
		Product Name:	White Frit	Diffuse (front)		Pr	oduct Name:	Wh	ite Frit Specular	(front)		
		Manufacturer:	LBNL			M	anufacturer:	LBN	۱L			
		Туре:	Coated				Туре:	Coa	ated			
		Conductivity:	1.000	W/m-K		C	onductivity:	1	1.000 W/m-K			
		Solar				ſ	Solar Trans Fra					
		Trans, Fro	· · · _	0.250			Trans, Fro					
		Trans, Bac	· · · ·	0.261		Trans, Back (Tsol2): 0.031						
		Reflect., From	· · · _	0.364			Reflect., Front (Rsol1): 0.030 Reflect., Back (Rsol2): 0.050					
		Reflect., Bac	K (HSOIZ):	0.209				K (NS	:ol2): 0.050			
		Visible Trans Fro	ont (Tivis):	0.251		ĽĽ	Visible Trans, Fr	nnt í T	vis): 0.067			
		Trans, Bac	_	0.263			Trans, Bac					
		Reflect., Fror		0.481			Reflect., From		· ·			
		Reflect., Bac	· · · -	0.308			Reflect., Bac					
		IB					B					
			rans (Tir):	0.000				rans	(Tir): 0.000			
		Emis., Fro	nt (Emis1)	0.840			Emis., Fro	nt (Er	nis1) 0.840			
		Emis., Bac	:k (Emis2)	0.840			Emis., Bao	k (Er	nis2) 0.840			
			Color:					С	iolor:			
				Diffusing	Ifusing			Diffusin	9			
			4	Spectral data					🗸 Spectra	l data		
CI-		puer Library (C-U	Loord D. F.		17 657 -	all.						_
Sh	iading L	Layer Library (U:N	osers vrubli	e\LBNL\WINDO\	W7.6\W7.N	iaD)						

Shadi	Shading Layer Library (C:\Users\Public\LBNL\WINDOW7.6\w7.mdb)											
	ID Name ProductName Manufacturer Type											
	17	Fritted glass										

Figure 9-17. Fritted layers in the Glass Library.

Shading	Layer Lib	rary
ID #:	17	
Name:	White F	irit
Product	t Name:	
Manufa	cturer:	Generic
Туре:		Fritted glass
Fritted gl		103 CLEAR 6.DAT
Gloss a	ubstrate	
Fritico	overage	50.0 %
	tical data	
S	pecular	30002 WhiteFritSpecularFront.lbl 🔻
	Diffuse	30000 White Frit Diffuse Front .lbl 🔹
underst which t	tanding o he frit wa	layers is an advanced operation and requires f the referenced spectral data. Only the substrate on is measured can be used as a substrate. Email I.gov for details.

Figure 9-18. Fritted record in the Shading Layer Library referencing the fritted Glass Library records.

## 9.7. Checksum Message

The Glass Library includes a "checksum" value, which is a security measure to indicate if the Glass Library data has been edited outside the WINDOW program. When a record is imported into the Glass Library, the checksum is calculated. If the calculated checksum does not match the checksum associated with the record, the program will put up a message saying that it appears the data has been edited out side of the program, and that the glass layer should be reimported into the Glass Library, as shown in the previous section.

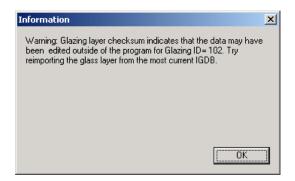


Figure 9-19. Glass Layer failed checksum test.

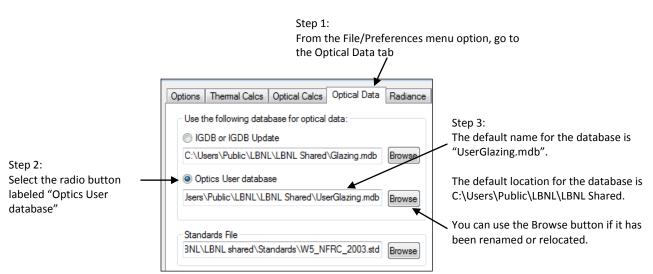
# 9.8. Importing a Layer from an Optics User Database

It is possible to create a layer in Optics and import it into the WINDOW Glass Library. This is useful for creating new laminates, or applying a coating or applied film to a different substrate than is in the IGDB. (See the WINDOW / THERM Simulation Manual for details about making a new layer in Optics). It is also possible to import a spectral data file (that has been measured in a spectrophotometer, for example) into Optics, and then import that layer into the WINDOW Glass Library. See windows.lbl.gov/software for information about the format of such a text file to import into Optics.

When a new record is created in Optics, it is stored in the "Optics User Database" which by default is called "UserGlazing.mdb". This is the database that you will be importing from (unless for some reason you have renamed it) when you import Optics records into the WINDOW Glass Library.

Here are the steps to import a user-created layer from Optics into WINDOW.

In File/Preferences, go to the Optical Data tab, and set the second option, **Optics User Database**, to your Optics5 user database. You can use the Browse button to browse to the file, which by default is located in



C:\Users\Public\LBNL\LBNL Shared

Figure 9-20. Setting Preferences for importing an Optics User Database.

Next, go to the Glass Library List View, click on the Import button, select the 2nd choice, "IGDB or Optics User Database" as the format, and click OK.

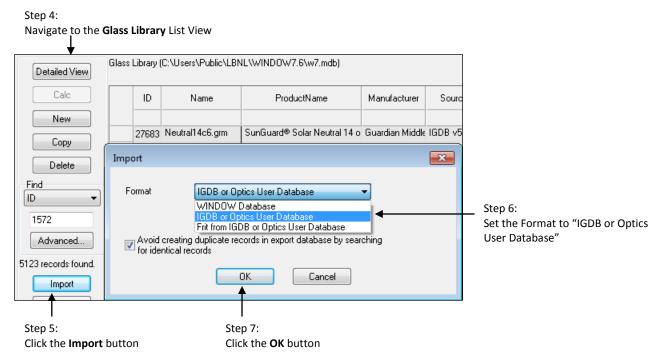
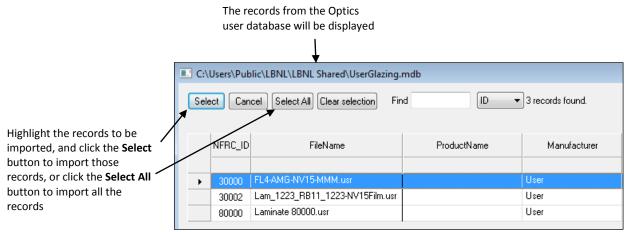


Figure 9-21. In the Glass Library List View, click the Import button and set the format to "IGDB or Optics User Database".

Records from the Optics user database set in the File/Preferences dialog box will be displayed.



*Figure 9-22. Select the records from the Optics User Database to be imported into WINDOW* 

You can select the records you want to import (use **Shift Click** to select contiguous records, **Ctl Click** to select multiple non-contiguous records, or **Select All** to select all records). Then click the **Select** button, which will import the selected records into the Glass Library.

The "Adding a record..." dialog box will appear, allowing you to keep the Optics ID, or enter a new ID for the record that will be imported into the Glass Library.

# 9.9. Creating a User-Defined Glass Layer

In most modeling situations, the IGDB data in the Glass Library will be used for glass layer definitions because it contains detailed spectral data. However, it is possible to create a "user-defined" Glass Library record in WINDOW. This type of glass record will not be protected, will have the **Source** field set to "User", and will NOT have spectral data associated with it, and therefore WINDOW will only be able to do a single-band calculation. In the case of a user-defined Glass Library created in WINDOW, the values input for the optical properties will represent average data supplied by the user rather than calculated by WINDOW from the spectral data, and which can be imported into the WINDOW Glass Library.)

A new Glass Library records can be created in either the List or Detail view using either the Copy (to copy an existing record) or New (to create a completely new record) buttons.

The steps below illustrate how to create a user-defined record in the **Glass Library** by copying an existing record:

 In the Glass Library List View, copy an existing record by highlighting the record to be copied and clicking on the Copy button.

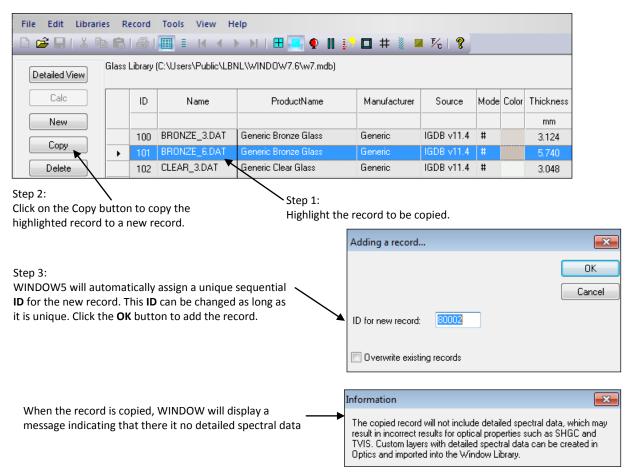


Figure 9-23. Select the record to copy an existing record to make a new entry, and click the Copy button.

- This will create a record where the fields are not protected, and can be edited. All the values from the copied record will be created, except:
  - **Source**: Will be set to "User"
  - **Type:** Will be set to "Unknown"

File Edit Librarie	es Reco	rd	Tools View H	elp					
🗅 🚅 🖬   🐰 🖻	BIA	31		🖂 N   🗄 🚾 🍨 🖩 🚯	🛛 # 🐰 🛛	1 ½ 💡			
Detailed View	Glass Libr	ary ((	C:\Users\Public\LBN	IL\WINDOW7.6\w7.mdb)					
Calc	1	D	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness
New									mm
	1	D1	BRONZE_6.DAT	Generic Bronze Glass	Generic	IGDB v11.4	#		5.740
Сору	1	02	CLEAR_3.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		3.048
Delete	1	03	CLEAR_6.DAT	Generic Clear Glass	Generic	IGDB v11.4	#		5.715
Find	1	04	GRAY_3.DAT	Generic Grey Glass	Generic	IGDB v11.4	#		3.124
ID 👻	1	05	THIN_06.DAT	Generic thin glass 0.6 mm	Generic	IGDB v54.0			0.600
	1	06	THIN_075.DAT	Generic thin glass 0.75 mm	Generic	IGDB v54.0			0.750
	1	07	THIN_11.DAT	Generic thin glass 1.1 mm	Generic	IGDB v54.0			1.100
Advanced	1	10	BRONZE_6.DAT	Generic Bronze Glass	Generic	User			5.740

The new record that was copied from BRONZE\_6.DAT has identical data in all the fields except for the Source, which will be set to "User".

Figure 9-24. The new record will have the same values for all the fields as the record it was copied from, except that **Source = User**.

- Click on the **Detailed View** button to edit the glazing layer information as needed, including the **Name**.
- Save the record using the **Save** button.

File Edit Libraries		-			
	Glass Library ID #: 110 Name: Product Name: Manufacturer: Type: Conductivity: Solar Trans, Fro Trans, Bac Reflect., Fror Reflect., Bac Visible Trans, Bac Reflect., Fror Reflect., Fror Reflect., Fror	Image: Second system         Thickness:         BRONZE_6.DAT         Generic Bronze Glass         Generic         JInknown         1.000         W/m-K         nt (Tsol):       0.486         k (Tsol2):       0.486         k (Rsol1):       0.053         k (Rsol2):       0.533         k (Tvis2):       0.533         k (Rvis1):       0.056         k (Rvis2):       0.056	5.7 mm	the desired of Notice that Ty Keep in mind user defined WINDOW, it spectal data t from a layer i	in the new record with ptical properties. ype is set to "Unknown". that because this is a record made in will not have the detailed hat would be available mported from the IGDB the Optics program and o this library.
	T Emis., Fro				
	Emis., Bac	k (Emis2) 0.840 Color: Diffusing	ata	<b></b>	
		Spectral d	ata		

*Figure 9-25. In the Detail View, the values for the copied record can be edited as needed.* 

## 10.1. Overview

The Gap Library is used to define gas and gap records that can be used when defining a glazing system in the Glazing System Library. The gap library can be used to define single pure gases, as well as gas mixures, and vacuum. The database that is installed with WINDOW has a standard set of default gaps for pure gases that are protected from editing.

## **10.2.** Gas Library List View

The List View shows all the records in the Gas Library.

File Edit Librari	es Re	cord	Tools View Help								
🗅 🚅 🖬   🐰 🖣	2 <b>R</b>		🏢 E 14 4 > >1   🗄 🛛	•	II 🗗 🗖 #	: 📗 🔟 🏷	?				
		_		_							
Detailed View					,						
Calc		ID	Name	Туре	Conductivity	Viscosity	Ср	Density	Prandtl	Conductance	Comment
New					W/m-K	kg/m-s	J/kg-K	kg/m3		W/m2-K	
	•	1	Air	Pure	0.024069	0.000017	1006.103271	1.292498	0.7197		
Сору		2	Argon	Pure	0.016349	0.000021	521.928528	1.782282	0.6704		
Delete		3	Krypton	Pure	0.008664	0.000023	248.090698	3.738740	0.6717		
Find		4	Xenon	Pure	0.005160	0.000021	158.339706	5.857955	0.6542		
ID 🔹		6	Air (5%) / Argon (95%) Mix	Mix	0.016704	0.000021	539.729126	1.757792	0.6731		
		7	Air (12%) / Argon (22%) / Krypton (68	Mix	0.011490	0.000023	322.703308	3.014770	0.6403		
		8	Air (5%) / Krypton (95%) Mix	Mix	0.009191	0.000023	261.636230	3.616428	0.6640		
Advanced		9	Air (10%) / Argon (90%) Mix	Mix	0.017063	0.000021	558.032715	1.733303	0.6758		
23 records found.		100	Air - EN673	Pure	0.024169	0.000017	1008.000000	1.292498	0.7138		
		101	Argon - EN673	Pure	0.016345	0.000021	519.000000	1.782282	0.6674		
		102	Krypton - EN673	Pure	0.008707	0.000023	245.000000	3.738740	0.6557		
Export		103	Xenon - EN673	Pure	0.005119	0.000022	161.000000	5.857955	0.6771		
Report		104	Air (5%) / Argon (95%) Mix - EN673	Mix	0.016705	0.000021	536.977966	1.757792	0.6700		
Print		105	Air (12%) / Argon (22%) / Krypton (66	Mix	0.011531	0.000023	319.890289	3.014770	0.6291		
		106	Air (5%) / Krypton (95%) Mix - EN673	Mix	0.009237	0.000023	258.634674	3.616428	0.6489		
		107	Air (10%) / Argon (90%) Mix - EN673	Mix	0.017068	0.000021	555,463989	1.733303	0.6726		
		200	CO2	Pure	0.014567	0.000014	827.734131	1.963508	0.7808		
		201	N2	Pure	0.023969	0.000017	1040.794678	1.250113	0.7207		
		202	SF6	Pure	0.013000	0.000014	418.600006	6.518257	0.4567		
		203	Helium	Pure	0.146171	0.000019	5197.000000	0.178460	0.6645		
		204	Neon	Pure	0.045416	0.000029	1030.000000	0.900331	0.6662		
		205	Octofluorpropane	Pure	0.010686	0.000011	762.015320	8.388474	0.8140		
		300	Vacuum-air P=0.001 (pr-1.5 ps-30)	Pure						0.106787	

Figure 10-1. Gas Library, List View.

#### 10.2.1. Buttons

The buttons on the left hand side of the List View have the following functions:

*Detailed View* Used to access the detailed view of the record, where the input values can be edited.

*Calc* Not used in the Gap Library. Grayed out.

NewUsed to make a new record, based on a default record.CopyUsed to copy an existing record (including name and all associated input values)<br/>into a new record.DeleteUsed to delete the highlighted record(s). The program allows deleting even<br/>protected records, which have a gray background.FindUsed to find a record based on the field selected from the pulldown list, and a value<br/>typed into the input box.

Advanced: Used to access a more advanced method of searching the list

Find		<b>—</b> X—
Find what:		Find Next
Match entire cell text	C Up  C Up  Down	Cancel

#### Import

Used to import records from various sources.

Import		X
Format	WINDOW Database	
Import database	C:\Users\Public\LBNL\WINDOW7.5\cellSha	
For identical re	g duplicate records in export database by searching cords	
	0K Cancel	

Format: Select from one of the following database formats

• WINDOW database: Import from another WINDOW database

*Import Database:* If the format is set to "WINDOW database" this option appears, allowing the user to select the desired WINDOW database to import records from.

**Avoid Creating Duplicate records ...**: A checkbox, which when checked, will cause the program to ask for new IDs if the IDs of the imported records conflict with existing records in the Library.

*Export* Used to export records from this database into either an existing WINDOW database, or a new WINDOW database.

Export	×
Export:	
Format WINDOW Database	
Export C:\Users\rdmitchell\Downloads\WINDOW \w Browse New	
Avoid creating duplicate records in export database by searching for identical records	
OK Cancel	

**Export:** Radio buttons that allow export of selected (highlighted in the List) or all records

Format: The export format options are

- WINDOW database: This option causes an Export field to be displayed which allows Browsing to an existing database to export the records into, or a New database to export the records into.
- Comma separated value (CSV): Selecting this option and clicking the OK button opens a Save As window which allows the user to specify the name of the CSV file and the directory location.

**Avoid Creating Duplicate records ...**: A checkbox, which when checked, will cause the program to ask for new IDs if the IDs of the imported records conflict with existing records in the Library.

Report

Allows creating a report containing a list of the records in the Glass Library.

Report 🛛
Report type: Library List
Generate report for:
Selected record(s)
<ul> <li>All records</li> </ul>
Text file options Use default column widths Vrap columns
V Preview
OK Cancel

Report Type: There is only one option, which is a Library List

**Generate report for:** Radio buttons which specify whether the report will contain only the selected (highlighted) records or all the records in the Library

## **Text file options:**

- Use default column widths: this option causes long names to be truncated
- Wrap columns: this option allows long names to be wrapped to another line or lines

Preview: check this box shows a preview of the report before it is saved or printed

Sav	ve Print Close				
ID	Name	Type	Conductivity	Viscosity	Cp
			Btu∕h-ft-F	lb∕ft-s	Btu∕lb-F
1	Air	Pure	0.013907	0.000011	0.240304
2	Argon	Pure	0.009446	0.000014	0.124660
3	Krypton	Pure	0.005006	0.000015	0.05925
4	Xenon	Pure	0.002981	0.000014	0.037819
6	Air (5%) / Argon (95 %) Mix	Mix	0.009651	0.000014	0.128912
7	Air (12%) / Argon (2 2%) / Krypton (66%)	Mix	0.006639	0.000015	0.077076
8	Air (5%) / Krypton ( 95%) Mix	Mix	0.005310	0.000015	0.062493
9	Air´(10%) / Argon (9 0%) Mix	Mix	0.009859	0.000014	0.13328

*Print* Used to print a report which contains a list of all the records in the library.

### 10.2.2. Column Headings

The List view contains columns with selected results (from the Detail view) for each record, as described below.

ID	The unique ID associated with each record.
Name	The name of the gap record.
Туре	This field indicates one of two gap types:
	<ul> <li>Pure: a pure gas</li> </ul>
	• Mix: a mixture of gasses
Conductivity	Conductivity of the gas defined for this gap. Units: W/m-K (SI); Btu/h-ft- $^{\circ}$ F (IP)
Viscosity	Viscosity of the gas defined for this gap. <b>Units:</b> kg/m-s (SI); lb/ft-s (IP)
Ср	Specific heat of the gas defined for this gap. Units: J/kg-oK (SI); Btu/lb-oF (IP)
Density	Density of the gas defined for this gap. Units: $kg/m^3$ (SI); $lb/ft^3$ (IP)
Prandtl	Prandtl number of the gas defined for this gap. Unitless.
Conductance	Conductance of layer. Units: W/m <sup>2</sup> -K (SI); Btu/h-ft <sup>2</sup> -oF (IP)
Comment	Comment that can be entered by the user.

# 10.3. Gas Library Detail View

The Detail View shows details of individual gasses in the Gas Library. WINDOW5 is shipped with several "protected" gas records, but it is also possible to create user defined records.

Сору	Name: Air	
)elete	Gas Mixture	Vacuum
Gave	Molecular Weight: 28.970	Pressure: 101325.00 Pa
	Conductivity Coefficients	Properties at STP
	A 0.00287300 W/m-K	Conductivity 0.024069 W/m-K
	B 0.00007760 W/m-K2	Viscosity 0.000017 kg/m-s
	C 0.00000000 W/m-K3	Specific Heat 1006.1032 J/kg-K
	Viscosity Coefficients	Density 1.292498 kg/m3
	A 0.00000372 kg/m-s	Prandtl 0.7197
	B 0.00000005 kg/m-s-K	
	C 0.00000000 kg/m-s-K2	Property Calculator
	Specific Heat Coefficients	
	A 1002.73699951 J/kg-K	
	B 0.01232400 J/kg-K2	
	C 0.00000000 J/kg-K3	
	Comment:	

*Figure 10-2. Gas Library, Detail View for a single gas protected (default) record.* 

The following describes the fields for the records in the Gap Library.

## 10.3.1. Buttons

The buttons on the left hand side of the List View have the following functions:

List	Used to access the List view of the library.
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s). The program allows deleting even protected records, which have a gray background.

## 10.3.2. Field Descriptions

#### **General Information**

The upper section of the Gap Library Detail view contains basic information about the gap. There are two checkboxes, both of which change the input values on the rest of the Gap Library Detail view (see detailed descriptions in the following sections):

Gas Mixture: Check this box to define a gap with more than one gas in it

**Vacuum:** Check this box to define an evacuated gap that would be used in a vacuum glazing system.

Gap L	ibrary	
ID #:	1	
Name:	Air	
	Gas Mixture	Vacuum
Mo	lecular Weight: 28.970	Pressure: 101325.00 Pa

- *ID* Unique ID number associated with each gap record. The ID is automatically assigned when a record is added in the List View, but can be changed by the user at that time as long as the ID is unique.
- *Name* The name of the gap layer. The name is input by the user for user-created records.
- *Gas Mixture* A checkbox to indicate if the record defines a single pure gas (unchecked) or a gas mixture (checked).

If the **Gas Mixture** box is checked, the screen changes. **Add** and **Delete** buttons appear and a small table showing the list of gasses is displayed. Also, the **Vacuum** checkbox disappears, indicating that gaps designed for vacuum glazing systems can only have pure gases, not mixtures. Additionally, the Pressure value also disappears for gas mixtures.

Ga	p Libra	ary						
ID	<b>#</b> : 6							
Nan	Name: Air (5%) / Argon (95%) Mix							
	Gas Mixture Add Delete							
	Molec	ular Weight:	146.100					
	ID	Name	Percent	Properties at STF				
Gap 1	1	Air	5.0%	Conductivity	0.016704	W/m-K		
Gap 2	2	Argon	95.0%	Viscosity	0.000021	kg/m-s		
				Specific Heat	539.72912	J/kg-K		
				Density	1.757792	kg/m3		
				Prandtl	0.6731			
				Property C	alculator			

**Add:** Click this button to add another gas to the mixture definition. A dialog box appears which allows selection of a pure gas and input of the percentage of that gas for this gas mixture

Gas Mixture	×
Gas to add	Krypton 💌
Mixture Percentage	0
ОК	Cancel

**Delete:** Highlight the row in the gas mixture list and click the Delete button to delete that row

As more gases are added to the mixture, the gas mixture list is updated

	ID	Name	Percent
Gap 1	1	Air	12.0%
Gap 2	2	Argon	22.0%
Gap 3	3	Krypton	66.0%

After a row in the gas mixture list has been added, the **Percent** value can be changed in the table by double clicking on the percentage value, typing a new value, and pressing the Enter key.

Adding new gases to the mixture, or changing their percentage, will cause the program to automatically recalculate the values in the **Properties at STP** box.

- Properties at STF	)	
Conductivity	0.024069	W/m-K
Viscosity	0.000017	kg/m-s
Specific Heat	1006.1032	J/kg-K
Density	1.292498	kg/m3
Prandtl	0.7197	
Property Ca	alculator	

*Vacuum* The Vacuum checkbox is used to define the properties of a gap represents an evacuated cavity. When this box is checked, the input values for the gap change substantially, as shown below.

The Conductivity, Viscosity and Specific Heat Coefficients are no longer displayed, and the Properties at STP box changes to Properties at Vacuum. In addition a few new fields are added, which are explained below.

Gap Library						
ID #: 300						
Name: Vacuu	um-air P=0.0	001 (pr-1.5 p	os-30)			
				Vacuum		
Molecular	Weight:	28.970	Pressure:	0.13332 F	Pa 0.00100	Torr
Specific h	eat ratio:	1.400	Pillar Definition:	1 1.5 radius 3	0 spacing 🔹 🔻	>>
			-Gap Proper	ties at Vacuum	_	
			Conducta	ince 0.106787	W/m2-K	

The fields used when defining a vacuum gap are:

Molecular Weight: The molecular weight of gas that is evacuated from the cavity.

**Pressure:** This is the vacuum pressure, either entered as Pascals (SI)/psi (IP) or Torr. Changing one input box will cause the other value to change.

Pressure: 0.13	3332 Pa	0.00100	Torr
----------------	---------	---------	------

**Specific heat ratio:** This is ratio of the heat capacity at constant pressure ( $C_P$ ) to heat capacity at constant volume ( $C_V$ ).

**Pillar Definition:** The Pillar Definition field is a pulldown list of user-defined pillar geometries that are used to define the pillars separating the layers in an evacuated glazing system. The double arrow button to the right of the pulldown list opens the following dialog box for the currently selected Pillar Definition in the pulldown list. This dialog box allows pillars to be defined and added to the pull down list.

Gap Pillar D	efinition				<b>—</b> X—
ID:	1		Manufacturer:	Generic	_
Name:	1.5 radius 30 sp		Comment:		
Type:	Circular 👻		coninent.		
Radius:	0.200	mm			
Spacing:	30.000	mm			
	New Del	ete	Save	ОК	Cancel

**ID:** An automatically generated ID number for each pillar definition.

**Manufacturer:** The manufacturer of the pillar or the vacuum product, input by the user.

**Name:** The name of the pillar, which is what will be displayed in the pulldown list in the Gap Library List view.

**Type:** A pulldown list of pillar types, which currently only includes the option of Circular, for circular pillars in the evacuated cavity.

Radius: The radius of the pillar. Units: mm (SI); inches (IP)

**Spacing:** The spacing of the pillars, assuming they are equally spaced in all directions. Units: mm (SI); inches (IP)

Comment: A comment that can be input by the user

Gap Properties at Vacuum, Conductance: The conductance of the gap at vacuum.

Molecular	Molecular weight of the gas
Weight	0 0

*Pressure* Pressure of the gas. Units: Pa (SI); psi (IP)

#### **Conductivity Coefficients**

The conductivity calculation is based on the following formula from ISO 15099:

 $Cond=A + B*T + C*T^2$ 

Where T = Temperature in degrees Kelvin

WINDOW has input values for each of the coefficients in that formula:

A Coefficient A for Conductivity from ISO 15099 Units: W/m-K (SI); Btu/h-ft-°F (IP)

В	Coefficient B for Conductivity from ISO 15099
	<b>Units:</b> W/m-K <sup>2</sup> (SI); Btu/h-ft-°F <sup>2</sup> (IP)
C	Coefficient C for Conductivity from ISO 15000

C Coefficient C for Conductivity from ISO 15099 **Units:** W/m-K<sup>3</sup> (SI); Btu/h-ft-°F<sup>3</sup> (IP)

## **Viscosity Coefficients**

The viscosity calculation is based on the following formula from ISO 15099:

Viscosity =  $A + B^{T} + C^{T^{2}}$ 

Where T = Temperature in degrees Kelvin

WINDOW has input values for each of the coefficients in that formula:

Α	Coefficient A for Viscosity from ISO 15099 Units: g/m-s (SI); lb-s/ft <sup>2</sup> (IP)
В	Coefficient B for Viscosity from ISO 15099 Units: g/m-s-K; (SI); lb-s/ft2-°F (IP)
С	Coefficient C for Viscosity from ISO 15099 Units: g/m-s-K2; (SI); lb-s/ft2-°F <sup>2</sup> (IP)

### **Specific Heat Coefficients**

The specific heat calculation is based on the following formula from ISO 15099:

Specific Heat =  $A + B^{T} + C^{T^{2}}$ 

Where T = Temperature in degrees Kelvin

WINDOW has input values for each of the coefficients in that formula:

Α	Coefficient A for Specific Heat from ISO 15099 <b>Units:</b> Kj/kg-K (SI); Btu/lb-°F (IP)
В	Coefficient B for Specific Heat from ISO 15099 <b>Units:</b> Kj/kg-K <sup>2</sup> (SI); Btu/lb-°F <sup>2</sup> (IP)
С	Coefficient C for Specific Heat from ISO 15099 <b>Units:</b> Kj/kg-K <sup>3</sup> (SI); Btu/lb-°F <sup>3</sup> (IP)

## **Properties at STP**

Gas properties at Standard Temperature and Pressure. Temperature = 0 C, Pressure = 101.3 kPa

Conductivity	Conductivity of the gas, based on the Conductivity Coefficients and formula above.
	Units: W/m-K (SI); Btu/h-ft-°F (IP)

*Viscosity* Viscosity of the gas, based on the Viscosity Coefficients and formula above. Units:

g/m-s (SI);  $lb-s/ft^2$  (IP)

- *Specific Heat* Specific heat of the gas, based on the Specific Heat Coefficients and formula above. Units: kJ/kg-K (SI); Btu/lb-°F (IP)
- Density Density of the gas. Units: kg/m<sup>3</sup> (SI); lb-ft<sup>3</sup> (IP)
- PrandtlPrandtl number (ratio of momentum diffusivity to thermal diffusivity) of the gas.<br/>Unitless

PropertyClicking this button allows calculation of the Gas properties at values other thanCalculatorstandard temperature and pressure. Property calculator for values at differentbuttonpressures and temperatures other than the standard values.

After clicking this button, a new dialog box appears, which allows input of a Temperature and Pressure.

	Gas Property Calculator
Properties at STP Conductivity 0.024069 W/m-K Viscosity 0.000017 kg/m-s Specific Heat 1006.1032 J/kg-K Density 1.292498 kg/m3 Prandtl 0.7197	Temperature 0.00000 C Pressure 101.00000 kPa Conductivity 0.024 W/m-K Viscosity 0.000 kg/m-s
Property Calculator	Specific Heat 1006.103 J/kg-K Density 1.3 kg/m3 Prandtl 0.720 Close

# 10.4. Gas Mixtures

To create a record that has a mixture of gasses, follow these steps:

- Make a new record by using the **Copy** or **New** button (either a single gas record or a mixture).
- Double click on the newly created record, or highlight it and click on the Detailed View button, to access the Detailed View
- Click on the **Mixture** checkbox if the gas is not already a mixture.
- Click on the **Add** button to add a new gas and the Gas Mixture dialog box will be displayed. Select the gas from the pulldown list and type in the gas percentage. A new line will appear in the gas mixtures section.
- Use the **Add** and/or **Delete** buttons create the desired gas mixture.

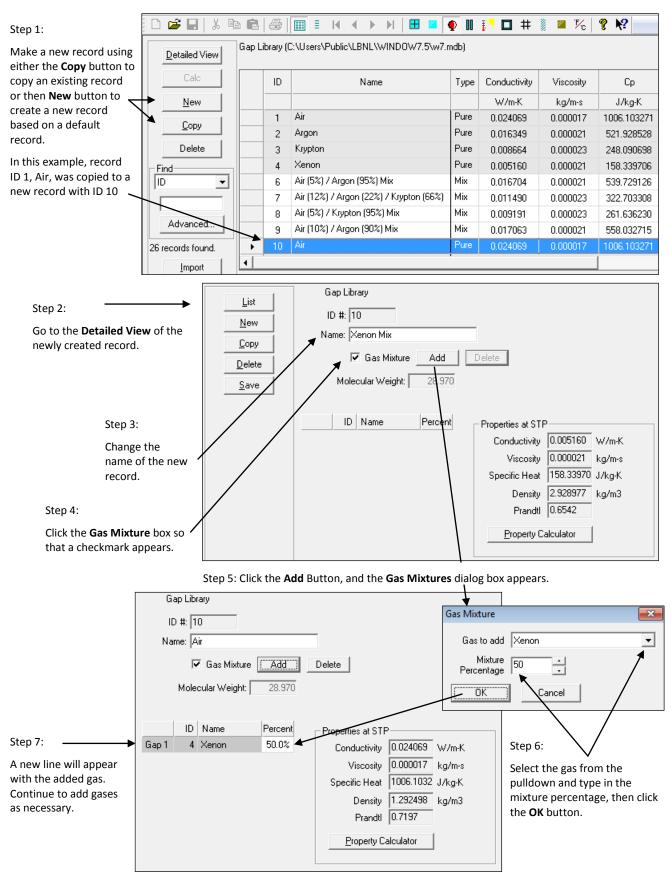


Figure 10-3. Steps to create a new gap that contains a gas mixture.

# 10.5. Vacuum Cavities

WINDOW can model glazing systems with evacuated cavities, referred to as "vacuum glazing systems". The first step in modeling this product is to define a gap in the Gap Library that represents the evacuated cavity in the glazing system. Then that gap record can be used when creating the vacuum glazing system (in the Glazing System Library) rather than a standard gap layer, and WINDOW will calculate the thermal characteristics of the glazing system with that vacuum cavity.

Here are the steps for creating the evacuated cavity record in the Gap Library. (See the detailed definitions for all the fields in the beginning section of this chapter).

- Make a new record by using the Copy or New button (a single gas record is best, as vacuum cavities must be composed of pure gases, rather than gas mixtures).
- Double click on the newly created record, or highlight it and click on the Detailed View button, to access the Detailed View
- Change the **Name** of the record to reflect what is being modeled.
- Click on the **Vacuum** checkbox. This will cause the input values to change significantly.
- Enter the appropriate values for
  - Molecular weight
  - Pressure: Specified in one of two unit systems, either Pascal/psi or Torr units
  - Specific heat ratio
  - Pillar definition: this is user defined based on the size and spacing of circular pillars in the evacuated cavity that keep the two layers on either side of the cavity from collapsing.
- The Properties at Vacuum value, which is not editable, will be updated automatically by the program based on the values input.

File Edit Libraries Record Tools View Help Step 1: □ 🗳 🖬 👗 🖻 🖻 🎒 🗐 🗉 🖬 🔺 🕨 ) 🗄 🔼 🍨 🛯 📴 🗮 1 👅 🍢 🦹 🖉 Make a new record Gap Library (C:\Users\Public\LBNL\WINDOW7.5\w7.mdb) using either the Copy Detailed View button to copy an Calc existing record or then ID Name Туре Conductivity Viscosity Ср New button to create a W/m-K J/kg-K New kg/m-s new record based on a 1 Air Pure 0.024069 0.000017 1006.103271 default record. <u>С</u>ору 2 Argon Pure 0.016349 0.000021 521.928528 In this example, record Delete 3 Krypton Pure 0.008664 0.000023 248.090698 ID 1, Air, was copied to Pure Xenon 4 0.005160 0.000021 158.339706 Find a new record with ID 10 Air (5%) / Argon (95%) Mix Mix ID 6 0.016704 0.000021 539.729126 • Mix Air (12%) / Argon (22%) / Krypton (66%) 7 0.011490 0.000023 322.703308 8 Air (5%) / Krypton (95%) Mix Mix 0.009191 0.000023 261.636230 Advanced.. Air (10%) / Argon (90%) Mix Mix 9 0.017063 0.000021 558.032715 Ai Pure 26 records found. Gap Library Step 2: ID #: 304 the newly created record. Name: Vacuum Step 4: 🔽 Vacuum 📥 Click the Vacuum Step 3: box so that a 28.970 0.00100 Torr Molecular Weight: Pressure: 0.13332 Pa checkmark Change the name of the appears. 1.400 new record. Specific heat ra Pillar Definition: ->> Gap Properties at Vacuum Condyctance 0.106787 W/m2-K Step 5: Input appropriate values for Molecular weight Step 6: Pressure (Pa/psi or Torr) Select an existing choice from the Pillar Definition pulldown list, or click on the Specific Heat Ratio double arrow button to open the Gap Pillare Definition dialog box. Gap Pillar Definition ж Step 7: ID: 2 Manufacturer: In the Gap Pillar Definition dialog box, it is Name: 1mm, 15mm spacir possible to create a new pillar definition, edit Comment: Type: Circular Ŧ an existing definition, or delete the currently selected definition. Fill out the input values as Radius: 1 mm needed to properly define the pillars in the Spacing: 20 vacuum gap, and click the Save button mm

Figure 10-4. Steps to create a vacuum gap.

Delete

Save

OK

Cancel

New

# 11.1. Frame Library

The **Frame Library** consists of frame elements (such as headers, jambs, sills, and meeting rails) and their associated frame and edge-of-glass properties for use in constructing a whole product in the **Window Library**.

# 11.1.1. Frame Library Detail View

The Frame Library Detail View shows all the data for an individual record.

File Edit Librarie	
🗅 🚅 🗔   👗 🖻	: 🛍   🖂   Ⅲ 📑   🛛 🔺 🕨     🗄 🔎 🖗 🛛 🔛 🗖 # 🐰 🛛 🌾   🦿
List Therm New Copy Delete Save	Frame Library ID #: 7 Name: sample-sill.THM Source: Therm ▼ Type: Sill ▼ Filename: _\Samples\sample-sill.THM U-VALUES Frame: 2.014089 W/m2-K Edge Correlation: ▼
	Edge of Glass: 2.336966 W/m2-K GLAZING SYSTEM Width: 25.933 mm Center of Glass U-value: 1.934666 W/m2-K
	FRAME Projected Frame Dimension: 42.875 mm Material Abs: 0.300000
	Color: Wetted Length: 56.333 mm Comment:
	Condensation Resistance based on Therm CR simulation           @30%RH         @50%RH         @70%RH         Overall           Frame         0.004         0.024         0.063         97.0           Edge         0.028         0.201         0.322         81.6
	*These CR numbers are based on To and Ti as defined in the INI

Figure 11-1. Frame Library, Detail View.

The properties defined for each gas entry are listed below:

ID #	The unique ID associated with this record. <b>Default:</b> WINDOW automatically assigns this number when creating a new record. When making a new record in the List View, it is possible to change the ID number as long as it is unique.							
Name		The name of the frame record. <b>Default:</b> for imported THERM files, WINDOW nutomatically sets the name field to the name of the THERM file. In any case, this name is editable by the user.						
Source	The source of the frame inform	nation, from the following list:						
		ice is used when not importing a THERM file. When Edge Correlation pulldown becomes enabled.						
	records that are shipped w	RAE/LBNL choice is used for the five protected with WINDOW for consistency with previous versions based on the Edge Correlation methodology.						
		oice is automatically set by WINDOW when a THERM rame Library from the List View. This setting will cause down to become disabled.						
Filename	The THERM file filename, including the path. Type in the value or use the <b>Browse</b> button to select it. <b>Default:</b> The complete filename of the THERM file if the Import button was used from the <b>List View</b> .							
Browse Button	Use the <b>Browse</b> button to select the THERM file associated with this <b>Frame Library</b> record.							
Туре	· -	e THERM file, based on the <b>Cross Section Type</b> value log box (accessed from the <b>File/Properties</b> menu) in						
U-VALUES								
Frame	U-factor of the frame, either in source is "Generic".	nported from the THERM file or input by the user if						
Edge of Glass	U-factor of the edge of glass, e user if source is "Generic".	ither imported from the THERM file or input by the						
Edge Correlation	Edge correlation for frames wi Correlation choices are:	ith Source set to either "Generic" or "ASHRAE/LBL".						
	Edge Correlation Number	Spacer Material						
	1	Aluminum - ASHRAE Metallic						
	2	Stainless stell; dual seal						

3	Butyl/Metal (also Fiberglass, Wood, Glass Edge)
4	Insulated
5	U-edge = U-center-of-glass (Used when modeling single glazing)

#### **GLAZING SYSTEM**

Width Width of the glazing system, either from an imported THERM file or input by the user. **Default:** if the record is from an imported THERM file, this is the width of the glazing system from that file.

Center of<br/>Glass U-valueU-factor of the center-of-glass, either from an imported THERM file or input by the user.Default:<br/>system from that file.Default: if the record is from an imported THERM file, this is the U-factor of the glazing<br/>system from that file.

#### FRAME

Width	Width of frame (projected frame dimension), which is the width of the fram element in the plane of the glazing. <b>Default:</b> if the record is from an imported THERM file, the width is the Frame Length which is displayed in the THERM U-factor dialog box when a file has results.									
Material Abs	-	Absorptivity of the frame, editable by the user. This value does not come from the IHERM file. <b>Default:</b> 0.500.								
Color	on the co	Frame color, input by the user. This value does not come from the THERM file. Click on the color block and a Color dialog box will appear, where the desired color can be selected.								
Comment	Commer	nt about th	e frame, ir	nput by the	e user. <b>De</b> f	fault:	blank			
Condenstation Resistance	Condensation index of the frame components, if the record was imported from a THERM file. The Condensation Resistance values are not calculated in THERM for vertical models, such as Jambs and Vertical Meeting Rails. When the THERM file is imported into the WINDOW Frame Library, the U-factor results (rather than the CR Results) are displayed in this CR section).									
	<ul> <li>Condensation Resistance based on Therm U-factor simulation</li> </ul>									
		@30%RH	@50%RH	@70%RH	Overall					
	Frame	0.002	0.020	0.079	96.6					
	Edge	0.017	0.133	0.264	86.2					

\*These CR numbers are based on To and Ti as defined in the INI

Condensation Resistance based on Therm CR simulation						
	@30%RH	@50%RH	@70%RH	Overall		
Frame	0.004	0.024	0.090	96.1		
Edge	0.042	0.206	0.326	80.9		

\*These CR numbers are based on To and Ti as defined in the INI

The Condensation Index values are:

- @30% RH, @50%RH, @70% RH: the S components of the Condensation Index equation for each of the three relative humidity (RH) points in the NFRC 500: Procedure for Determining Fenestration Product Condensation Index document for the Frame and Edge components of the THERM file.
- Overall: the overall CI value calculated from the intermediate relative humidity values, for the Frame and Edge components of the THERM file, based on the formula in the the NFRC 500: Procedure for Determining Fenestration Product Condensation Index document.

			Condensation Index						
	@30%RH	@50%RH	@70%RH	Overall					
Frame	0.658	0.747	0.786	26.9					
Edge	0.046	0.244	0.361	78.3					

Figure 11-2. Condensation Index details on Frame Library record.

**11.1.2. Frame Library list View** The Frame Library List View shows all the records in the library.

File Edit Librarie	es Re	ecord	Tools View Help									
D 🖻 🖬   🐰 🖻	8	6	🏢 I I I I I I I E	8 🔳 🌒	0 🗗	🗖 # 🐰	🛛 🏹	?				
Detailed View	Frame	Library	(C:\Users\Public\LBNL\WIND(	)W7.6\w7	.mdb)							
Update		ID	Name	Source	Туре	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs	Color
New						W/m2-K	W/m2-K		mm	mm		
Сору	•	1	Al w/break	ASHRAE	N/A	5.680	N/A	Class1	N/A	57.2	0.90	
Copy		2	Al flush	ASHRAE	N/A	3.970	N/A	Class1	N/A	57.2	0.90	
Delete		3	Wood	ASHRAE	N/A	2.270	N/A	Class1	N/A	69.8	0.90	
Find		4	Vinyl	ASHRAE	N/A	1.700	N/A	Class1	N/A	69.8	0.90	
ID 🔹		5	sample-head.THM	Therm	Head	2.007	2.350	N/A	26.5	42.9	0.30	
		6	sample-jamb.THM	Therm	Jamb	1.995	2.343	N/A	26.5	42.9	0.30	
		7	sample-sill.THM	Therm	Sill	2.001	2.344	N/A	26.5	42.9	0.30	
Advanced												
7 records found.												
Export												
Report												
Print												

<b>T</b> '		-	T 11	<b>T</b> • •	x 71
Figure	11-3.	Frame	Library,	List	View.

The buttons on the left hand side of the List View have the following functions:

Detailed View	goes to the detailed view of the record, where the input values can be edited.
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s).
Find	Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.
Advanced	Used to access a more advanced method of searching the list
Import	Used to import THERM files into the Frame Library.
Export	Used to create a comma-separated text file of library records, which can be imported into a spreadsheet or database program.
Report	Currently disabled.
Print	Used to print a report which contains a list of all the records in the library.

## 11.1.3. Importing THERM files

The THERM program is used to generate frame (and divider) profiles which can then be imported into the WINDOW5 Frame Library, and then referenced in the Window Library.

There are two different methods for importing a THERM file into the Frame Library:

- From the **Frame Library List View**, use the **Import** button to select a THERM file.
- From the **Frame Library Detail View**, use the **Browse** button to select a THERM file to be associated with the current frame record.

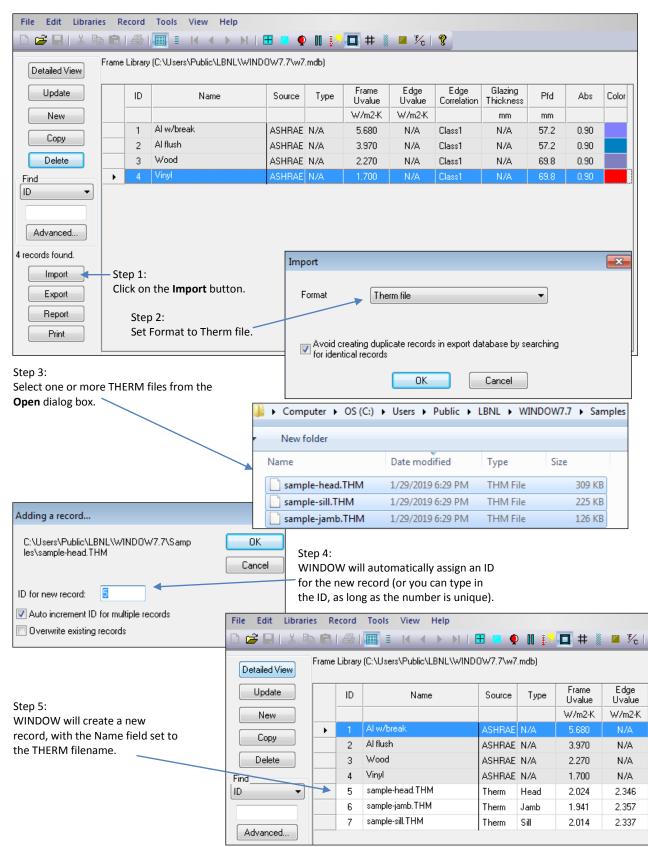


Figure 11-4. Use the Import button to create Frame Library records from THERM files.

In order to make change to the newly imported THERM file, click on the Detailed View button and change the input values as needed.

Note: In order for the CI (Condensation Index) values to be imported from the THERM file into the WINDOW Frame Library, it is necessary to check the "Save Simulation Results in THM files" in the THERM program under the **Options/Preerences** menu, the **Simulation** tab.

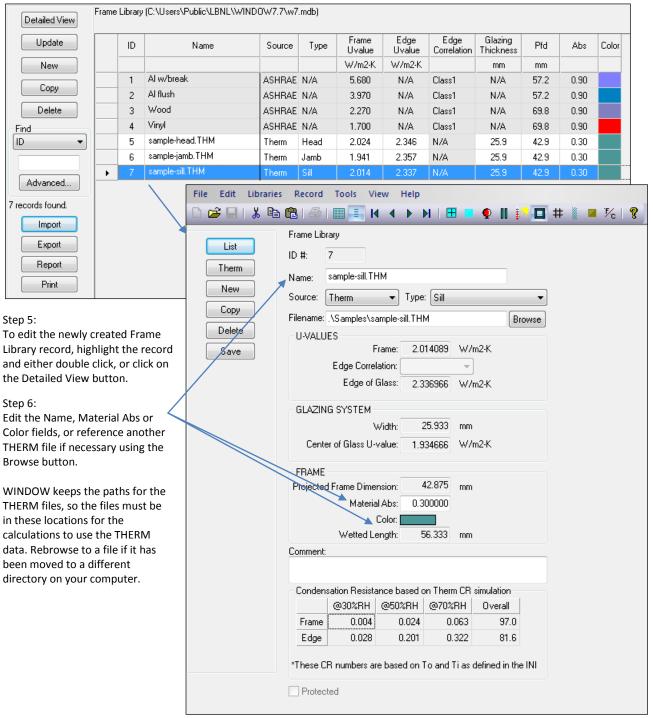


Figure 11-5. Edit the THERM file frame record if neccessary.

#### 11.1.4. Condensation Resistance (CR) Calculation

WINDOW includes a feature which calculates the whole product Condensation Resistance (CR) using the methodology presented in NFRC 500. This process involves importing surface temperatures from THERM for each frame cross-section.

The CR values from the THERM files are shown in WINDOW in the Condensation Resistance section of the Frame Library Detailed View.

		Frame Lib	orary				
		ID #:	7				
		Name:	sample-sill.Tl	нм			
		Source:	Therm	👻 Туре	x Sill		•
		Filename:	.\Samples\s	ample-sill.TH	м	В	rowse
		- U-VALL	JES			_	
			F	Frame: 2.0	)14089 W/r	m2-K	
			Edge Corre	lation:	~		
			Edge of	Glass: 2.3	36966 W/r	m2-K	
		GLAZIN	IG SYSTEM				
			N N	Width:	25.933 mm		
		Cent	er of Glass U-	value: 1.9	34666 W/r	m2-K	
		FRAME	:				
		Projecte	d Frame Dime	nsion:	42.875 mm		
			Materia	al Abs: 0.3	800000		
				Color:			
			Wetted L	ength:	56.333 mm		
		Comment					
		Conder	nsation Resista	ance based (	on Therm CR	simulation	
Results from the THERM file used for	-		@30%RH	@50%RH	@70%RH	Overall	
the WINDOW whole product		Frame	0.004	0.024	0.063	97.0	
Condensation Resistance calcultion		Edge	0.028	0.201	0.322	81.6	
		*These (	CR numbers a	re based on "	To and Tias (	defined in th	e INI

Figure 11-6. The Condensation Resistance section shows the values from the THERM file.

# 12.1. Divider Library

The Divider Library is very similar to the Frame Library. The **Divider Library** has frame and edge-of-glass properties, which can be input by the user or imported from THERM files, for use in constructing a whole product in the **Window Library**.

# 12.1.1. Divider Library Detail View

The Detail View shows details of individual dividers in the Divider Library

	Divider Li	brary							
List	ID #:	7							
Therm New	Name:	Divider.THM	Divider.THM						
	Source:	Therm	👻 Туре	< Vertica	al Divider		-		
Сору	Filename:\THERM7.7\Samples\Divider.THM Browse								
Delete	U-VALUES								
Save		F	Frame: 1.9	08924	W/m2-K				
		Edge Corre	lation:		-				
		Edge of	Glass: 1.6	07107	W/m2-K				
	GLAZIN	IG SYSTEM							
		1	Width:	25.426	mm				
	Center of Glass U-value: 1.480598 W/m2-K								
	FRAME								
	Projected Frame Dimension:			25.400	mm				
	Material Abs: 0.300000								
			Color:						
		Wetted L	ength: 2	25.400	mm				
	Comment	:							
	Conder	sation Resista	ance based o	on Therm	U-factor	simulati	on		
		@30%RH	@50%RH	@70%R	H O	verall			
	Frame	0.000	0.006	0.1	56	94.6			
	Edge	0.000	0.000	0.1	13	96.2			
		R numbers a	re based on "	To and Ti	as defin	ed in the	e INI		
	Protec	ted							

Figure 12-1. Divider Library, Detail View.

The properties defined for each gas entry are listed below:

ID #	The unique ID associated with this record. <b>Default:</b> WINDOW automatically assigns this number when creating a new record. When making a new record in the <b>List View</b> , it is possible to change the ID number as long as it is unique.
Name	The name of the divider record. <b>Default:</b> for imported THERM files, WINDOW automatically sets the name field to the name of the THERM file. In any case, this name is editable by the user.
Source	The source of the divider information, from the following list:
	<ul> <li>Generic: The Generic choice is used when not importing a THERM file. When this selection is made, the Edge Correlation pulldown becomes enabled.</li> </ul>
	<ul> <li>ASHRAE/LBL: The ASHRAE/LBNL choice is used for the protected records that are shipped with WINDOW for consistency with previous versions of the</li> </ul>

	program. They ar	e based on the Edge Co	orrelation methodology.		
	file is imported in		tically set by WINDOW when a THERM from the List View. This setting will become disabled.		
Filename		fault: The complete file	h. Type in the value or use the <b>Browse</b> ename of the THERM file if the Import		
Browse Button	Use the <b>Browse</b> button to select the THERM file associated with this <b>Divider Library</b> record.				
Туре	specified in the Prope	The type of cross section of the THERM file, based on the <b>Cross Section Type</b> value specified in the <b>Properties</b> dialog box (accessed from the <b>File/Properties</b> menu) in the THERM program, from the following list:			
	<ul> <li>Divided: for "tru</li> </ul>	ıe" divided lite divider	s		
	• Suspended: for a system	dividers suspended bet	ween the glass layers of the glazing		
U-VALUES					
Frame	U-factor of the divide source is "Generic".	er, either imported from	n the THERM file or input by the user if		
Edge of Glass	U-factor of the edge of glass, either imported from the THERM file or input by the user if source is "Generic".				
Edge Correlation	Edge correlation for d Correlation choices a		t to either "Generic" or "ASHRAE/LBL".		
		Edge Correlation Number	Spacer Material		
		Div	rided Lights:		
		1	Aluminum, hollow		
		2	Butyl, solid, with aluminum backing		
		3	Wood, solid		
		4	Insulating material, solid (k=0.012		

Insulating material, solid Btu/hr-ft-°F
Divided Lights:
Aluminum, hollow
Vinyl, hollow

GLAZING SYSTEM

Width	Width of the glazing system, either from an imported THERM file or input by the user. <b>Default:</b> if the record is from an imported THERM file, this is the width of the glazing system from that file.
Center of Glass U-value	<i>U-factor of the center-of-glass, either from an imported THERM file or input by the user.</i> <b>Default:</b> <i>if the record is from an imported THERM file, this is the U-factor of the glazing system from that file.</i>
FRAME	
Width	Width of divider (projected dimension), which is the width of the divider element in the plane of the glazing. <b>Default:</b> if the record is from an imported THERM file, the width is the Frame Length which is displayed in the THERM U-factor dialog box when a file has results.
Material Abs	Absorptivity of the divider, editable by the user. This value does not come from the THERM file. <b>Default:</b> 0.500.
Color	Frame color, input by the user. This value does not come from the THERM file. Click on the color block and a Color dialog box will appear, where the desired color can be selected.
Comment	Comment about the divider, input by the user. Default: blank.
Condenstation Index	Condensation index of the divider components, if the record was imported from a THERM file. The Condensation Index values are:
	• @30% RH, @50% RH, @70% RH: the S components of the Condensation

- @30% RH, @50% RH, @70% RH: the S components of the Condensation Index equation for each of the three relative humidity (RH) points in the *NFRC 500: Procedure for Determining Fenestration Product Condensation Index* document for the Frame and Edge components of the THERM file.
- **Overall:** the overall CI value calculated from the intermediate relative humidity values, for the Frame and Edge components of the THERM file, based on the formula in the the *NFRC 500: Procedure for Determining Fenestration Product Condensation Index* document.

_	@30%RH	@50%RH	@70%RH	Overall
Frame	0.000	0.006	0.156	94.6
Edge	0.000	0.000	0.113	96.2

Figure 12-2. Condensation Index details on Frame Library record.

## 12.1.2. Divider Library List View

The List View shows all the records in the Divider Library.

File Edit Librarie	s Re	cord	Tools View Help									
🗅 🚅 🗐   🐰 🖻		6		🖽 🖪 🍳	0 🛃		🛛 🏹	8				
Detailed View	Divider	Library	(C:\Users\Public\LBNL\WIN	DOW7.7\wi	7.mdb)							
Update		ID	Name	Source	Туре	Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs	Color
New						W/m2-K	W/m2-K		mm	mm		
Сору	•	1	Alum/Divided	ASHRAE	N/A	N/A	N/A	Class1	N/A	15.9	0.90	
Copy		2	Butyl/Divided	ASHRAE	N/A	N/A	N/A	Class2	N/A	15.9	0.90	
Delete		3	Wood/Divided	ASHRAE	Suspende	N/A	N/A	Class3	N/A	15.9	0.90	
Find		4	Insul/Divided	ASHRAE	Suspende	N/A	N/A	Class4	N/A	15.9	0.90	
ID 🔻		5	Alum/Suspended	ASHRAE	Suspende	N/A	N/A	Class5	N/A	16.0	0.30	
		6	Vinyl/Suspended	ASHRAE	N/A	N/A	N/A	Class1	N/A	16.0	0.30	
		7	Divider.THM	Therm	Vertical D	1.909	1.607	N/A	25.4	25.4	0.30	
Advanced												
7 records found.												
Import												
Export												
Report												
Print												
or Help, press F1									Mode	: NFRC	SI CAP	IUM SC

Figure 12-3. Divider Library, List View.

The buttons on the left hand side of the List View have the following functions:

Detailed View	goes to the detailed view of the record, where the input values can be edited.
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s).
Find	Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.
Advanced	Used to access a more advanced method of searching the list
Import	Used to import THERM files into the Divider Library.
Export	Used to create a comma-separated text file of library records, which can be imported into a spreadsheet or database program.
Report	Currently disabled.
Print	Used to print a report which contains a list of all the records in the library.

### 12.1.3. Importing THERM Files

The technique for importing THERM files into the Divider Library is the same as for the Frame Library (see *Section 4.7.3,* "Importing THERM Files").

There are two different methods for importing a THERM file into the Divider Library:

- From the Divider Library List View, use the Import button to select a THERM file.
- From the Divider Library Detail View, use the Browse button to select a THERM file to be associated with the current frame record.

# 13.1. Overview

The Environmental Conditions Library contains sets of environmental conditions for the U-factor and Solar Heat Gain Coefficient (SHGC) calculations. U-factor environmental conditions are typically defined for winter, night-time conditions while solar heat gain environmental conditions are defined for summer, daytime conditions.

#### 13.1.1. Environmental Conditions Library Detail View

The Detail View shows details of individual environmental condition records in the Environmental Conditions Library. One environmental condition record consists of definitions for all four tabs in the detailed view, which consists of two tabs for U-factor (Inside and Outside) and two tabs for SHGC (Inside and Outside).

#### U-factor Inside tab

The U-factor Inside tab of the Environmental Conditions library is used to define the conditions for the U-factor calculations for the inside surface of the window.

File Edit Librario	es Record Tools View Help
List New Copy Delete Save	Environmental Conditions Library ID #: 1 Name: NFRC 100-2010 U-factor: Inside U-factor: Outside SHGC: Inside SHGC: Outside Inside Air Temperature 21.0 C Convection Modet ASHRAE/NFRC Inside
	Radiation ASHRAE/NFRC Effective Room Temperature 21.0 C Effective Room Emissivity 1.000  Protected

Figure 13-1. Environmental Conditions Library, Detail View, U-factor Inside Tab.

The input values are the following:

Inside Air	Inside air temperature. Units: C (SI); F (IP)
Temperature	

*Convection* The convection model, which controls what other input values appear in this section, from the following choices:

Model	Convection Coeff	Inside Air Velocity	Air Direction
ASHRAE/NFRC Outside	User Input	User input	Choices:
			Windward Leeward
ASHRAE/NFRC Inside	N/A	N/A	N/A
Fixed Convection Coefficient	User Input	N/A	N/A
Fixed Combined Coefficient	User Input	N/A	N/A
Yazdanian-Klems	N/A	N/A	N/A
Kimura	User Input	User input	Choices:
			Windward Leeward

Radiation

The radiation model, which controls what other input values appear in this section, and which is dependent on the input for the Convection model:

	Effective Room Temperature	Effective Room
Model	Units: C (SI); F (IP)	Emissivity
ASHRAE/NFRC Outside	User Input	User input
ASHRAE/NFRC Inside	User Input	User input
Fixed Convection Coefficient	User Input	User input
Fixed Combined Coefficient	N/A	N/A
Yazdanian-Klems	User Input	User input
Kimura	User Input	User input

### **U-factor Outside tab**

The U-factor Inside tab of the Environmental Conditions library is used to define the conditions for the U-factor calculations for the outside surface of the window.

File Edit Librarie	es Record Tools View Help
List New Copy Delete Save	Environmental Conditions Library ID #: 4 Name: default U-factor: Inside U-factor: Outside SHGC: Inside SHGC: Outside Coutside Outside SHGC: Outside Coutside
	Convection Model: ASHRAE/NFRC Outside  Convection Coef. 26.000 W/m2-K Outside Wind Speed 5.50 m/s Wind Direction Windward  Radiation
	ASHRAE/NFRC   Effective Sky Temperature 18.0 C Effective Sky Emissivity 1.000  Protected

Figure 13-2. Environmental Conditions Library, Detail View, U-factor Outside Tab.

The input values are the following:

Outside Air	Outside air temperature. Units: C (SI); F (IP)
Temperature	

*Convection* The convection model, which controls what other input values appear in this section, from the following choices:

Model	Convection Coeff	Outside Wind Speed	Wind Direction
ASHRAE/NFRC Outside	User Input	User input	Choices:
			Windward Leeward
ASHRAE/NFRC Inside	N/A	N/A	N/A
Fixed Convection Coefficient	User Input	N/A	N/A
Fixed Combined Coefficient	User Input	N/A	N/A
Yazdanian-Klems	N/A	N/A	N/A
Kimura	User Input	User input	Choices:
			Windward Leeward

Radiation

The radiation model, which controls what other input values appear in this section, and which is dependent on the input for the Convection model:

Model	Effective Sky Temperature	Effective Sky Emissivity
	Units: C (SI); F (IP)	
ASHRAE/NFRC Outside	User Input	User input
ASHRAE/NFRC Inside	User Input	User input
Fixed Convection Coefficient	User Input	User input
Fixed Combined Coefficient	N/A	N/A
Yazdanian-Klems	User Input	User input
Kimura	User Input	User input

#### SHGC Inside tab

The SHGC (Solar Heat Gain Coefficient) Inside tab of the Environmental Conditions library is used to define the conditions for the SHGC calculations for the inside surface of the window.

File Edit Librari	es Record Tools View Help 🖻 💼 🖅 🔲 들 🖊 🔺 🕨 🕅 🗄 🗖 🍨 💵 👬 🗖 井 🐰 🜌 🇞 🛛 🍞
List New Copy Delete Save	Environmental Conditions Library ID #: 4 Name: default U-factor: Inside U-factor: Outside SHGC: Inside SHGC: Outside Inside Air Temperature 24.0 C Convection Modet: ASHRAE/NFRC Inside
	Radiation         ASHRAE /NFRC         Effective Room Temperature         24.0 C         Effective Room Emissivity         1.000

Figure 13-3. Environmental Conditions Library, Detail View, Solar Heat Gain Coefficient Inside tab.

The input values are the following:

Inside Air	Inside air temperature. Units: C (SI); F (IP)
Temperature	

*Convection* The convection model, which controls what other input values appear in this section, from the following choices:

Model	Convection Coeff	Inside Air Velocity	Air Direction
ASHRAE/NFRC Outside	User Input	User input	Choices:
			Windward Leeward
ASHRAE/NFRC Inside	N/A	N/A	N/A
Fixed Convection Coefficient	User Input	N/A	N/A
Fixed Combined Coefficient	User Input	N/A	N/A
Yazdanian-Klems	N/A	N/A	N/A
Kimura	User Input	User input	Choices:
			Windward Leeward

Radiation

The radiation model, which controls what other input values appear in this section, and which is dependent on the input for the Convection model:

Model	Effective Room Temperature	Effective Room Emissivity
	Units: C (SI); F (IP)	
ASHRAE/NFRC Outside	User Input	User input
ASHRAE/NFRC Inside	User Input	User input
Fixed Convection Coefficient	User Input	User input
Fixed Combined Coefficient	N/A	N/A
Yazdanian-Klems	User Input	User input
Kimura	User Input	User input

#### SHGC Outside tab

The SHGC (Solar Heat Gain Coefficient) Inside tab of the Environmental Conditions library is used to define the conditions for the SHGC calculations for the inside surface of the window.

File Edit Libraries	s Record Tools View Help
🗅 🚅 🖃   🐰 🖻	n 🛍   🗇   🎟 🔚 🙌 🔺 🕨 🕅   🖽 💻 🍨 💵 👫 🗖 🗰 🌾   🦹
List	Environmental Conditions Library
New	ID #: 4
Сору	Name: default
Delete	U-factor: Inside   U-factor: Outside   SHGC: Inside   SHGC: Outside
Save	Outside Air Temperature 32.0 C
	Direct Solar Radiation 783.0 W/m2
	Convection
	Convection Coef. 15.000 W/m2-K
	Outside Wind Speed 2.75 m/s
	Wind Direction Windward
	Radiation
	ASHRAE/NFRC -
	Effective Sky Temperature 32.0 C
	Effective Sky Emissivity 1.000
	Protected

Figure 13-4. Environmental Conditions Library, Detail View, Solar Heat Gain Coefficient Outside tab.

The input values are the following:

Outside Air Temperature	Outside air temperature. Units: C (SI); F (IP)
Direct Solar Radiation	Solar radiation at 0 degrees incidence (normal incidence).

*Convection* The convection model, which controls what other input values appear in this section, from the following choices. The highlighted rows are the default values in WINDOW:

Convection Model	Convection Coeff	Outside Wind Speed	Wind Direction
ASHRAE/NFRC Outside	User Input	User input	Choices: Windward Leeward
ASHRAE/NFRC Inside	N/A	N/A	N/A
Fixed Convection Coefficient	User Input	N/A	N/A
Fixed Combined Coefficient	User Input	N/A	N/A
Yazdanian-Klems	N/A	N/A	N/A
Kimura	User Input	User input	Choices:
			Windward Leeward

#### Radiation

The radiation model, which controls what other input values appear in this section, and which is dependent on the input for the Convection model:

Convection Model	Effective Sky Temperature Units: C (SI); F (IP)	Effective Sky Emissivity
ASHRAE/NFRC Outside	User Input	User input
ASHRAE/NFRC Inside	User Input	User input
Fixed Convection Coefficient	User Input	User input
Fixed Combined Coefficient	N/A	N/A
Yazdanian-Klems	User Input	User input
Kimura	User Input	User input

#### 13.1.2. Environmental Conditions Library List View

The List View shows all the records in the Environmental Conditions Library. There are three pre-defined, protected records provided, and it is possible to copy these records and create other (unprotected) records with any conditions that need to be defined.

File Edit Libraries Record Tools View Help								
D 😂 🔲   🎖 🖻 💼   🔿   🎟 🗉 🙌 🔺 🕨 > >     🗄 🧧 🍨 💵 🚰 🗖 🗰 🧏 🦉 👘								
Detailed View	Detailed View Environmental Conditions Library (C:\Users\Public\LBNL\WIND0W7.6\w7.mdb)							
Calc		ID	Name	U-factor Tin	U-factor Tout	SHGC Tin	SHGC Tout	SHGC Solar
New				С	С	С	С	W/m2
Сору	•	1	NFRC 100-2010	21.0	-18.0	24.0	32.0	783
Сору		2	NFRC 100-2010 Winter	21.0	-18.0	21.0	-18.0	0
Delete		3	NFRC 100-2010 Summer	24.0	32.0	24.0	32.0	783
Find		4	CEN	20.0	0.0	25.0	30.0	500
ID  Advanced 4 records found.								
Import Export Report Print								

Figure 13-5. Environmental Conditions Library, Detail View, Solar Heat Gain Coefficient Outside tab.

The buttons on the left hand side of the List View have the following functions:

Detailed View	Goes to the detailed view of the record, where the input values can be edited.
Calc	This field is disabled in this library
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s).
Find	Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.
Advanced	Used to access a more advanced method of searching the list
Import	Used to import Environmental Conditions Library records from another WINDOW database.
Export	Used to create a comma-separated text file of library records, which can be imported

into a spreadsheet or database program.

*Report* Generates a simple list of the properties of all the records in the Environmental Conditions Library.

ID Name	3	U-factor T in	U-factor T out	SHGC Tin	SHGC Tout	SHGC Solar
2 NFRO	C 100-2010 C 100-2010 Winter C 100-2010 Summer	C 21.0 21.0 24.0 20.0	C -18.0 -18.0 32.0 0.0	C 24.0 21.0 24.0 25.0	C 32.0 -18.0 32.0 30.0	W∕m2 783 0 783 500

Figure 13-6. Environmental Conditions Library List view report

Print

Used to print a report which contains a list of all the records in the library.

# 14.1. Overview

The **Shade Material Library** contains the optical and thermal properties for shading layer materials, which are then referenced from the **Shading Layer Library** for some shading layers. The shade types which use the **Shade Material Library** are:

- Slat shades: Defines the properties of the slat material (for Venetian blinds and horizontal slat blinds)
- Cellular shades: Defines the properties of the cellular shade fabric
- **Pleated shades:** Defines the properties of the pleated shade fabric
- Roller shades (some): Defines the properties of the roller shade fabric if it is a homogeneous diffusing material
- Solar screens: Defines the properties of the solar screen material

The optical properties in this library are based on spectral data measured in a spectrophotometer. The values in the **Shade Material Detailed View** are spectrally averaged properties calculated by the program, in the same manner as glass layers with spectral data.

# 14.2. Shade Material Library

The **Shade Material Library** defines the optical and thermal properties shading materials, which are then referenced from the **Shading Layer Library**.



Figure 14-1. Access the Shade Material Library either from the Libraries menu or the toolbar button.

#### 14.2.1. Shade Material Library List View

The **Shade Material Library List View** shows the records in the library.

File Edit Libraries	s Record	Tools View Help						
다 🚅 🔜   🗴 ங 💼   종   🏢 🗉 🖂 🔺 > >>   🖽 💻 🍨 💵 👬 🗖 # 🐰 🜌 7%   🍞								
Detailed View Shade Material Library (C:\Users\Public\LBNL\WINDOW7.6\w7.mdb)								
Calc	ID	Name	ProductName	Manufacturer	Source	Mode	Color	
New								
	31025	CS04_glueline.txt	Accordia Des. Col. LF Snow, 1	Levelor	CGDB	@		
Сору	31026	CS03_White.txt	Acc. Des. Col. LF Snow, 1947	Levelor	CGDB	@		
Delete	31027	CS03_glueline.txt	Acc. Des. Col. LF Snow, 1947	Levelor	CGDB	@		
Find	31028	CS02_WhiteBack.txt	Accordia LF Cream, 19170202	Levelor	CGDB	@		
ID 🔻	31029	CS02_glueline.txt	Accordia LF Cream, 19170202	Levelor	CGDB	@		
	31030	CS02_frontsheerfabric.txt	Accordia LF Cream, 19170202	Levelor	CGDB	@		
	31031	CS01_glueline.txt	Accordia Classic LF Toffee, 19	Levelor	CGDB	@		
Advanced	31032	CS01_brownfabric.txt	Accordia Classic LF Toffee, 19	Levelor	CGDB	0		
62 records found.	31033	C23_innerwalls.txt	C23 White/Alumium back	Hunter Douglas	CGDB	0		
Innert	31034	C22-951_innerwalls.txt	C22-951 Inner wall	Hunter Douglas	CGDB	0		
	31035	C22-951_outerwalls.txt	C22-951 Outer wall	Hunter Douglas	CGDB	@		
Export	31036	C22-951_glueline.txt	C22-951 Glue line	Hunter Douglas	CGDB	@		
Report	31037	C82_TransparentPlastic.txt	C82 Transparent plastic	Hunter Douglas	CGDB	@		
Print	31038	D2_WhiteWallMaterial.txt	D2 White wall	Hunter Douglas	CGDB	@		
	31039	D7_WhiteOnSilverBack.txt	D7 White on Silver back	Hunter Douglas	CGDB	@		

Figure 14-2. The Shade Material Layer Library List View.

The records in the default WINDOW Shade Material Library are from the Complex Glazing Database (CGDB), which is distributed by LBNL as new shade materials are submitted by manufacturers. See the LBNL windows.lbl.gov website for more information about the CGDB, including the latest version.

#### Buttons

The buttons on the left hand side of the List View have the following functions:

Detailed View	Used to display the detailed view of the record.
Calc	Not used in this library.
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s).
Find	Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.
Advanced	Used to access a more advanced method of searching the list
Import	Use to import spectral data for the material if it is available. The data must have been imported into the Optics program as a text file, saved into the Optics user database,

	and then imported using the choice of "Optics User Database" on the import dialog box.
Export	Used to export records to either another WINDOW database or to a comma-separated text file.
Report	Used to create a report containing a summary of the records in the List View.
Print	Used to print a report which contains a list of all the records in the library.

# **Column Headings**

See the description in the Shade Material Library Detailed View section for definitions for most of the column headings. Listed here are columns not included in that description.

Source	Source of the optical data. Current options are:
	<ul> <li>Optics: Indicates that the data was imported from the Optics database. These records will have the spectral data information from the Optics database.</li> </ul>
	<ul> <li>User: Indicates that the data was created when the user copyied an existing record into a new record. User defined records will not have associated spectral data values.</li> </ul>
Mode	An identifier to determine if the layer is approved by NFRC. Only records with "#" in this field can be used for NFRC simulations. This field is currently not relevant, but may be used in the future if complex glazings are approved for use with NFRC certified simulations.

#### 14.2.2. Shade Material Library Detailed View

The **Shade Material Library Detailed View** is where the thermal and optical detailed properties for a material can be entered.

File Edit Librarie	is Record Tools View Help a 💼   →   Ⅲ 📑   I 🔺 🔺 ▶ ▶     ⊞ 🖉 🗣 💵 👬 🗖 井 🐰 🜌 🇞   🎖
List Optics 5 New Copy Delete Save	Shade Material       ID #: 30101       Thickness: 0.6 mm         Name:       Slat Metal A         Product Name:       Dpaque white colored slat mater         Manufacturer:       Generic
Update IGDB	Conductivity:         160.000         W/m-K           Solar         0.000         0.000           Trans, Front (Tsol):         0.000           Trans, Back (Tsol2):         0.000           Reflect., Front (Rsol1):         0.700           Visible         0.700           Trans, Front (Tvis):         0.000           Trans, Back (Tsol2):         0.000           Visible         0.000           Trans, Back (Tvis2):         0.000           Reflect., Front (Tvis):         0.000           Reflect., Front (Rvis1):         0.700           Reflect., Back (Rvis2):         0.700           IR         Trans (Tir):         0.000           Emis., Front (Emis1)         0.900           Emis., Back (Emis2)         0.900
	Color: Von-specular Spectral data Comment: ISO 15099 Example Material V Protected

Figure 14-3. The Shade Material Layer Library Detailed View.

The properties of the slat or other shade material are defined in detail in this library, based on spectrophotometric measurements. If spectral data was imported into this library for a material, the values in the **Shade Material Detailed View** are spectrally averaged properties calculated by the program, in the same manner as for glass layers with spectral data.

# Shade Material Input

The optical properties defined for each Shade Material entry are listed below:

1 1 1	, ,
ID	The unique ID associated with this record. For records whose <b>Source</b> is "IGDB User", this ID is assigned in the Optics User Database. For records whose <b>Source</b> is "User", this ID is assigned automatically by WINDOW but can be overwritten by the user as long as it is unique.
Thickness	The thickness of the Shade Material. <b>Units:</b> mm (SI); inches (IP).
Name	The name of the shade material. If the record was imported from the Optics User Database, this name will automatically come from that database.
Product Name	A text field that can be used to specify the product name. If the record was imported from the Optics User Database, this name will automatically come from that database.
Manufacturer	The name of the shade material manufacturer. If the record was imported from the Optics User Database, this name will automatically come from that database.
Conductivity	Conductivity of the material. Units: W/m-K (SI);Btu/h-ft-F (IP)
Solar	
Trans. Front (Tsol)	Solar transmittance of the front, exterior-facing side of the shade material.
Trans. Back (Tsol)	Solar transmittance of the back, interior-facing side of the shade material.
Reflect., Front (Rsol1)	Solar reflectance of the shade material, exterior-facing side.
Reflect., Back (Rsol2)	Solar reflectance of the shade material, interior-facing side.
Visible	
Trans. Front (Tsol)	Visible transmittance of the front, exterior-facing side of the shade material.
Trans. Back (Tsol)	Visible transmittance of the back, interior-facing side of the shade material.
Reflect., Front (Rsol1)	Visible reflectance of the shade material, exterior-facing side.
Reflect., Back (Rsol2)	Visible reflectance of the shade material, interior-facing side.
IR	
Trans (Tir)	Thermal infrared (longwave) transmittance of the shade material.
Emis., Front (Emis1)	Infrared (longwave) emittance of the shade material, exterior-facing side

Emis., Back (Emis2)	Infrared (longwave) emittance of the shade material, interior-facing side
Color	A graphic representation of the color of the shade material.
Non-specular	This checkbox indicates whether the material is specular.
Spectral Data	This checkbox indicates whether there is spectral data (by wavelength) associated with the material.
Comment	
Protected	If this box is checked, the record is protected from editing.

### Spectral Data for Shade Materials

If spectral data is available for Shade Materials, the data is first imported into the Optics program, saved into an Optics User Database. The data can then be imported into the Shade Material Library from the Optics User Database, as discussed below. The spectral data to be imported into Optics must be in the format described for a submission to the International Glazing Database (IGDB). See the windows.lbl.gov website under IGDB for specific data format instructions.

Steps for importing spectral data from an Optics User Database:

 From the File menu, Preferences choice, Optical data tab, select the "Optics User Database" option, and specify the path for the database using the Browse button

Options	Thermal Calcs	Optical Calcs	Optical Data	Radiance	Deflection	Updates
⊂ Use t	he following data	base for optical	data:			
⊚ IG	DB or IGDB Upd	ate				
C:\U	sers\Public\LBN	L\LBNL Shared	\Glazing.mdb	Browse		
⊚ Op	otics User databa	se				
Jsers	\Public\LBNL\LI	3NL Shared\Us	erGlazing.mdb	Browse		
Stand	dards File					
C:\Pr	ogram Files (x86)	\LBNL\LBNL s	hared\Standaı	Browse		
Stand	dards File					

Figure 14-4. In File/Preferences/Optical Data, select "Optics User Database" and browse to the desired file.

- From the **List View** of the **Shade Material Library**, click on the **Import** button.
- In the Import dialog box, set Format to "IGDB or Optics User Database" and click OK. (The Optics User Database that the program will open is set in the File / Preferences menu, Optical Data tab).
- A dialog box showing the records in the Optics User Database will display. Select the desired records and click the **Select** button.
- The selected records will be added to the **Shade Material Library**.

14-6

etailed View	Shade M	aterial Library (C:\Use	rs\Public\LBNL\WINDOW7.6\w7.	mdb)				
Calc		ID	Name	ProductName	Manufacturer	Source	Mode C	olor Thickne
<u>N</u> ew								mm
	▶ 30	101 Slat Metal A		Opaque white colored slat material	Generic	CGDB		0.600
<u>С</u> ору	30	)102 Slat Metal B		Opaque pastel colored slat material	Generic	CGDB		0.600
Delete	30	)103 Slat Metal C		Opaque light-dark colored slat material	Generic	CGDB		0.600
	30	)104 Slat Metal D		Translucent white colored slat material	Generic	CGDB		0.600
•	31	000 WINDAT Intern	al Light Venetian Blind-Optics5.txt	light venetian blind	WINDAT	CGDB		1.500
	31	002 Diffusing shade	material	Example	Generic	CGDB		2.000
	31	006 Woven Shade I	Material	Woven Shade	Generic	CGDB		0.600
dvanced	31	008_vb02_glf14.txt		Horizontal slat - White GLF14	Generic	CGDB		2.900
rds found.	31	009 vb14_pk138.txt		Horizontal slat - Wood PK138	Generic	CGDB		3.100
laun aut	31	010 vt01_Mocha.txt		Vertical slat - Mocha	Generic	CGDB		1.000
<u>Import</u>	31	011 vt02_Snow.txt		Vertical slat - Snow	Generic	CGDB		1.000
Export	31	012 vt03_Presidenti	al.txt	Vertical slat - Presidential	Generic	CGDB		1.000
Report	31	013 rs_AntiqueWhite	e.txt	Roller shutter - Antique White	Generic	CGDB		4.000
Print	31	014 rs_Bronze.txt		Roller shutter - Bronze	Generic	CGDB		4.000
<u>_</u> mk	31	015 rs_Silver.txt		Roller shutter - Silver	Generic	CGDB		4.000
	F	ormat	DB or Optics User Database	•				
		Avoid creating dup for identical record	licate records in export database					
		Avoid creating dup for identical record	OK Cance Select Cancel Select	t All Clear selection Find	ID Ma	▼ 23 anufacture	records ar	found.
	V	Avoid creating dup for identical record	OK Cancel Select Cancel Select	Lat All Clear selection Find	Generic	anufacture		
		Avoid creating dup for identical record	OK Cancel Select Cancel Select	A Clear selection Find Name ProductName ha.txt Vertical slat - Mocha w.txt Vertical slat - Snow	Generic Generic	anufacture		

Figure 14-5. Importing spectral data into the Shade Material Library.

File Edit Libraries	Record Tools View Help
🗅 📂 🖬   👗 🖻	🛍   🍜   🎟 📑 🙌 🔹 🕨   🗄 🔳 🍨 🖩 👫 🖉 🌾   🤶
List	Shade Material ID #: 31010 Thickness: 1.0 mm
Optics 5	Name: vt01_Mocha.txt
New	Product Name: Vertical slat - Mocha
Сору	Manufacturer: Generic
Delete	
Save	
	Conductivity: 0.120 W/m-K
	Solar Trans, Front (Tsol): 0.213
	Trans, Back (Tsol2): 0.213
	Reflect., Front (Rsol1): 0.449
Update IGDB	Reflect., Back (Rsol2): 0.449
	Visible Trans, Front (Tvis): 0.052
	Trans, Back (Tvis2): 0.052
	Reflect., Front (Rvis1): 0.201
	Reflect., Back (Rvis2): 0.201
	IR
	Trans (Tir): 0.046
	Emis., Front (Emis1) 0.825
	Emis., Back (Emis2) 0.825
	Color:
	✓ Non-specular
	✓ Spectral data
	Comment
	Comment:
	✓ Protected

In the **Detailed View**, the optical properties displayed are spectrally averaged values calculated from the spectral data.

*Figure 14-6. The Detailed View of the Shade Material Library displays the average values for optical properties calculated from the imported spectral data..* 

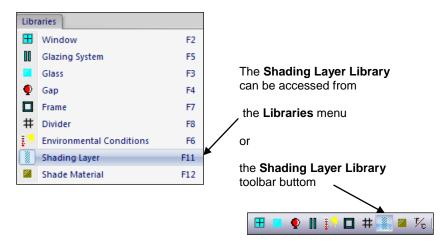
# 15.1. Overview

This chapter discusses in detail the WINDOW Shading Layer Library, which can be used to model the following types of shading system:

- Slat shades: Defines the properties of the slat material (for Venetian blinds and horizontal slat blinds)
- Cellular shades: Defines the properties of the cellular shade fabric
- **Pleated shades:** Defines the properties of the pleated shade fabric
- Roller shades (some): Defines the properties of the roller shade fabric if it is a homogeneous diffusing material
- Solar screens: Defines the properties of the solar screen material

## 15.2. Shading Layer Library

The Shading Layer Library defines may different types of shading layers, which can be added to glazing systems and windows to calculate the properties of those complete systems.



*Figure 15-1. The Shading Layer library has been added to the Libraries menu.* 

#### 15.2.1. Shading Layer Library List View

The Shading Layer Library List View shows the records in the library. There are several example records in the WINDOW 6 database (W6.mdb) that is included in the installation. These records include venetian blind examples from ISO 15099 ("Venetian A0" to "Venetian D90" with the slat angle and slat material incorporated into the name of the Shading Layer), as well as an example of a BSDF file, a diffusing layer being defined for the shading layer, and a ventian blind with spectral data (the WINDAT example).

File Edit Libraries	Record T	ools View Help			
D 🖻 🖬   X 🖻 I	8 6 5	🗊 = K K > > I   🖽 🔳 🗣 🛚 🚺	🗖 # 🎚 🛛 ½ 💡		
		.ibrary (C:\Users\Public\LBNL\WINDOW7.6\w7.ma			
Detailed View	auny Layer L	IDIAIY (C. YOSHSYFADIICYEDNE YWYND OWY, 6YWY, III	וטב		
Calc	ID	Name	ProductName	Manufacturer	Туре
New					
	17	White Frit		Generic	Fritted glass
Сору	19	Woven shade. Gray. 25% open area		Generic	Woven
Delete	20	Off White Blind 24 mm slat at 45 degrees		Generic	Venetian (horizontal)
Find	21	Dark Blue Blind 24 mm slat at 45 degrees		Generic	Venetian (horizontal)
ID 👻	22	Clear Frit (no pigment)		Generic	Fritted glass
	23	Woven shade, Gray, 3% open area		Generic	Woven
	24	Woven shade. Gray. 10% open area		Generic	Woven
Advanced	28	Perforated screen, 8,7% open area		Generic	Perforated Screen
80 records found.	29	1" horizontal VB (white) - 45 deg		Generic	Venetian (horizontal)
	30	3" horizontal VB (white) - 45 deg		Generic	Venetian (horizontal)
	31	3" vertical VB (white) - 0 deg (open)		Generic	Venetian (vertical)
Export	32	0.4" inbetween VB (white) - 45 deg		Generic	Venetian (horizontal)
Report	50	Cellular Shade. Single cell, light color	ID50_CS	Generic	Therm File
Print	51	Cellular Shade. Stacked double cell, light color	ID51_CS	Generic	Therm File
	52	Cellular Shade. cell-in-cell, light color	ID52_CS	Generic	Therm File
	53	Cellular Shade. Single cell, blackout, low-e	ID53_CS	Generic	Therm File
	54	Cellular Shade. Single cell, light color, sheer	ID54_CS	Generic	Therm File
	1000	Black, Close Weave	Black, Close Weave	Ricky Richards	BSDF
	1500	Alabaster 2772	Alabaster 2772	Shaw	BSDF
	1501	Urbanshade White 2685	Urbanshade White 2685	Shaw	BSDF
	2000	Twilight 279-A10 Light Grey	Twilight 279-A10 Light Grey	Living Shade	BSDF

Figure 15-2. The Shading Layer Library List View.

# Buttons

The buttons on the left hand side of the List View have the following functions:

Detailed View	Used to display the detailed view of the record.
Calc	Not used in this library.
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s).
Find	Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.
Advanced	Used to access a more advanced method of searching the list
Import	Use to import spectral data for the material if it is available. The data must have been imported into the Optics5 program as a text file, saved into the Optics5 user database, and then imported using the choice of "Optics User Database" on the import dialog
	box.
Export	box. Used to export records to either another WINDOW database or to a comma-separated text file.
Export Report	Used to export records to either another WINDOW database or to a comma-separated

#### 15.2.2. Shading Layer Library Detailed View

The **Shading Layer Library** detail view displays the different input values for the various shading systems that can be defined.

WINDOW can model several different shading system types, which results in the need for very different input parameters for each of them. This section is a basic overview of what is contained in the Shading Layer Library. Detailed information about how to model the various types of shading systems is discussed in detail in Chapter 19.

The figure below shows the **Shading Layer Library** detail view for a Venetian blind, but this screen will be different for each shading system type, based on the selection from the **Type** pulldown list.

	File Edit Libraries	Record Tools	View Help			
	🗅 🚅 🖬   👗 🗈	🛍   🕭   🔳 📮	- IA 🔺 🕨 🖬 🖪 🖪	🍨 II 📴 🗖	1 # 🎆 🛛 🏷   🤋	
The <b>Type</b> pulldown menu choice is used to define the different models that are used for different shading systems.	List New Copy Delete Save	Shading Layer Libr ID #: 30 Name: 3" horize Product Name: Manufacturer: Type: Material: Perm Venetian Blind Slat width: Spacing: Tilt: Tilt: [ Tilt angle: Blind thickness:			Venetian blind, horizontal lomogeneous diffusing shade verforated screen hade with XML data herm File (*.thmx) enetian blind, horizontal voven shade	

*Figure 15-3. The Shading Layer Library Detailed View for Horizontal Venetian Blinds.* 

#### **Buttons**

The buttons on the left hand side of the List View have the following functions:

Detailed View	Used to display the detailed view of the record.
Calc	Not used in this library.
New	Used to make a new record, based on a default record.
Сору	Used to copy an existing record (including name and all associated input values) into a new record.
Delete	Used to delete the highlighted record(s).
Find	Used to find a record based on the field selected from the pulldown list, and a value typed into the input box.
Advanced	Used to access a more advanced method of searching the list
Import	Use to import Shading Layers from another WINDOW database.
Export	Used to export records to either another WINDOW database or to a comma-separated text (CSV) file.
Report	Used to create a report containing a summary of the records in the List View.
Print	Used to print a report which contains a list of all the records in the library.

#### **Column Headings**

See the description in the **Shade Material Library Detailed View** section for definitions for most of the column headings. Listed here are columns not included in that description.

#### Shading Layer Library Input

ID	The unique ID	associated y	with each	Shading	Layer record.

Name The name of the **Shading Layer**.

Type of **Shading Layer**, from the following list:

Venetian blind, horizontal 🗾 👻
Homogeneous diffusing shade Perforated screen Shade with XML data Therm File (*.thmx)
Venetian blind, horizontal Venetian blind, vertical Woven shade

Figure 15-4. The options for the Shading Layer "Type"

• **Homogeneous diffusing shade:** Use this choice for any perfectly diffusing layer that does not have an open weave construction

- Perforated screen: Use this choice for a screen that has circular, square or rectangular perforations that are geometrically uniform across the shade material.
   Shade with XML data: Use this for any shading layer that has bi-directional scattering distribution function (BSDF) data from either modeling (such as with a ray tracing method) or measurements. Examples of shades that might use this method would be roller shades with diffusing fabric
  - **THERM file (\*.**thmx): Use this for a shading system that has a complex geometry that is defined in a THERM file that is then referenced for both the optical and thermal calculations in this library.
  - **Venetian blind, horiztonal:** Use this for the classic horizontal slat Venetian blind.
  - Venetian blind, vertical: Use this to define vertical slat blinds.
  - **Woven shade:** Use this to define a shade fabric that has a uniform weave that can be geometrically defined based on thread diameter and thread thickness.

# MaterialThis is a pull-down list that shows the records in the Shade Material Library, which<br/>represents measured data. The record chosen will determine the optical and thermal<br/>properties of the material.

This material needs to be defined for the following Shading Layer Types:

- **Homogeneous diffusing shade:** The base material for the diffusing shade
- **Perforated screen:** The base material for the perforated screen
- Venetian blind, horiztonal: The blind slat material.
- **Venetian blind, vertical:** The blind slat material.
- Woven shade: The material that defines the thread in the woven shade.
- PermeabilityThe permeability factor defines the "thermal" openness area of a shading layer and is<br/>used in the WINDOW heat transfer algorithms (from ISO 15099) to quantify convective<br/>heat transfer through the shading layer.
- *BSDF file* An input box and a **Browse** button will appear in this section of the Shading Layer Library detail view for the following Types:
- Е

Browse

• Shade with XML data: Browse to the XML file that contains the BSDF data for the shading system being defined.

Туре:	Shade with XML data 👻	
BSDF File:	.VXML\2014-SC7.XML	Browse

Figure 15-5. For Type = Shade with XML data, use the Browse button to select the XML file.

• **THERM file (\*.**thmx): Browse to the THERM "thmx" file created for the shading system being defined (for example, cellular or pleated shades).

Туре:	Therm File (*.thmx)	*	
BSDF File:	XML\Levolor_19570216.thmx		Browse

*Figure 15-6. For* **Type = Therm file (\*.thmx)**, use the Browse button to select the XML file.

The rest of the input values in this library are dependent on the **Type** selected above, and are discussed individually in the following sections.

#### 15.2.2.1. Homogeneous Diffusing Shade:

For shading layer of Type "Homogeneous diffusing shade", no geometry needs to be defined. It is just necessary to reference the appropriate material in the Shade Material library, which should represent a perfectly Lambertian diffusing material.

ihading	Layer Lib	orary	Shade Material
ID #:	15		ID #: 31002 Thickness: 2.000 n
Name:	Diffusir	ng Shade	Name: Diffusing shade material
Product	Name:		Product Name: Example
Manufa	cturer:	Generic	Manufacturer: Generic
уре:		Homogeneous diffusing shade 🔹	
/laterial	Ŀ	31002 -	Conductivity: 0.900 W/m-K
	Perr	neability Factor 0.000	Trans, Front (Tsol): 0.500
			Trans, Back (Tsol2): 0.500
			Reflect., Front (Rsol1): 0.300
			Reflect., Back (Rsol2): 0.300
			Visible
			Trans, Front (Tvis): 0.400
			Trans, Back (Tvis2): 0.400
			Reflect., Front (Rvis1): 0.200
			Reflect., Back (Rvis2): 0.200
			IR Trans (Tir): 0.000
			Emis., Front (Emis1) 0.840
			Emis., Back (Emis2) 0.840
			LINS., DOCK (LINS2) 0.040
			Color:
			Von-specular
			Spectral data

*Figure 15-7.* Homogeneous diffusing blinds do not have a geometric definition, just a reference to the Shade Material Library.

#### Homogeneous Diffusing Shade Input

- *Type* Set type to **Homogeneous diffusing shade**
- MaterialSet Material to a record in the Shade Material Library that is defined for a<br/>homogeneous perfectly diffusing shade.

#### 15.2.2.2. Perforated Screen

For shading layer of Type "Perforated Screen", the geometry of the perforations needs to be defined, and the base material containing the perforations must be selected from the Shade Material Library

Radiant Barrier Comfort Radiant Barrier SC comfort orated screen 1 9 Factor 0.370	:400 Perforated :		Name: SCRadian	fort Radiant Barrier
r Comfort Radiant Barrier SC r Comfort prated screen 1	400 Perforated !		Product Name: Solar Com	fort Radiant Barrier
r Comfort prated screen	400 Perforated !			
1	4		Manufacturer: Solar Com	fort
1	*			
	*			
y Factor 0.370				W/m-K
			Solar Trans, Front (Tsol): Trans, Back (Tsol2): Reflect., Front (Rsol1): Reflect., Back (Rsol2):	0.000 0.000 0.866 0.490
ar 🔻	-Sx-		Visible Trans, Front (Tvis): Trans, Back (Tvis2): Reflect., Front (Rvis1): Reflect., Back (Rvis2):	0.000 0.000 0.890 0.488
230 mm 590 mm	Sy diamet		IR Trans (Tir): Emis., Front (Emis1) Emis., Back (Emis2)	0.000 0.863 0.840
		thickness	Color:	Non-specular
6	90 mm	90 mm diamet	90 mm 90 mm	90 mm 90 mm 90 mm thickness Color:

Figure 15-8. Perforated Screens.

#### **Perforated Screen Input**

Туре	Set type to <b>Perforated Screen</b>
Material	Set <b>Material</b> to a record in the <b>Shade Material Library</b> which represents the base material for the perforated screen
Permeability factor	WINDOW will automatically calculate this value based on the geometry of the perforations.

#### **Perforated Screen tab**

*Geometry* Select from a pulldown list one of the following options (this assumes that the perforation geometries and their spacing in the shade material are perfectly uniform.

- Circular
- Square
- Rectangular

#### Geometry = Circular

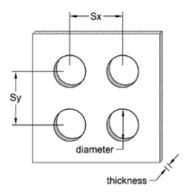


Figure 15-9. Dimensions for Perforated Screens with uniform cicular perforations.

*Dimensions* Enter the dimensions for the geometry of the circular perforation.

- Diameter: the diameter of the circular perforation
- Thickness: the thickness of the base perforated material

Spacing

- Sx: the spacing in the "x" (horizontal) direction of the circular perforations, from the center of each perforation
- **Sy:** the space in the "y" (vertical) direction of the circular perforations, from the center of each perforation

#### Geometry = Square

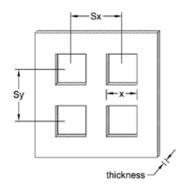


Figure 15-10. Dimensions for Perforated Screens with uniform square perforations.

*Dimensions* Enter the dimensions for the geometry of the square perforation.

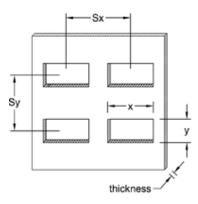
- **x:** the dimension of the opening of the square
- Thickness: the thickness of the base perforated material

• **Sx:** the spacing in the "x" (horizontal) direction of the square perforations, from the center of each perforation

• **Sy:** the space in the "y" (vertical) direction of the circular perforations, from the center of each perforation

Spacing

#### Geometry = Square



*Figure 15-11. Dimensions for Perforated Screens with uniform rectangular perforations.* 

*Dimensions* Enter the dimensions for the geometry of the rectangular perforation.

- **x:** the "x" (horizontal) dimension of the rectangular opening
- **y**: the "y" (vertical) dimension of the rectangular opening
- Thickness: the thickness of the base perforated material

Spacing

- Sx: the spacing in the "x" (horizontal) direction of the rectangular perforations, from the center of each perforation
- Sy: the space in the "y" (vertical) direction of the rectangular perforations, from the center of each perforation

#### 15.2.2.3. Shade with XML data

 $\leq$ 

For shading layer of Type "Shade with XML data", an XML file is referenced which contains BSDF (bidirectional scattering function) matrices for optical properties as well as definitions for the thermal properties of the shade.

ID #: 17010	1					
Name: sheer	Weave 2410 Performance	e + P13 Oyster/Beige	9			
Product Name:	sheerWeave 2410 Pe	rformance + P13 Oys	ster/B			
Manufacturer:	Phifer Incorporated					
Туре:	Shade with XML data					
	ML\2014-SC21.XML	7	Bro	wse		
	meability Factor 0.03	7 Thickness	Bre	Emissivity Front	Emissivity Back	TIR

🛯 📔 🕨 Computer 🕨	OS (C:) ► Users ► Public	► LBNL ► WINDO	DW7.6 ► XML
▼ 🔡 Open 👻	Share with 🔻 🛛 Burn	New folder	
Name	Date modified	Туре	Size
2014-SC21.XML	10/4/2017 9:45 AM	XML Document	1,981 KB
🖹 2014-SC22.XML	10/4/2017 9:45 AM	XML Document	1,981 KB
2014-SC23.XML	10/4/2017 9:45 AM	XML Document	1,981 KB

📃 2014-SC	C21.XML 🛛						
100	<sources< th=""><th>pectrum&gt;CIE</th><th>Illuminant D</th><th>65 1nm.ssp<!--</th--><th>SourceSpectr</th><th>um&gt;</th><th></th></th></sources<>	pectrum>CIE	Illuminant D	65 1nm.ssp </th <th>SourceSpectr</th> <th>um&gt;</th> <th></th>	SourceSpectr	um>	
101	<detecto< th=""><th>rSpectrum&gt;AS</th><th>TM E308 1931</th><th>Y.dsp<th>ctorSpectrum</th><th>&gt;</th><th></th></th></detecto<>	rSpectrum>AS	TM E308 1931	Y.dsp <th>ctorSpectrum</th> <th>&gt;</th> <th></th>	ctorSpectrum	>	
102 E	- <wavelen< th=""><th>gthDataBlock</th><th>&gt;</th><th></th><th></th><th></th><th></th></wavelen<>	gthDataBlock	>				
103	<wav< th=""><th>elengthDataD</th><th>irection&gt;<b>Tra</b></th><th>nsmission Fr</th><th>ont<th>gthDataDirec</th><th>tion&gt;</th></th></wav<>	elengthDataD	irection> <b>Tra</b>	nsmission Fr	ont <th>gthDataDirec</th> <th>tion&gt;</th>	gthDataDirec	tion>
104	<col< th=""><th>umnAngleBasi</th><th>s&gt;LBNL/Klems</th><th>Full<th>nAngleBasis&gt;</th><th></th><th></th></th></col<>	umnAngleBasi	s>LBNL/Klems	Full <th>nAngleBasis&gt;</th> <th></th> <th></th>	nAngleBasis>		
105	<row.< th=""><th>AngleBasis&gt;L</th><th>BNL/Klems Fu</th><th><pre>ll</pre></th><th>Basis&gt;</th><th></th><th></th></row.<>	AngleBasis>L	BNL/Klems Fu	<pre>ll</pre>	Basis>		
106	<sca< th=""><th>tteringDataT</th><th>ype&gt;BTDF<th>atteringData</th><th>Type&gt;</th><th></th><th></th></th></sca<>	tteringDataT	ype>BTDF <th>atteringData</th> <th>Type&gt;</th> <th></th> <th></th>	atteringData	Type>		
107 8	<sca< th=""><th>tteringData&gt;</th><th></th><th></th><th></th><th></th><th></th></sca<>	tteringData>					
108	1.451332,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
109	0.005906,	1.447264,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
110	0.005906,	0.005809,	1.447264,	0.005809,	0.005809,	0.005809,	0.005809
111	0.005906,	0.005809,	0.005809,	1.447264,	0.005809,	0.005809,	0.005809
112	0.005906,	0.005809,	0.005809,	0.005809,	1.447264,	0.005809,	0.005809
113	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	1.447264,	0.005809
114	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	1.447264
115	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
116	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
117	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
118	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
119	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
120	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
121	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
122	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809
123	0.005906,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809,	0.005809

Figure 15-12. Shade with XML data.

#### Shade with XML data Input

Туре	Set type to Shade with XML data
BSDF File & Browse	When Type = Shade with XML data, a <b>BSDF File</b> input line appears accompanied by a <b>Browse</b> button to browse to the needed XML file. This XML file is generally located in an XML subdirectory in the same directory as the WINDOW database, but the program will store the path for the XML file, so it can be located elsewhere.
Permeability factor	WINDOW will automatically calculate this value based on the thermal properties of the XML file.
Summary table	WINDOW displays a summary table of the information in the XML file

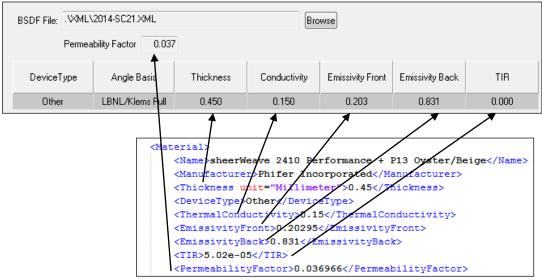


Figure 15-13. Summary table information from the XML file is displayed.

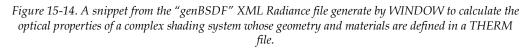
### 15.2.2.4. THERM file (\*.thmx)

For shading layer of Type "THERM file (\*.thmx)", a THERM file is referenced which contains geometry and material information which is used in the calculation of the optical and thermal properties of the shade. This type of shading layer definition is used for systems that have complex geometries that can be modeled in THERM, such as cellular and pleated shades.

#### THERM file (\*.thmx) Input

Туре	Set type to <b>Therm File (*.thmx)</b>
BSDF File & Browse	When Type = Therm file (*.thmx), a <b>BSDF Fil</b> e input line appears accompanied by a <b>Browse</b> button to browse to the needed XML file. This XML file is generally located in an XML subdirectory in the same directory as the WINDOW database, but the program will store the path for the XML file, so it can be located elsewhere.
Permeability factor	This value is based on the permeability of the material used in the THERM file. See Chapter 19 for more details for specific implementations of this method.
Optical Openness	This value is based on the optical openness of the material used in the THERM file. See Chapter 19 for more details for specific implementations of this method.
Calculate button	This button is used to calculate the "genBSDF" Radiance file which is then used by WINDOW to calculate the optical properties of the shading system. This is an XML file, and can take a very long time to generate (30 – 60 minutes potentially).

📄 ID50_C	S_g	enBSDF.xml 🔀
44	#	The following was converted from RADIANCE scene input
45	0	Untitled
46	#	Begin conversion from: C:\Users\ROBERT~1\AppData\Local
47	#	xform -e
48	m	<pre>trans_segment_266 =</pre>
49		c
50		cxy 0.3333 0.3333
51		td 0.4451
52		ts 0.0000 0.0000
53		rd 0.5291
54		c
55		rs 0.0000 0.0000



Х

ihading Layer Li	brary					
ID #: 51						
Name: Cellula	r Shade. Stacked double cell, light color					
Product Name:	ID51_CS					
Manufacturer:	Generic					
Туре:	Therm File (*.thmx)					
BSDF File: XM	L\ID51_CS.thmx	Browse				
Per	meability Factor 0.000 Sptical Openness	0.000	Computer 🕨	OS (C:)  Users	▶ Public ▶ LBNL ▶	WINDOW7.6 • XM
HERM File		-	🖁 Open 🔻	Share with 💌	Burn New fo	lder
		Name	ŕ		Date modified	Туре
		🖷 ID:	50_CS.thmx -	<b>_</b>	9/5/2018 4:59 PM	Microsoft Office
			50_CS_genBSD	F.xml	9/5/2018 4:59 PM	XML Document
Pict	ure is not available This calculate button is u calculate the "genBSDF" file that is then used by Radiance to calculate the properties of the shading	" XML e optical	to ge su	THERM file is or represent the ometry of the s ch as this cellu ade, and saved IMX file	shade, Ilar	

*Figure 15-15. Input for Type = Therm File (\*.thmx).* 

#### 15.2.2.5. Venetian Blind, Horizontal

For shading layer of Type "Venetian blind, horizontal", a Shade Material record is referenced for the slat material, and the geometry of the slats is also defined. At this time, each different slat angle must be modeled as a separate record in the **Shading Layer Library**. So for example, there are three entries for most venetian blinds (from the Complex Glazing Database) one for the "open" case of 0° tilt, one for the "closed" case of 90° tilt, and one for the angled case of 45°.

Venetian Blind		
Slat width:	14.808 mm	<u> </u>
Spacing:	12.700 mm	T N
Tilt:	closed (90°)	
Tilt angle:	88.1363 degrees	
Blind thickness:	0.482 mm	
Rise:	0.838 mm	
Venetian Blind		. 3
Slat width:	14.800 mm	<mark>)</mark>
Spacing:	11.989 mm	·
Tilt:	fully open (0°) 🔹	
Tilt angle:	0.00000 degrees	
Blind thickness:	14.800 mm	
Rise:	0.838 mm	
Venetian Blind		
Slat width:	14.808 mm	<u> </u>
Spacing:	12.700 mm	
Tilt:	45 degrees 💌	
Tilt angle:	45.0000 _ degrees	
Blind thickness:	10.471 mm	
Rise:	0.838 mm	

Figure 15-16. Usually three different slat positions are modeled for a Venetian blind.

#### Venetian blind, horizontal Input

Туре	Set type to Venetian blind, horizontal
Material	Set <b>Material</b> to a record in the <b>Shade Material Library</b> which represents the slat material.
Permeability factor	WINDOW will automatically calculate this value based on the geometry of the blind. It will be different for each slat angle defined.

#### Venetian Blind tab

Shading	Layer Lib	rary		
ID #:	3004			
Name:	Slim Ma	arine 45		
Product	t Name:	Slim Marine Blue Venetian Blind		
Manufa	icturer:	Pella		
Туре:		Venetian blind, horizontal		
Materia	Ŀ	31107 👻		
Venetian		neability Factor 0.989 🗲		WINDOW automatically calculates the thermal Permeability Factor from the salt geometry
Slat wid	th:	14.808 mm	1	
Spacing	g:	12.700 mm	/	
Tilt:		45 degrees 👻	/	For Venetian Blinds, slat
Tilt angl	le:	45.0000 * degrees	1	geometry must be input.
Blind thi	ickness:	10.471 mm		
Rise:		0.838 mm		
Helį	p		//	

Figure 15-17. The Venetian Blind tab in the Shading Layer Library

*Slat width* Width of the slat. **Units:** millimeters (SI), inches (IP).

*Spacing* Spacing of the slats. **Units:** millimeters (SI), inches (IP).

- TiltTilt of the slat. A different record must be created in the Shading Layer Library for<br/>every tilt that is to be modeled. Units: degrees from horizontal, can be either positive<br/>or negative.
  - Closed (90°): the slats are vertical (blinds closed) with the curvature (if Rise is non-zero) facing the "interior"; for slats that overlap or have a curvature, the program will calculate what the actual closed angle will be (as it is probably not actually 90°) and display it in the **Tilt angle** field as a protected value.



• 45 degrees: the slats are tilted down at the outside, up at the inside, at 45 degrees

- Fully open (0°): the slats are horizontal
- -45 degrees: the slats tilted up at the outside, and down at the inside, at 45 degrees
- Closed (-90°): the slats are vertical (blinds closed) with the curvature (if Rise is non-zero) facing the "exterior"; for slats that overlap or have a curvature, the program will calculate what the actual closed angle will be (as it is probably not actually 90°) and display it in the **Tilt angle** field as a protected value.
- Custom Angle: A custom angle can be input in the **Tilt angle** field
- Tilt angleThe actual angle of the blind, based on the Tilt and the curvature (rise) of the blind. For<br/>example, if a blind with significant curvature, can not actually get to a real 90 degree<br/>tilt. The program will calculate the actual tilt and present the result in this field, which<br/>is not editable unless the Tilt = Custom Angle, in which case this value can be input<br/>manually. Units: degrees
- *Blind thickness* The thickness (projected horizontally) calculated by the program based on the input for **Slat width** and **Tilt**. **Units:** millimeters (SI), inches (IP).
- *Rise* The interior radius of the curvature of the venetian blind slat. **Units:** millimeters (SI), inches (IP).
- *Comment* Comment about the Shading Layer, optional input.
- ProtectedFor Shading Layers imported from the Complex Glazing Database, this checkbox will<br/>be checked, indicating that none of the values in that record can be edited.

It is possible to copy a "protected" record, and the values of the newly copied record will be editable.

#### 15.2.2.6. Venetian Blind, Vertical

For shading layer of Type "Venetian blind, vertical", the inputs are the same as Venetian Blind, horiztonal, but the blinds are in a vertical orientation. The diagram is shown as a cross section through the vertical blind set.

Shading L	.ayer Lib	rary					
ID #:	27006						
Name:	Slim Wł	nite Open					
Product	Name:	Slim White Vertical Louver	ed blind				
Manufac	cturer:	Generic					
Туре:		Venetian blind, vertical		-			
Material:		31100		•			
Venetian	Permeability Factor .991728 Venetian Blind						
Slat widt	h:	14.800 mm					
Spacing	:	11.989 mm					
Tilt:		fully open (0°) 🔻					
Tilt angle	e:	0.00000 🚔 degrees	1	١	١	١	١
Blind thic	kness:	14.800 mm					
Rise:		0.838 mm					
Help							

Figure 15-18. The Venetian Blind, vertical.

### 15.2.2.7. Woven Shade

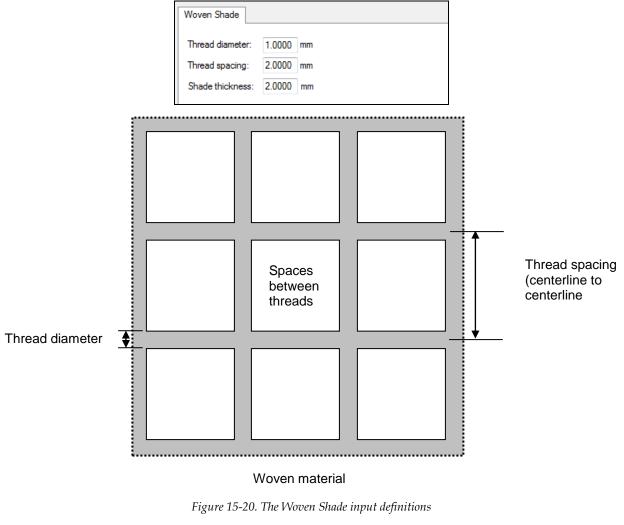
For shading layer of Type "Woven shade" is used to model a fabric or other shade material that has a uniform weave structure.

Shading l	Shading Layer Library				
ID #:	19	]			
Name:	Woven	shade. Gray. 25% open area			
Product	Name:				
Manufac	cturer:	Generic			
Туре:		Woven shade 👻			
Material:		31006 💌			
Permeability Factor 0.250 Woven Shade					
Thread s	diameter: spacing: hickness:	1.0000 mm 2.0000 mm 2.0000 mm			

Figure 15-19. Shading Layer Type = Woven Shade.

Woven Shade Input					
Туре	Set type to Woven Shade				
Material	Set <b>Material</b> to a record in the <b>Shade Material Library</b> which represents the thread material of the woven shade material.				
Permeability factor	WINDOW will automatically calculate this value based on the geometry of the weave.				

#### Woven Shade tab



Thread diameter	This value is the diameter of an individual thread in the fabric of the woven shade.
Thread spacing	This value is the spacing between threads in the weave of the fabric of the woven shade.
Shade thickness	This value is the thickness of the fabric of the woven shade

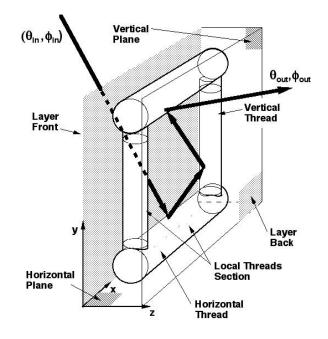


Figure 15-21. Woven shade modeling technique.

# 16.1. Preferences

The File/Preferences menu brings up a dialog box with several tabs.

The following sections describe the settings for each tab.

Options Themal Calcs Optical Calcs Optical Data Radiance Deflection Updates
Localization
Unit system O IP O SI
Language choice English
Misc. options
Don't show CR warning messages
Create debug output
Create log file
Use Nominal Heights
Glazing system height: 1000.000 mm
Nominal window height: 1000.000 mm
Use Nominal Glass Thickness
Display precision: 3
Default Frame Absorptance 0.300
Frame Glazing System Thickness Tolerance % 25.000
☑ Use Torr for Gas Library Pressure Units
Database integrity check before database close (recommended)
OK Cancel Apply Help

Figure 16-1. File/Preferences displays a dialog box with several tabs for different WINDOW settings.

# 16.1.1. Options

The **Options** tab contains general overall settings for the program.

Options Thermal Calcs Optical (	Calcs Optical Data
Localization	
Unit system 🔘 IP	SI
Language choice English	•
Misc. options	
Don't show CR warning mea	ssages
Create debug output	
Create log file	
Use Nominal Heights	
Glazing system height: 1000.	.000 mm
Nominal window height: 1000.	.000 mm
Use Nominal Glass Thickne	SS
Display precision: 3	
Default Frame Absorptance 0	.300
Frame Glazing System 2 Thickness Tolerance %	5.000
Use Torr for Gas Library P	ressure Units
Database integrity check database close (recomme	before nded)

Figure 16-2. File/Preferences displays a dialog box with several tabs for different WINDOW settings.

The values defined in the Options tab are described below:

Localization	
Unit System	There are two options for the unit system in the program:
Language Choice	<ul> <li>IP: Inch-pound units</li> <li>SI: International System of Units</li> </ul> There are two language options:
	<ul><li>English</li><li>Chinese</li></ul>
Misc Options	
Don't show CR warning messages	If this is checked, the program will show a warning when a file is set to a type that the Condensation Resistance calculation can not be performed on, such as a jamb, vertical divider, or any other model with a vertical frame cavity.
Create debug output	Checking this box causes 4 files to be created in the "Debug" subdirectory where the database is located. These are text files which contain detailed information about how the program calculated the results

Computer 🕨 OS (C:)	► Users ► Public ►	LBNL > WINDOW7.	7 🕨 Debug
✓ Include in library ▼	Share with 🔻 🛛 Bu	urn New folder	
Name	Date modified	Type Size	
8_Sample GlzSys.dbg	2/4/2019 1:33 PM	DBG File	9 KB
8_Sample GlzSys.w7	2/4/2019 1:33 PM	W7 File	5 KB
8_Sample GlzSysU.dbg	2/4/2019 1:33 PM	DBG File	9 KB
8_Sample GlzSysU.w7	2/4/2019 1:33 PM	W7 File	5 KB

# *Create log file* Checking this box causes the program to create a file called "w7.log", located in C:\Users\Public\LBNL\BNL Shared. It contains a log of the processes the WINDOW program does through while running.

	🔚 W7.log 🗵						
	1 Tue Sep 18 11:5:	2:13 2018: Be	gin CWindowEd	it::DoDataExc	hange		
	2 Tue Sep 18 11:5		-				
						rom CWindowEdit:	:DoDataExchange
	4 Tue Sep 18 11:5: 5 Tue Sep 18 11:5:						
						m CWindowEdit::D	oDataExchange
	7 Tue Sep 18 11:5						_
Use Nominal Heights	<ul> <li>This checkbox causes the program to use the nominal heights input as follows:</li> <li>Glazing system height: If "Use Nominal Heights" is checked, this is the value the program will use to calculate the glazing system properties. That value will be displayed in the Glazing System Library Detail View in the "IG Height" input box</li> <li>Nominal window height:</li> </ul>						
			-8				
Use Nominal Glass Thickness	This checkbox will cause the program to use a nominal thickness for glass layers rather than the exact thickness. This can be seen in the Glazing System Library Detail View in the "Thick" field for each layer. For example, the real thickness for Glass ID 101 is 5.74 mm, and this is the value that will display under the "Thick" field unless the "Use Nominal Glass Thickness" is checked. In that case, the "Thick" field will display 6.0 mm.						
Display precision	The display precis example, it contro System results sec	ls the num	ber of deci			0	
	In the image below	v, the "Dis	play precis	ion" is set t	io 5.		
	Center of Glass Results	Temperature D	ata Optical Data	Angular Data	Color Properties	Radiance Results	
	Ufactor	SC	SHGC	Rel, Ht. Gain	Tvis	Keff	Layer 1 Keff
	W/m2-K			W/m2		W/m-K	W/m-K
	5.80861	0.72242	0.62850	496.6	0.53286	N/A	1.0000
	3.00001	0.72242	0.62600	436.6	0.03206	N/A	1.0000

*Default Frame* The default value for the frame absorptance in the Frame Library. Default: 0.30 *Absorptance* 

This value can always be changed as needed in the individual Frame Library records.

Frame Library			
ID #: 5			
Name: sample-head.THM			
Source: Therm 👻	Type: Head		
Filename: \Samples\sample-h	nead.THM		Browse
U-VALUES			
Frame:	2.024073	W/m2-K	
Edge Correlation:		-	
Edge of Glass:	2.346296	W/m2-K	
GLAZING SYSTEM			
Width:	25.933	mm	
Center of Glass U-value:	1.934666	W/m2-K	
FRAME			
Projected Frame Dimension:	42.875	mm	
Material Abs:	0.300000		
Color:			
Wetted Length:	56.743	mm	

Frame GlazingThis value is used in the Window Library when the program compares the glazingSystemsystem in the frame (for a THERM file) to the glazing system used in the center of the<br/>window. The thicknesses need to be within the tolerance input here. Default: 25.0Tolerance %Tolerance input here. Default: 25.0

This value is contained in the w7.ini file:

FrameToleranceGlazingSystemThickness=0.2500

Use Torr for GasWhen defining a Gap Library record for vacuum glazing, pressure values need to be<br/>defined. This setting allows the pressure value to be input either in Torr or Pascals.UnitsDefault: checked.

Gap L	ibrary				
ID #:	301				
Name:	Vacuum sample	•			
				📝 Vacuum	
Мо	lecular Weight:	28.970	Pressure:	0.13332 Pa	0.00100 Torr
Spe	ecific heat ratio:	1.400	Pillar Definition:	1 1.5 radius 30 spa	acing 🔻 >>
			Gap Proper	ties at Vacuum	
			Conducta	nce 0.106787 W	/m2-K

Database integrity check before database close (recommended) This checkbox causes the program to do a referential integrity check, when closing the program (and thus the database), to make sure that there are no records that were "orphaned" during a deletion, etc. **Default:** checked.

# 16.1.2. Thermal Calcs

The **Thermal Calcs** tab contains settings which control the thermal calculations.

Options Thermal	Calcs Optical Calcs	Optical Data Radiance	e Deflection	Updates	
<ul> <li>Thermal calculat</li> <li>Calculation stan</li> </ul>		•			
Convection mod	dels Model	Model	Iral	Model	
Venetian blinds	ISO 15099	▼ ISO 15099	•	ISO 15099	-
Woven shades	ISO 15099	▼ ISO 15099	•	ISO 15099	•

*Figure 16-3. The Thermal Calcs tab controls options for the thermal calculations.* 

The values defined in the Options tab are described below:

Calculation The calculation standard to be used for the thermal calculations. There are two options: standard ISO 15099 EN673 • Convection The following models are available to be applied to calculations for Venetian Blinds models and Woven Shades. Different models can be selected depending on the location of the shading system. Outside: this is a shading system that is located on the outside of the glazing • system. Integral: this is a shading system that is located between layers of glass. • Inside: this is a shading system that is located on the interior (room-facing) • side of the glazing system. The choice of thermal models are as follows: ISO 15099: this is the default thermal model for all the shading options. It is • based on the ISO 15099 standard for modeling shading systems. Waterloo: • Scalar – material width: Scalar - shade width:

## 16.1.3. Optical Calcs

The **Optical Calcs** tab contains settings which control the optical calculations.

Options Thermal Calcs Optical Calcs Optic	cal Data Radiance Deflection Updates
Optical calculation options Use matrix method for specular systems (glazing systems without shading devices) Write CSV output file Write XML BSDF output Generate full spectrally-averaged matrix for Solar band Visible band	FIR range   Directional diffuse     # of segments:   5
Spectral data       Condensed spectral data         Number of visible bands:       5         Number of IR bands:       10         Angular basis       W6 quarter-size	•

Figure 16-4. The Optical Calcs tab controls options for the optical calculations.

#### **Matrix Calculation Options**

There are several options in this section for complex glazings such as venetian blinds.

Use matrixChecking this box will cause the program to use the matrix calculation engine, usually runMethod foronly for complex glazing systems, for glazing systems without shading devices. Not usually<br/>used in normal calculations. If this box is checked, the program will use the spectral data<br/>pulldown choices. Also, the results may be different from WINDOW5, which does not use<br/>the matrix method for calculations of systems without shading devices. Default: Unchecked.

Write CSVChecking this box will cause a CSV file to be created , when a record in the Glazing Systemoutput fileLibrary is calculated, in the "BSDFs" subdirectory where the WINDOW database is located.<br/>It is named after the glazing system, <glazing system name>.csv.

If the "Use matrix Method for specular systems" is unchecked, the program will write the summary of the center-of-glass results, as shown below.

🔚 Single	: Clear.csv 🔀
1	
2	"Identifying Information"
3	Ivis, Rfvis, Rbvis, Isol, Rfsol, Rbsol, Abs1, Idw-K, Idw-ISO, Iuv
4	0.532856, 0.0559836, 0.056048, 0.485604, 0.0526195, 0.052822, 0.461776, 0.303718, 0.428859, 0.236568

If the "Use matrix Method for specular systems" is checked (for specular glazing systems) or there is a shading system in the glazing system, the CSV file will contain bi-directional scattering function data, as shown below

🔚 Samp	ole GizSys.csv 🔀							
1	8,"Sample	GlzSys",2	,2,""					
2	"Solar <u>Tf</u>							
3	7.120173,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,
4	0.000000,	7.601175,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,
5	0.000000,	0.000000,	7.601175,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,
6	0.000000,	0.000000,	0.000000,	7.601175,	0.000000,	0.000000,	0.000000,	0.000000,
7	0.000000,	0.000000,	0.000000,	0.000000,	7.601175,	0.000000,	0.000000,	0.000000,
8	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	7.601175,	0.000000,	0.000000,
9	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	7.601175,	0.000000,
10	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	7.601175,
11	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,
12	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,
13	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,
14	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,
15	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,	0.000000,

Write XMLIf this is box checked, the program will write an XML file that contains BSDFs (bi-directional<br/>BSDFBSDFscattering matrices) for the glazing system. The file is named <glazing system name>.XML,<br/>and is located in the BSDFs subdirectory where the WINDOW database is located.

If the glazing system contains only specular layers, the "Use matrix method for specular systems" must be checked in order to generate this file. For shading systems, the matrix method will automatically be used and that box does not have to be checked to generate the XML BSDF output file.

📄 Sam	ple GlzSys.xml 🗈	3
3	<wi< th=""><th>.ndowElementType&gt;System</th></wi<>	.ndowElementType>System
4	¢ <or_< th=""><th>otical&gt;</th></or_<>	otical>
5	¢ l	<layer></layer>
6	<b>白</b>	<material></material>
7		<name>Sample GlzSys</name>
8		<manufacturer></manufacturer>
9		<thickness unit="Meter">0.026510</thickness>
10		<devicetype>Other</devicetype>
11	-	
12	¢	<datadefinition></datadefinition>
13		<incidentdatastructure>Columns</incidentdatastructure>
14	¢	<anglebasis></anglebasis>
15		<anglebasisname>LBNL/Klems Quarter</anglebasisname>
16	¢.	<anglebasisblock></anglebasisblock>
17		<theta>0.000000</theta>
18		<nphis>1</nphis>
19	<b>白</b>	<thetabounds></thetabounds>
20		<lowertheta>0.000000</lowertheta>
21		<uppertheta>9.000000</uppertheta>
22	-	
23	-	

😑 Sample	GizSys.xml 🔀											
63	<wavelengthdatablock></wavelengthdatablock>											
64	<wavelengthdatadirection>Transmission Front</wavelengthdatadirection>											
65	<columnanglebasis>LBNL/Klems Quarter</columnanglebasis>											
66	<rowanglebasis>LBNL/Klems Quarter</rowanglebasis>											
67	<scatteringdatatype>BTDF</scatteringdatatype>											
68	<pre><scatteringdata></scatteringdata></pre>											
69	7.120173, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000,											
70	0.000000, 7.601175, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000,											
71	0.000000, 0.000000, 7.601175, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000,											
72	0.000000, 0.000000, 0.000000, 7.601175, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000,											
73	0.000000, 0.000000, 0.000000, 0.000000, 7.601175, 0.000000, 0.000000, 0.000000, 0.000000,											
74	0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 7.601175, 0.000000, 0.000000, 0.000000,											
75	0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 7.601175, 0.000000, 0.000000,											
76	0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 7.601175, 0.000000,											
77	0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 7.601175,											
78	0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000, 0.000000,											

Generate full spectrallyaveraged matrix for When these boxes are NOT checked, WINDOW6 will display the resulting optical properties of complex glazing systems at normal incidence for the incoming angle (horizontal to the glazing system) and hemispherically integrated on the outgoing side. This is what is displayed in the "Center of Glass Results" tab in the lower section of the Glazing System Library for SC, SHGC, Tvis as well as the results in the Optical Data tab in that same section.

The two check boxes in this section will cause the program to generate results for all the angles in the basis used for the calcuation (145 incoming and 145 outgoing angles for the WINDOW 6 Full Basis, for example), rather than just the normal incidence hemispherically integrated results. The full matrix of results is needed for the matrix reader to give complete results. *Checking these boxes will add somewhat to calculation time, but it is not significant.* **Default:** unchecked.

SpectralThis pulldown list allows several different options for the type of spectral data to use in the<br/>matrix method calculations. These choices ONLY effect calculations using the matrix<br/>calculation method, ie, for complex glazing systems. These choices do not apply to<br/>calculations that do not use the matrix calculation method, such as glazing systems without<br/>shading systems (unless the "Use matrix method for specular systems is checked, in which<br/>case this choice will be used for glazing systems without shading devices). Default:<br/>Condensed spectral data.

The choices are:

- **Full spectral data:** Selecting full spectral data for a matrix calculation means that the program will use the full set of spectral data for each glass layer and shading layers if availabile. This choice can result in long calculation times for shading layers. Use this choice to ensure accurate results for the Color Properties tab (although the color tab is currently disabled for complex glazings).
- **ISO 9050 wavelength set:** This is a reduced set of spectral data wavelengths that will be used to select the spectral data values for the glass layers and shading layers if available. This wavelength set is documented in the technical appendix of this manual. Use this choice to ensure accurate results for the Color Properties tab (although the color tab is currently disabled for complex glazings).
- **Condensed spectral data:** This selection allows values to be input in the following two input boxes for "Number of visible bands" and "Number of IR bands". This is a temporary feature which allows quick results. In the future, a "smart condensing" option will be implemented to replace this.

Number of visible bands	If the " <b>Condensed spectral data</b> " choice is selected in the " <b>Spectral Data</b> " pulldown list, this input box can be edited. Input the value for the number of wavelengths to be used in the visible band, which is defined as wavelengths of 380 nanometers to 780 nanometers. The wavelengths are sampled evenly across the range. <b>Range:</b> 5 to 500. <b>Default:</b> 5
Number of IR bands	If the " <b>Condensed spectral data</b> " choice is selected in the " <b>Spectral Data</b> " pulldown list, this input box can be edited. Input the value for the number of wavelengths to be used in the "near" infrared (IR) band, which is defined as wavelengths of 780 nanometers to 2500 nanometers. The wavelengths are sampled evenly across the range. <b>Range:</b> 5 to 500. <b>Default:</b> 10.
Angular basis	The choices in this pulldown list define the set of angles used by the matrix method calculation. There are currently three choices in the pulldown list:

- W6 standard basis: 145 incoming and 145 outoing angles
- W6 half-size: 73 incoming and outgoing angles
- W6 quarter-size: 41 incoming and outgoing angles

The number of angles that the matrix calculation engine calculates makes a significant impact on calculation speed, which is why the smaller basis choices have been included. The impact on the results of the number of angles used in the calculations will depend on the properties of the shading device, for example the angle of venetian blind slats. The matrix reader can display results from any of these basis choices, as long as the "Generate full Spectrally-averaged Matrix for" checkboxes (defined above) are checked. **Default:** W6 quarter-size.

#### Venetian blind calculation methods

# Solar/VisibleThis pulldown for the calculation methods for venetian blinds in the solar (which includes<br/>near IR) / visible range has the following choices (**Default:** Directional diffuse):

- **Uniform diffuse:** uniform diffuse means that a uniform distribution of radiance across all outgoing directions for a given incident direction.
- **Directional diffuse:** directional diffuse means that there is a "beam" incident radiation source that produces diffuse transmitted and reflected radiance. This method takes into account individual contributions radiosities of all parts (segments) of both slat surfaces which are visible at a certain outgoing diection. This approach provides better angular distribution of the diffuse radiation.

# *FIR range* This pulldown for the calculation methods for venetian blinds in the solar/visible range has the following choices (**Default:** Directional diffuse):

- **Uniform diffuse:** uniform diffuse means that a uniform distribution of radiance across all outgoing directions for a given incident direction.
- **Directional diffuse:** directional diffuse means that there is a "beam" incident radiation source that produces diffuse transmitted and reflected radiance. This method takes into account individual contributions radiosities of all parts (segments) of both slat surfaces which are visible at a certain outgoing diection. This approach provides better angular distribution of the diffuse radiation.
- ISO 15099: This model is as described in 7.3.2.7 in ISO 15099

# 16.1.4. Optical Data

The **Optical Data** tab contains settings which control where the program will find the optical data for the optical calculations.

Options	Thermal Calcs	Optical Calcs	Optical Data	Radiance								
Use t	he following data	base for optical	data:									
IG 🔘	IGDB or IGDB Update											
C:\U	C:\Users\Public\LBNL\LBNL Shared\Glazing.mdb											
Op	otics User databa	se										
				Browse								
Stand	lards File											
BNL	LBNL Shared\Sta	andards\W5_N	FRC_2003.std	Browse								

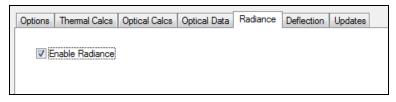
*Figure* 16-5*. The Optical Data tab controls options for where the optical data is located.* 

The following settings are available on the Optical Data tab:

Use the following database for optical data	<ul> <li>These two radio buttons control what database is opened when the Import button is selected in the Glass Library:</li> <li>IGDB or IGDB Update: If this option is selected (and the correct database is defined using the Browse button), this is the database that WINDOW will open when the Import button is used in the Glass Library, allowing the data</li> </ul>
	from the IGDB to be imported. This should also be set in order to use the Update IGDB button in the Window Glass Library, which will automatically update that library to the latest IGDB version that is installed.
	• Optics User database: If a new layer is created in Optics (such as a laminate, applied film, coating applied to a different substrate), it is saved in the Optics User database. Selecting this option, as well as selecting the database file using the Browser button, will cause that file to be opened when clicking the Import button in the Glass Library, allowing those layers created in Optics to be imported into WINDOW.
Standards file	The file (including the directory path where it is located) to be used for the optical calculations. <b>Default</b> : W5_NFRC_2003.std

## 16.1.5. Radiance

The Radiance tab controls whether or not Radiance is enabled.



*Figure 16-6. The Radiance tab controls whether or not Radiance is enabled.* 

The following setting is available on the Radiance tab:

Enable Radiance Checking this box will allow the Radiance calculations (and generated images) to be performed in the Glazing System Library.
 In order to run Radiance, it is also necessary to install it separately from the WINDOW installation. See the WINDOW download website for the download information (windows.lbl.gov/window/software-download)

### 16.1.6. Deflection

The **Deflection** contains settings for the deflection calculations.

Options	Thermal Calcs	Optical Calcs	Optical Data	Radiance	Deflection	Updates				
	)efault Initial Tem	30		с						
		perature			30					
0	)efault Initial Pres	1013	101325							
C	)efault Atmospher	101	325	Pa						

Figure 16-7. The Deflection tab sets default conditions for the deflection calculation.

The following setting is available on the Deflection tab:

Default Initial Temperature	The default temperature that the program will use when calculating deflection in a glazing system. Default: 86 (IP); 30 (SI);
Default Initial Pressure	The default pressure of the gas in the glazing system gap the program will use when calculating deflection in a glazing system. Default: 14.696 (IP); 101325 (SI); Units: PSI (IP); Pa (SI)
Default Atmospheric Pressure	The default atmospheric pressure the program will use when calculating deflection in a glazing system. Default: 14.696 (IP); 101325 (SI); Units: PSI (IP); Pa (SI)

# 16.1.7. Updates

The **Updates** tab contains settings about how program updates are displayed.

Options Thermal Calcs Optical Calcs	Optical Data	Radiance	Deflection	Updates
Check for updates				
Every time program opens				
Every 3 days				
Never				
Notify when there are updates for				
Everything				
Only				
√ beta				
V NFRC				
General releases				
👿 Use cookie for website login				
Anonymous Updates				

Figure 16-8. The Updates tab controls when update information is displayed.

The following settings, which control when notifications about program updates are displayed, are available on the Updates tab:

Check for Updates	Specify the frequency that the program will check the WINDOW website to see if there are program updates available:										
	Every time program opens										
	<ul> <li>Every X days: specify the number of days between checks</li> </ul>										
	Never: never check for updates										
Notify when there are updates for	Specify what information to get notifications about										
1 5	Beta: Beta versions of the software										
	• NFRC: Versions of the software that pertain to NFRC										
	General releases: any new release of the software										
Use cookie for website login	If this is checked, some information is sent to LBNL to keep track of the number of users of our software (such as what program was downloaded), which we provide to our funder, the U.S. Department of Energy. This link provides complete information about what is tracked and why:										
	https://windows.lbl.gov/lbnl-software-update-tracking										
Anonymous Updates	If this is checked, no data is tracked, to conform with the GDPR rules.										

# 17. MODELING CENTER-OF-GLAZING WITH WINDOW

# 17.1. Overview

The WINDOW program calculates the center-of-glazing U-factor (U<sub>c</sub>), Solar Heat Gain Coefficient (SHGC<sub>c</sub>), Visible Transmittance (VT<sub>c</sub>), and Condensation Resistance (CR) indices according to the ISO 15099 standard and NFRC standards. Calculating to the EN/ISO 10077 and associated standards is also available but they are not the default settings.

The procedure for calculating the center-of-glazing U-factor in WINDOW is as follows:

- Create a glazing system for the product to be modeled which is composed of entries from the Glass and Gap Libraries. Select layers from the following libraries:
  - o Glass
  - Shading Layer
  - Gap (which can be used to define a vacuum gap)
- Specify the **Environmental Conditions** based on the desired standard
- Calculate the results

If desired, you can import the glazing system into the THERM program to calculate the frame and edge properties, and then import those results back into the WINDOW Frame Library, which can then be used to define a whole product in the Window Library. (See Section 17 for more details)

See Section 8 for complete details of the input and settings for the Glazing System Library. This section shows how to create various types of glazing systems, including

- **Deflection:** show the effect on glazing systems when they are exposed to atmospheric pressure that is different than the pressure in the gap
- Vacuum glazing: glazing systems that have a vacuum in the gap between layers
- Chromogenic glazing: glazing sysetms that are comprised of chromogenic layers that change state depending
- **Radiance results:** run a simple Radiance model on a glazing system

# 17.2. Create a New Glazing System

There are several methods for making a new glazing system

From the **List** view:

• Click the **New** button to make a new record with the name **Default**, and all the values based on the default settings

or

• Highlight and existing record and click the **Copy** button to make a copy of that record with the same name but a new ID

From the **Detail** view:

• Click the **New** button to make a new record with the name Default, and all the values based on the default settings

or

• Move to the desired record (either from the List view or using the record navigation buttons) and click the Copy button to make a copy of the current record.

#### 17.2.1. Create a Glazing System using Copy from the List View

To create a new glazing system from the List view using the **Copy** button, follow these steps:

- In the **Glazing System Library List View**, copy an existing record by highlighting the record to be copied and clicking on the **Copy** button.
- Click on the **Detailed View** button to edit the glazing system information as needed, including the **Name**.
- Save the record using the Record/Save menu (or Alt-S).

#### 17. MODELING CENTER-OF-GLAZING WITH WINDOW

	Step 1: Highlight the record by clicking on the re	Step 3: WINDOW5 will automatically assign a unique ID for the new Glazing system. A different ID number can be typed, as long as it is unique.																	
Step 2: —	Detailed View		Gyste	<b>∢</b> Isers∖F	▶ ▶I Public\L	⊞ BNL\\	VINDOW		-	<b>)</b>	#	<b>)</b>	₹ <mark>∕</mark> c	<u>ଡ</u> ଼ା	?				
	Calc		ID		Name									# of Layers	Mode	Til			nmental ditions
	<u>N</u> ew		1	Single C Double		A :-								2	#	90			00-2010
Click on the Copy button to copy the	Delete	<b>•</b>	2 3 4	Double Double Double	Low-e	e Air		dding	a record	d		_		2	#	90			00-2010 00-2010 00-2010
highlighted record.	Find ID •		4 5 7	Triple C	lear									OK				00-2010 00-2010	
	Advanced		, 8 9	Sample Double	GlzSy	 /S	ստի				ł		,				Cano	cel	00-2010 00-2010
	32 records found.		10 11		low-e	(air) - c	(air) - defle								0-2010 00-2010 00-2010				
	Import Export		12	Triple w	ith su:	spended Ic 🗖 Overwrite existing records								irnun	00-2010				
	Rep <u>o</u> rt		20						forated si	-				3	#	90		IFRC 1	00-2010
	Print	•	30	Double	Double low-e (argon) with int. horiz. VB (45 deg)									3	#	90	I N	IFRC 1	00-2010

*Figure 17-1. Use the Copy button to copy an existing record to a new record.* 

Step	5:	
------	----	--

/Click on the Detailed View button to copy the highlighted record.

<u>File Edit</u> Libraries	<u>R</u> eco	ord T	ools <u>V</u> iew	<u>H</u> elp	)												
D 🖻 🖌 🖬   X 🖻	a Ra	8	III I II	-()		H	2	•	0 12		#	8	🛛 🏹	? )	?		
Detailed View Glazing System Library (C:\Users\Public\LBNL\W/INDOW7.5\w7.mdb)																	
Calc		ID Name										# of Layer	L Mood	le Tilt		vironmental Conditions	<b>^</b>
<u>N</u> ew																	
		1	Single Clear									2	#	90	NFF	RC 100-2010	
		2	Double Clear	Air								2	#	90	NFF	RC 100-2010	
Delete		3	Double Low-	e Air								2	#	90	NFF	RC 100-2010	
- Find		4	Double Clear	with Ar	gon							2	#	90	NFF	RC 100-2010	
ID 💌		5	Triple Clear									3	#	90	NFF	RC 100-2010	
·		7	Double high	solar ga	iin low-	e						2	#	90	NFF	RC 100-2010	
		8	Sample GizS	/s								2	#	90	NFF	RC 100-2010	
Advanced		9	Double low-e	(vacuu	ım)							2	#	90	NFF	RC 100-2010	
33 records found.		10	Double low-e	(air) - d	leflecte	ed						2	#	90	NFF	RC 100-2010	
Innet		11	Triple low-e (	argon) -	deflec	ted						3	#	90	NFF	RC 100-2010	
Import		12	Triple with su	spende	d low-	e film (a	irgon)					3		90	NFF	RC 100-2010	
E <u>x</u> port		13	Double clear	(air) wit	h white	e frit - 5	0% co	verag	е			2	#	90	NFF	RC 100-2010	
Report 15 Double Clear Air										2	#	90	NFF	RC 100-2010			
<u>P</u> rint		20	Double low-e	(argon)	) with e	ext. perl	forated	d scre	en			3	#	90	NFF	RC 100-2010	- <b>-</b>

### Step 4:

Make sure the new record is highlighted, then either click on the Detailed View button to make changes to the new record, or double click on the highlighted record.

Figure 17-2. Highlight the newly copied record and click on the **Detailed View** button.

Type a new name for the glazing system.				View is first operation of the copied states and the copied states and the copied states and the copied states and the copied states are states and the copied states are states and the copied states are states			<b>;</b>					
giazing system.	ID #: 15		Name	: Double Clear Air								
Use the <b>up/down arrows</b> to add or delete glass layers.	# Layers: 2 Environmental N Conditions: N			×								
Click on the pulldown list arrow to select the desired record from the	Conditions:											
Environmental Conditions Library	Overall thickness: 23		1	2								
Click on the <b>Select</b> arrows to pick a new glass layer												
from the Glass Library.			ID	Name	Mode	Thick	Flip Tsol	Rsol1	Rsol2	Tvis		Rγ
	Glass Gap		103 C	LEAR_6.DAT	#	5.7 12.0	0.771	0.070	0.070	0.884	0.080	0.
	Glass			LEAR_6.DAT	#	5.7	0.771	0.070	0.070	0.884	0.080	0.
			The	Select screen	displa	ys the	e records f	rom th	e Glas	ss Lib	rary.	
then click on the				Select Cancel			Find		ID	▼ 4886 re	cords found.	<b>×</b>
in the glazing sy	stem.			ID Nar	ne	P	roductName	Manul	facturer	Source	Mode Colo	▲ IC
				6360 VUE840.v 6361 VUE1140.v 6362 VUE140.v	vir		n Evergreen n Arctic Blue	Viracor Viracor Viracor	n 10	GDB v18.2 GDB v18.2 GDB v18.2	#	
				6362 VBE2438.	VIR	VRE38 L	owE on OptiWhite owE on OptiWhite	Viracor	n 10	GDB v21.0 GDB v21.0	#	•
											•	
	ID #:	15	Na	me: Double Green Lov	νE							_
	# Layers:	2	÷	Til: 90 * 1	IG Heigl	nt: 1000	.00 mm					
	Environmental Conditions:	NFRC	00-201	0 🔹	IG Wid	h: 1000	.0( mm					
	Comment:											
	Overall thickness:	23.375	m	m Mode: #		Model D	eflection		1	2		
			ID 🗸	Name	Mod		Flip Tsol	Rsol1	Rsol2	Tvis	Rvis1	B١
		s1 ₩		VUE140.vir	#		0.188	0.265	0.542	0.449	0.138	0.
		p1 ►► s2 ►►		Air CLEAR_6.DAT	#	12.0 5.7		0.070	0.070	0.884	0.080	0.

When all the changes have been made to define the new glazing system, click on the Calc button and the results will be updated

Figure 17-3. Editing the Glazing System characteristics in the Detailed View.

The Center of Glass Results tab at the bottom of the screen shows the results for the glazing system. The U-factor results are based on a default glazing system height of one meter. This center-of-glazing U-factor value will be recalculated in the Window Library to reflect the true height of the product being modeled.

All the **Glazing System Library** records can be seen in the **List View**, accessed by clicking the **List** button from the **Glazing System Library Detailed View**.

H W6.3 - Glazing System Library (C:\Users\Public\LBNL\WINDOW6\w6.mdb)															
File	File Edit Libraries Record Tools View Help														
	D 🚅 🖬   % 🖻 💼   🚭   🏢 🗉 H 🔺 🕨 H   🖽 🖉 🍨 📗 📴 # 🕈   %   🤋 😢														
	Detailed View Glazing System Library (C:\Users\Public\LBNL\W/INDOW6\w6.mdb)														
[	Calc			ID	Name	# of Layers	Mode	Tilt	Environmental Conditions	Keff	Overall Thickness	Uval	SHGC	SC	Tvis
	<u>N</u> ew									W/m-K	mm	W/m2-K			
	Сору	- I	•		3mm low-E	2	#	90	NFRC 100-2010	0.033	18.50	1.773	0.618	0.710	0.783
	Cobà			2	Double Clear Air	2	#	90	NFRC 100-2010	0.064	24.00	2.699	0.704	0.809	0.786
	Delete			3	Double Low-e Air	2	#	90	NFRC 100-2010	0.067	21.70	2.677	0.468	0.538	0.698
Fir	nd			4	Double Clear with Argon	2	#	90	NFRC 100-2010	0.060	18.70	2.576	0.764	0.878	0.814
ID		•		5	Triple Clear	3	#	90	NFRC 100-2010	0.081	43.40	1.742	0.617	0.709	0.703
Шг		-		6	3mm Low-e air	2	#	90	NFRC 100-2010	0.051	25.46	1.784	0.500	0.574	0.720
	A.I	- II		7	3mm Clear	2	#	90	NFRC 100-2010	0.049	26.51	1.932	0.686	0.788	0.741
	Advanced			8	Sample GlzSys	2	#	90	NFRC 100-2010	0.049	26.51	1.932	0.686	0.788	0.741
9 rec	cords found.			9	Sample GlzSys w Int Blue VB	3	#	90	NFRC 100-2010	0.107	56.18	1.749	0.625	0.718	0.085
Πr	Import	1					Ť								
	Export														
-															
	Report														
	<u>Print</u>														

A "#" in the Mode field indicates that all the glass layers in the glazing system are NFRC approved. The exception is that laminates and applied films imported from the Optics6 User database will not have a "#".

Figure 17-4. The List View of the Glazing System Library shows all the glazing systems.

## 17.2.2. Create a Glazing System with a Shading System

To model a glazing system with a shading system, specify that the layer is a Shade, which then allows selection for that layer from the Shading Layer Library. The shading layer can be put on the outside or inside of the glazing system, or between two of the glass layers. It is possible to model multiple shading systems in one glazing system.

To add a shading layer to the glazing system, select "Shade or frit" from the pulldown list on the left hand side of the layer table.



Figure 17-5. To select a fritted layer, select "Shade or frit"

The double arrow to the left of this option will then display all records in the Shading Layer Library

Sel	ect				
Sele	ect Car	ncel	Find	<ul> <li>280 records found.</li> </ul>	
	ID	Name	ProductName	Manufacturer	Туре
	3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian (horizontal)
	3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)
	3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)
	3003	Slim Marine Closed	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)
	3004	Slim Marine 45	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)
	3005	Slim Marine Open	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)
	3500	Dickson Orchestra #0681 Dune	Dickson Orchestra #0681 Dune	Goodearl and Bailey	BSDF
	4000	Uniview Charcoal	Uniview Charcoal	Uniline	BSDF

Figure 17-6. Click the double arrow to the left of the ID column and the records from the Shading Layer Library are displayed.

The desired shading layer can be selected and it will be added as a layer in the glazing system. The graphic of the glazing system will show the shading layer with diagonal stripes.

	ID #: 31		Name	E Double low-e (argon) with inbetween	horiz. VB	(45 deg	1)										
#	‡Layers: 3		🗎 Til	t 90 Å* IG Height 1000.00	mm j						_						
Enviro Coi	onmental Inditions: N	FRC 1		✓ IG Width: 1000.00	mm												
Co	omment:																
) Verall thi	nickness: 30	.941	mm	Mode: ? 📃 Model Defle	ction		1/	2	3								
					l		-										
					l	/	/										
			ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
•	Glass 1	••		Name LEAR_6.DAT	Mode	Thick 5.7	Flip		Rsol1 0.070	Rsol2 0.070	T vis 0.884	Rvis1 0.080	Rvis2	Tir 0.000	E1 0.840	E2 0.840	Cond 1.000
•	Glass 1 Gap 1		103 C		Mode												
•		ÞÞ	103 C 9 A	LEAR_6.DAT	*	5.7											
	Gap 1	•• 2 ••	103 C 9 A 21 D	LEAR_6.DAT ir (10%) / Argon (90%) Mix	*	5.7 1.3											

Figure 17-7. The selected shading layer will now be defined for that layer in the Glazing System.

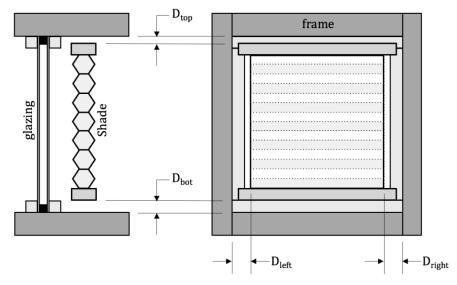
To complete the definition of the shading system it is necessary to define how the shading layer relates to the frame it will be sitting it, in terms of the distances from the top, sides and bottom. These values are called

- Dtop
- Dbot
- Dright
- Dleft

			ID	Name	Mode	Thick	Flip	Tir	E1	E2	Cond	Dtop (mm)	Dbot (mm)	Dright (mm)	Dleft (mm)
•	Glass 1	₩	103	CLEAR_6.DAT	#	5.7		0.000	0.840	0.840	1.000				
	Gap 1	H	9	Air (10%) / Argon (90%) Mix		1.3									
-	Shade 2	₩	32	0.4" inbetween VB (white) - 45 deg		7.2						0.000	0.000	0.000	0.000
	Gap 2	H	9	Air (10%) / Argon (90%) Mix		1.3									
-	Glass 3	÷	103	CLEAR_6.DAT	#	5.7		0.000	0.840	0.840	1.000				

*Figure 17-8. Define Dtop, Dbot, Dright, and Dleft for the shading system.* 

Section 19, there are extensive descriptions about how to define this relationship depending on the type of shading system being modeled. Below is one example of how these values would be defined for a specific shading system case. See Section 19 for more details.



*Figure 17-9. Perimeter gap widths between frame and shade with continuous hardware. The figure illustrates a roomside shading system, but the defined gap distances apply to all shade locations (roomside, outside, and between-glass).* 

## 17.2.3. Create a Glazing System with a Frit layer

Fritted glass layers are found in the Shading Layer Library. For the layer, select the option for the layer of "Shade or frit".

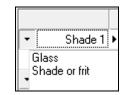


Figure 17-10. To select a fritted layer, select "Shade or frit"

The double arrow to the left of this option will display all records in the Shading Layer Library, which will include any fritted layers that are defined there.

💷 Se	elect				
Se	elect Car	Find	ID  280 records found.		
	ID	Name	ProductName	Manufacturer	Туре
	5000	Viraspan(TM) Medium Gray (V-948) 30%	Viraspan(TM) Ceramic Frit, Medium Gray (V-948) 30% Coverage	Viracon	Fritted glass
	5001	Simulated Sandblast (V-1086) 70%	Translucent Frit, Simulated Sandblast (V-1086) 70% Coverage	Viracon	Fritted glass

Figure 17-11. Click the double arrow to the left of the ID column and the records from the Shading Layer Library are displayed, which include any layers defined as fritted glass.

The desired fritted layer can be selected and it will be added as a layer in the glazing system.

ID #: 61	Name: Viracon Frit												
		Height: 1000.00 mm											
Environmental Conditions: NFRC 10	D-2010 ▼ IG	a Width: 1000.00 mm		-12	× .								
Comment:													
Overall thickness: 23.114	mm Mode: #	Model Deflection		1	2								
	ID Nar	me Mode	Thick Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
▼ Fritted glass 1 ▶	5000 Viraspan(TM) Medium	m Gray (V-948) 30%	4.7	0.796	0.062	0.063	0.888	0.065	0.066	0.000	0.840	0.840	1.000
Gap 1 🕨	1 Air		12.7										
Glass 2 ▶	103 CLEAR_6.DAT	#	5.7 🗌	0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000

Figure 17-12. The selected fritted layer will now be defined for that layer in the Glazing System.

## 17.2.4. Create a Vacuum Glazing System

Modeling a vacuum glazing system requires that a vacuum "gap" be defined in the Gap Library, which can then be selected as a layer between two pieces of glass.

In the example below, the gap for the double glazed system is referencing a record in the Gap Library that has been defined as a vacuum.

	ID #:	9		Na	me: Double low-e (vacuum)													
	# Layers:					10.00 m	n L											
En	Environmental NFRC 100-2010  IG Width: 1000.00 mm																	
	Comment																	
Dvera	all thickness: 8.062 mm Mode: # 12																	
				ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	T vis	Rvis1	Rvis2	Tir	E1	E2	Cond
-	Gla:	ss 1	H	2027	LoE270-4.CIG	#	4.0		0.370	0.341	0.470	0.765	0.074	0.055	0.000	0.840	0.037	1.000
	Ga	р1	H	300	Vacuum-air P=0.001 (pr-1.5 ps-30)		0.1											
-	Gla	ss 2	••	888	CLR_4.AFG	#	4.0		0.845	0.078	0.078	0.899	0.077	0.077	0.000	0.840	0.840	1.000

Figure 17-13. For a vacuum glazing system, the Gap layer is defined in the Gap Library as a vacuum.

Here is the definition in the Gap Library for that vacuum.See Section XX. Gap Library for details about defining a vacuum gap.

Gap L	ibrary				
ID #:	300				
Name:	Vacuum-air P=0	).001 (pr-1.5 p	ps-30)		
				Vacuum	
Мо	lecular Weight:	28.970	Pressure:	0.13332 Pa	0.00100 Torr
Spe	ecific heat ratio:	1.400	Pillar Definition:	1 1.5 radius 30 s	spacing 👻 >>
			Gap Proper	ties at Vacuum	
			Conducta	nce 0.106787	W/m2-K

*Figure 17-14. An example Gap Library record defined as a vacuum.* 

## 17.2.5. Create a Chromogenic Glazing System

There are several chromogenic glass layers in the Glass Library, both electrochromic and thermochromic, which can have several different "states".

SAGE Electrochromics is one example of an electrochromic manufacturer, but there are others in the Glass Library. See the WINDOW Knowledge Base website (under Chromogenics) to see the list of chromogenic layers in WINDOW.

Glass	Library (	C:\Users\Public\LBNL\WINDOW7.6\w7.	mdb)					
	ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness
								mm
	8900	SageGlass_Classic_7_64clr.SAG	SageGlass® Classic_7mm lami full clear 64%	SAGE Electrochromics, Inc.	IGDB v33.0	#		6.990
	8905	SageGlass_7_SR2_60clr.SAG	SageGlass® SR2.0_7mm lami full clear 60%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		6.990
•	8910	SageGlass_9_Gray_45clr.SAG	SageGlass® Gray 9mm Iami full clear 45%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.830
	8915	SageGlass_9_Green_49clr.SAG	SageGlass® Green 9mm Iami full clear 49%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.700
	8920	SageGlass_9_Blue_40clr.SAG	SageGlass® Blue 9mm lami full clear 40%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.760
	8925	SageGlass_9_GraySVC_24clr.SAG	SageGlass® Gray SVC 9mm lami full clear 24%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.820
	8930	SageGlass_9_GrnSVC_26clr.SAG	SageGlass® Green SVC 9mm Iami full clear 26%T	SAGE Electrochromics, Inc.	IGDB v33.0	#		8.730

*Figure 17-15. There are several chromogenic layers in the Glass Library.* 

Looking at the detail view of the layer, it is possible to see the characteristics of the different states

Glass Library						
ID #: 8910	Thickness:	8.8 mm				
Name:	SageGlass_9_G	iray_45clr.SAG				
Product Name:	SageGlass® Gr	ay 9mm lami full	l c			
Manufacturer:	SAGE Electrock	nromics, Inc.				
Туре:	Electrochromic					
	0.707					
Conductivity:	0.727 W/m	ъК				
		Light				Dark
	Tvis	0.512	0.215	0.169	0.071	0.006
	Color:					
Solor						
Trar	ns, Front (Tisol):	0.286	0.091	0.070	0.028	0.003
Trans	, Back (Tsol2):	0.286	0.091	0.070	0.028	0.003
Reflect	, Front (Rsol1):	0.066	0.058	0.057	0.058	0.058
Reflect	, Back (Rsol2):	0.124	0.113	0.113	0.114	0.116
Visible						
Tran	ns, Front (Tivis):	0.512	0.215	0.169	0.071	0.006
Trans	, Back (Tvis2):	0.512	0.215	0.169	0.071	0.006
Reflect	, Front (Rivis1):	0.052	0.048	0.047	0.047	0.048
Reflect	, Back (Rvis2):	0.032	0.016	0.013	0.013	0.014
IR						
	Trans (Tir):	0.000	0.000	0.000	0.000	0.000
Emis.	, Front (Emis1):	0.840	0.840	0.840	0.840	0.840
Emis.,	Back (Emis2):	0.142	0.142	0.142	0.142	0.142

*Figure 17-16.* The Glass Library Detail View shows the properties of the different states for chromogenic layers.

When an electrochromic layer is used in a glazing system, the program automatically creates two tabs in the glazing system layer construction section, one which displays the glazing system in the "Light" state, and the other in the "Dark" state.

ID #: 5	i0	Na	me: Sage Green													
# Layers: 2		*	Tilt: 90 ° IG He	ight:	1000.0	0 m	m [									
Environmental Conditions:	NFRC	100-201	0 🔹 IG W	'idth:	1000.0	0 m	m									
Comment:																
Overall thickness: 2	Verall thickness: 24.40000 mm Mode: # Model Deflection 1 2															
🔲 Use switching I	<sup>o</sup> aram	eter														
Light Dark																
		ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
▼ Glass	1 🉌	8915	SageGlass_9_Green_4	#	8.7		0.208	0.047	0.124	0.550	0.052	0.035	0.000	0.840	0.140	0.727
Gap	1 🕨	1	Air		12.7											
▼ Glass	2 🉌	102	CLEAR_3.DAT	#	3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	1.000

Figure 17-17. The Glazing System "Light" tab shows the electrochromic layer in the lightest state.

ID #: 50 Name:	Sage Green												
# Layers: 2 🚊 Tilt: Environmental NEBC 100-2010	# Layers: 2 _ Tilt: 90 * IG Height: 1000.00 mm Environmental Conditions: NFRC 100-2010    IG Width: 1000.00 mm												
Conditions: NFRC 100-2010 V IG Width: 1000.00 mm Comment:													
verall thickness: 24.40000 mm Mode: # Model Deflection 1 2													
Use switching Parameter													
Light Dark													
ID	Name Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
<ul> <li>Glass 1 ➡ 8919 Sag</li> </ul>	geGlass_9_Green_1c #	8.7		0.003	0.045	0.094	0.008	0.048	0.011	0.000	0.840	0.140	0.727
Gap1 ➡ 1 Air		12.7											
<ul> <li>Glass 2 ➡ 102 CLE</li> </ul>	EAR_3.DAT #	3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	1.000

*Figure 17-18. The Glazing System "Dark" tab shows the electrochromic layer in the darkest state.* 

For an electrochromic layer, the program reports the results based on the different states of the glass layer based on the switching parameter, which in this case is Visible Transmittance (Tvis).

ID #: 50	Name:	Sage Green															
# Layers: 2	🚊 Tilt	90 ° IG Hei	ght	1000.0	0 mr	m _											
Environmental Conditions: NFRC		→ IG Wi	dth:	1000.0	0 mr	m											
Comment:																	
Commeria																	
Overall thickness: 24,400	100 mm	Mode: #	M	odel Def	lecti	on		1	2								
								-									
🔲 Use switching Param	eter																
Light Dark																	
	ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond	Comment	
Glass 1      →	8915 Sag	eGlass_9_Green_49	#	8.7		0.208	0.047	0.124	0.550	0.052	0.035	0.000	0.840	0.140	0.727		
Gap 1 🕨	1 Air			12.7													
🔹 🛛 Glass 2 🕨	102 CLE.	AR_3.DAT	#	3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	1.000		
Center of Glass Results	Temperature	Data Optical Data	Ang	ular Dat	a (	Color Pro	operties	Radiano	e Resul	ts Dyn	amic Proj	perties					
	1								<u> </u>	- ··							
Switching Paramater	Tsol	AL 4								Propertie	_	<b>T</b> ·		D( )		DL :	CUCC
Layer Tvis 0.550	0,185	Abs1 5 0.754			bs2 007		Rfsc 0.05			osol		T vis		Rfvis		Rbvis	SHGC
0.550	0.185						0.05			160 153		D. 496 D. 209		0.078		0.111	0.273
0.231	0.073				002		0.04			153		0.209 D.144		0.052		0.096	0.172
0.160	0.050				001 001		0.04			153		0.144 0.071		0.050		0.094	0.152
0.079	0.026																
0.008	0.003	8 0.953		0.1	000		0.04	9	υ.	139		0.007		0.048		0.091	0.109

For a thermochromic layer, where the states are determined by glass temperature, the program reports the properties of the glazing system depending on temperature under the Dynamic Properties tab (which only appears when a chromogenic layer is used in a glazing system).

Checking the "Use switching Parameter" allows you to enter a specific temperature value, which the program will then report, along with the other states, in the results section.

# Layers: 2       Tilt: 90 * IG Height: 1000.00 mm         Conditions:       NFRC 100-2010       IG Width: 1000.00 mm         Comment:       IG Width: 1000.00 mm       IG Width: 1000.00 mm         Overall thickness: 27.70000 mm       Model Deflection       1       2         V Use switching Parameter       Value:       59.423       C       C         V Use switching Parameter       Value:       59.423       C       C         Second Thick Flip       Tsol       Rsol1       Rsol2       Tvis       Rvis1       Rvis2       Tir       E1       E2       Cond       Comment         V Use switching Parameter       Value:       59.423       C       C       C       D       D       Name       Model Deflection       I       2       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D       D	
Environmental Conditions:       IG Width: 1000.00 mm         Comment:       IG Width: 1000.00 mm         Overall thickness:       27.70000 mm         W Use switching Parameter       Value:         59.423       C         ID       Name         Model Thick Flip       Tsol         Rsol1       Rsol2         Tir       E1         E2       Cond         Comment:       0.229         0.045       0.055         0.055       0.000         0.840       1.000	
Comment:       Model Deflection       1       2         Overall thickness: 27.70000       mm       Model Deflection       1       2         Image: Use switching Parameter       Value:       59.423       C       C       C         Image: Use switching Parameter       Value:       59.423       C       C       C       C         Image: Use switching Parameter       Value:       59.423       C       C       C       C         Image: Use switching Parameter       Value:       59.423       C       C       C       C         Image: Use switching Parameter       Value:       59.423       C       C       C       C         Image: Use switching Parameter       Value:       59.423       C       C       C       Sepcific temperature for the program to calculate the results         Image: Use Switching Parameter       Value:       59.423       C       C       C       C         Image: Use Switching Parameter       Value:       59.423       C       C       C       C       Sepcific temperature for the program to calculate the results         Image: Use Switching Parameter       Value:       0.029       0.045       0.054       0.055       0.065       0.000       0.840       0.840 <td></td>	
Overall thickness:       27.70000       mm       Model Deflection       1       2         Image: Constraint of the system of	
Overall thickness:       27.70000       mm       Model Deflection       1       2       Parameter" box in order to enter specific temperature for the program to calculate the results         ✓ Use switching Parameter       Value:       59.423       C       C       Parameter" box in order to enter specific temperature for the program to calculate the results         ✓       ID       Name       Model Thick Flip       Tsol       Rsol1       Rsol2       Tvis       Rvis1       Rvis2       Tir       E1       E2       Cond       Comment         ✓       Glass 1       > 30020       Thermochromic2_24.LBI       12.0       0.029       0.045       0.054       0.055       0.065       0.000       0.840       0.840       1.000         Gap 1       >       1       Air       12.7       0.045       0.054       0.545       0.055       0.065       0.000       0.840       0.840       1.000	
ID       Name       Mode       Thick       Flip       Tsol       Rsol1       Rsol2       Tvis       Rvis1       Rvis2       Tir       E1       E2       Cond       Comment <ul> <li>Glass 1</li> <li>Glap 1</li> <li>1</li> <li>Air</li> <li>12.7</li> <li>D</li> <li>D</li> <li>Resolar</li> <li>Re</li></ul>	
✓ Use switching Parameter       Value:       59.423       C       C       program to calculate the results         •       ID       Name       Mode       Thick       Flip       Tsol       Rsol1       Rsol2       Tvis       Rvis1       Rvis2       Tir       E1       E2       Cond       Comment         •       Glass 1       >>       30020       Thermochromic2_24.LBI       12.0       0.229       0.045       0.054       0.055       0.065       0.000       0.840       0.840       1.000         Gap 1       >>       1       Air       12.7       0       0       0.054       0.055       0.065       0.000       0.840       0.840       1.000	for
ID         Name         Mode         Thick         Flip         Tsol         Rsol1         Rsol2         Tvis         Rvis1         Rvis2         Tir         E1         E2         Cond         Comment             Glass 1         >>         30020         Thermochromic2_24.LBI         12.0         0.229         0.045         0.054         0.545         0.055         0.065         0.000         0.840         0.840         1.000           Gap 1         >>         1         Air         12.7 <td>tor</td>	tor
▼       Glass 1       →       30020       Thermochromic2_24.LBI       12.0       0.229       0.045       0.054       0.555       0.065       0.000       0.840       0.840       1.000         Gap 1       →       1       Air       12.7       0       0.545       0.555       0.065       0.000       0.840       0.840       1.000	
▼       Glass 1       →       30020       Thermochromic2_24.LBI       12.0       0.229       0.045       0.054       0.555       0.065       0.000       0.840       0.840       1.000         Gap 1       →       1       Air       12.7       0       0.545       0.555       0.065       0.000       0.840       0.840       1.000	
Gap1 >> 1 Air 12.7	
▼       Glass 2 ▶▶       102       CLEAR_3.DAT       #       3.0       0.834       0.075       0.899       0.083       0.000       0.840       0.840       1.000	
Center of Glass Results Temperature Data Optical Data Angular Data Color Properties Radiance Results Dynamic Properties	
Switching Paramater System Properties	
Layer Temp Tsol Abs1 Abs2 Rfsol Rbsol Tvis Rfvis Rbvis	SHGC
24.000 0.203 0.893 0.005 0.054 0.113 0.493 0.080 0.135	0.337
34.000 0.169 0.773 0.008 0.050 0.112 0.396 0.068 0.132	0.310
48.000 0.102 0.848 0.006 0.044 0.110 0.206 0.049 0.125	0.256
64.000 0.048 0.906 0.004 0.042 0.109 0.064 0.043 0.122	0.212
76.000 0.029 0.926 0.003 0.042 0.108 0.021 0.042 0.121	0.196
59.423 🛪 0.060 0.893 0.005 0.042 0.109 0.094 0.044 0.123	0.222

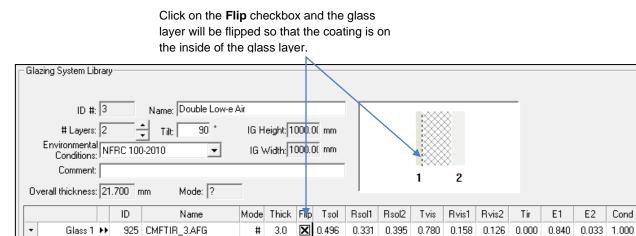
The value entered when "Use switching Parameter" is checked will be added to the table of results for the different temperature states

Figure 17-19. The Glazing Systems Library results for thermochromic layers show the properties at each state.

## 17.2.6. Coatings

The location of coatings on a glass layer can affect the **center-of-glazing** U-factor and therefore the whole product calculation, so it is important to specify the location correctly. When using a glass entry from the WINDOW **Glass Library**, if the coating is not on the correct surface, the glass layer shall be flipped. To flip a glass layer, while on a glass layer in **Edit** mode, click on the **Flip** checkbox, and the glass surfaces will be flipped, as indicated by the dashed line in the graphic display of the glazing system.

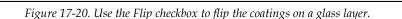
- Glazing System Lit ID #: # Layers: Environmenta Conditions: Comment: Overall thickness:	3 2 NFRC	_	0( mm 0( mm			1	2		— t	he out	g is or side o ss lay	f				
	ID		Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
▼ Glass 1	•• 93	25 CMFTI	R_3.AFG	#	3.0		0.496	0.395	0.331	0.780	0.126	0.158	0.000	0.033	0.840	1.000
Gap 1	**	1 Air			12.7											
▪ Glass 2	► 1	03 CLEAR	_6.DAT	#	6.0		0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000



12.7

6.0

#



0.070

0.070 0.884 0.080 0.080 0.000 0.840 0.840 1.000

0.771

Gap 1 🕨

Glass 2 🕨

÷

1 Air

103 CLEAR\_6.DAT

## 17.2.7. Laminated Glass / Applied Films

If a laminated glass or applied film was created in Optics and imported into the WINDOW Glass Library from the Optics User Database, those layers can be used in a glazing system. Section 9, Glass Library, contains detailed information about this procedure.

They are treated as any other glass layer, by selecting them from the Glass Library in the layer construction section of the Glazing System Library.

## 18.1. Overview

Total products are defined in the Window Library, where the following components are brought together to define the window:

- Frames (head, sill, jambs, meeting rails, etc) are selected from the Frame Library
- Dividers (if applicable) are selected from the Divider Library
- Glazing systems (with or without shading systems, vacuum glazing, chromogenic glazing, etc) are selected from the Glazing System Library

When all these components have been defined, the program can calculate standard performance metrics for the entire window, which will include the frame and edge effects.

WINDOW determines the total product U-factor according to *NFRC 100* and *ISO 15099* by calculating an area-weighted average of the U-factors of the product components and accounting for product height:

- Frame and edge values for each cross section (frames and dividers) calculated in THERM: The U-factors are area-weighted based on the projected area on a plane parallel to the glass (the Projected in the Glass Plane choice in the THERM U-factors dialog box), not the total surface area of the frame and edge.
- Center-of-glazing values from WINDOW

WINDOW calculates the total product area-weighted solar heat gain coefficient (SHGC) and visible transmittance (VT) according to the *NFRC 200* procedures and the total product Condensation Resistance (CR) according to the *NFRC 500* procedures.

WINDOW cannot calculate the total product area-weighted properties for some fenestration products. These include entry doors and Vehicular Access Garage/Rolling Doors. For these cases, a spreadsheet can be used to calculate the total product area-weighted values.

# 18.2 Center of Glass

Chapter 17 contains detailed information about calculating the center-of-glazing U-factors.

Access the **Glazing System Library List View** either from the **Libraries/Glazing System** menu, by clicking on the **Glazing System Library** toolbar button, or by pressing **F5**.

File Edit Librarie	s R	ecord	Tools View Help									
D 🚅 🖬   X 🖻	8		🏢 🗉 K 🖌 🕨 I 🗄 🖻 🍨 🎹 📴 #	1	K   9	?						
Detailed View	Glazin	g Syste	m Library (C:\Users\Public\LBNL\WINDOW7.7\W7.mdb)			_						
Calc		ID	Name	# of Layers	Mode	Tilt	Environmental Conditions	Overall Thickness	Uval	SHGC	Tvis	Tdw-IS
New								mm	W/m2-K			
		1	Single Clear	1	#	90	NFRC 100-2010	3.05	5.913	0.861	0.899	0.842
Сору		2	Double Clear Air	2	#	90	NFRC 100-2010	23.43	2.703	0.704	0.786	0.690 _
Delete	►	3	Double Low-e Air	2	#	90	NFRC 100-2010	21.60	1.684	0.431	0.639	0.487
Find		4	Double Clear with Argon	2	#	90	NFRC 100-2010	18.80	2.576	0.764	0.814	0.738
ID 👻		5	Triple Clear	3	#	90	NFRC 100-2010	42.55	1.744	0.617	0.703	0.601
		7	Double high solar gain low-e	2	#	90	NFRC 100-2010	25.93	1.935	0.686	0.741	0.635
		8	Sample GizSys	2	#	90	NFRC 100-2010	25.93	1.935	0.686	0.741	0.635
Advanced		9	Double low-e (vacuum)	2	#	90	NFRC 100-2010	8.06	0.634	0.354	0.691	0.517
26 records found.		10	Double low-e (air) - deflected	2	#	90	NFRC 100-2010	21.75	1.663	0.362	0.685	0.512
		11	Triple low-e (argon) - deflected	3	#	90	NFRC 100-2010	43.12	0.700	0.298	0.515	0.349
		13	Double clear (air) with white frit - 50% coverage	2	#	90	NFRC 100-2010	24.13	2.689	0.499	0.528	0.423
Export		20	Double low-e (argon) with ext. perforated screen	3	#	90	NFRC 100-2010	37.33	1.050	0.056	0.062	-1.000
Report		30	Double low-e (argon) with int. horiz. VB (45 deg)	3	#	90	NFRC 100-2010	54.69	1.243	0.264	0.147	0.092
Print	•	~	Provide town of the state of th		#		NEDC 100 2010	04.45	0.705	0.007	0.450	•

Figure 18-1. WINDOW Glazing System Library.

The U-factors shown in the **Glazing System Library** are based on a one meter default height (set in the File/Preferences menu, Options tab). When these glazing systems are used in whole products, in the **Window Library**, the center-of-glazing U-factors will be recalculated based on the actual product height specified in the **Window Library**. Therefore, the U-factors in the **Glazing System** and **Window Libraries** will usually be slightly different.

I Lager:       2       To       0       6 Hefr       10000 mm         Convert       1       2       1       0       Convert       1       2         Overall Indense:       2533       m       Node       1       1       2       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1 </th <th>ID #: 8 Name: Samp</th> <th>ole GizSys</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th>I</th>	ID #: 8 Name: Samp	ole GizSys									I
Environmental LeftBL 100-2010       Is Vricht.       1000.00 mm         Constant       Constant       1       2         Image: Constant       Image: Constant       Image: Constant       Image: Constant       Image: Constant         Overall Hickness: 25.533       mm       Mode: #       Mode: Detection       1       2         Image: Constant       Im			nt: 1000.0	0 mm r							1
Common:       Derail frikkmes:       25.333 mm       Mode:       #       Mode:       1       2         Derail frikkmes:       25.333 mm       Mode:       #       Mode:       Tak       1       2         Derail frikkmes:       25.333 mm       Mode:       #       4       0       1.2       1.2       Localization         Derail frikkmes:       25.333 mm       Mode:       #       4.7       0.676       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074       0.074	· · · · · · · · · · · · · · · · · · ·		_				****:				1
Dered Hickness: 25.333 mm       Mode: #       Model Delection       1       2         Options       Image: Application of the second of th			1. 1000.0								1
Oreal Hickness: 25:933       m       Model IP Model Defection       1       2         Image: Constraint of the second o	Comment:										
Under 1 + 100       Name       Mode Thick Fip       Tad       Root 2       Twite Fip         Image: Glass 1 + 10       B03       LEARS LDF       II       A.7       D.75       D.074       D.074       D.084       Mac. options         Image: Glass 2 + 10       H       A.7       D.75       D.074       D.074       D.084       Mac. options         Image: Glass 2 + 100       Elssing System U-factor is based on the glazing System Meight in the Perforences dialog box, the Perforences			_			X	××××	Options Them	nal Cales Optica	I Calcs Op	tical Data
Image: construction of the second	Overall thickness: 25.933 mm M	lode: #	Model Def	lection		1	2	Localization			
ID       Name       Mode Thick Fip Tool Road Place Type Fig         Glas 1 ** 9303 CLEAPS.LDF       # 4 7       O 726 0074 0074 0086         Glas 1 ** 9303 CLEAPS.LDF       # 4 7       O 726 0074 0074 0086         Glas 2 ** 9203 LDV-E_5.LDF       # 4 7       O 676 0117 0105 0886         Glas 2 ** 9203 LDV-E_5.LDF       # 4 7       O 676 0117 0105 0886         Glas 7 System U-factor is based on the glazing system height: 1000.000 mm         NFRC default being one meter (1000 mm).         Nemeenture Data Optical Data Angular Data Calor Properties Radiance Result         W/m2K       Temperature Data Optical Data Angular Data Calor Properties Radiance Result         W/m2K       Selection of the Size of the S				L				Unit system	IP (	SI	
ID       Name       Mode Thick Fip Tool Road Place Type Fig         Glas 1 ** 9303 CLEAPS.LDF       # 4 7       O 726 0074 0074 0086         Glas 1 ** 9303 CLEAPS.LDF       # 4 7       O 726 0074 0074 0086         Glas 2 ** 9203 LDV-E_5.LDF       # 4 7       O 676 0117 0105 0886         Glas 2 ** 9203 LDV-E_5.LDF       # 4 7       O 676 0117 0105 0886         Glas 7 System U-factor is based on the glazing system height: 1000.000 mm         NFRC default being one meter (1000 mm).         Nemeenture Data Optical Data Angular Data Calor Properties Radiance Result         W/m2K       Temperature Data Optical Data Angular Data Calor Properties Radiance Result         W/m2K       Selection of the Size of the S											
• Giass 1 ** 9003 CLEARSLOF       # 4 7 0 0.75 0.074 0.074 0.074 0.888         • Giass 2 ** 9203 LOVE_5.LOF       # 1 4 7 0 0.75 0.074 0.074 0.076 0.856         • Giass 2 ** 9203 LOVE_5.LOF       # 1 7 0 0.57 0.017 0.105 0.856         • Giass 2 ** 9203 LOVE_5.LOF       # 1 7 0 0.57 0.017 0.105 0.856         • Giass 2 ** 9203 LOVE_5.LOF       # 1 7 0 0.57 0.017 0.105 0.856         • Giass 1 ** 9003 CLEARSLOF       # 4 7 0 0.75 0.074 0.074 0.074 0.076         • Giass 2 ** 9203 LOVE_5.LOF       # 1 7 0 0.57 0.017 0.105 0.856         • Giass 1 ** 9003 CLEARSLOF       • He Preferences dialog box, the NFRC default being one meter (1000 mm).         • NFRC default being one meter (1000 mm).       • Window Neght: 1000 0.00 mm         • Utactor       SC       SHGC Rel Ht Gain       * Kelf       Layer 1 Kelf <td< td=""><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>Language d</td><td>hoice English</td><td></td><td>•</td></td<>								Language d	hoice English		•
Gap 1 * 1 Au       1 65         Gas 2 * 952 LOV-E_5.LOF       II 47         Giszing System V-factor is based on the glazing system height in the Preferences dialog box, the NFRC default being one meter (1000 mm).       Don't show CR warning mesages         Center of Giss Result       Imperature Data       Optical Data       Angular Data       Code Result         Uractor       SC       SHGC       Ret H. Gan       Tvis       Keff       Layer 1 Keff	ID	Name M	ode Thick	Flip Tso	Rsol1	Rsol2	Tvis R				
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Glazing System U-factor is based on the glazing system height in the Preferences dialog box, the NFRC default being one meter (1000 mm).       If the Preferences dialog box, the Nemai window height: 1000.000 mm         Center of Glass Result       Temperature Data Optical Data Angular Data Color Properties Name       Rediance Result         Vinadi window height:       Tota       Keff       Layer 1 Keff       Gap 1 Keff       Layer         Vinadi window height:       Tota       Wink       Wink       Wink       Wink       Wink         Vinadi window height:       Tota       Wink       Keff       Layer 1 Keff       Gap 1 Keff       Layer         Vinadi window height:       Tota       Wink       Wink       Wink       Wink       Wink       Wink         1935       0.789       0.686       511       0.711       0.0754       1.0000       0.0434       1         Node       HFRC       Image: Stating Stating       Image: Stating St	✓ Glass 2 ➡ 9923 LOW-E_	5.LOF	# 4.7	0.676	0.117	0.105	0.826 0	Create d	ebug output		
system height in the Preferences dialog box, the NFRC default being one meter (1000 mm).       Gaing system height: 100.000 mm         NFRC default being one meter (1000 mm).       Window height: 1000.000 mm         Utactor       SC       SHGC       Rel Ht Gain       Tvic       Keff       Layer 1 Keff       Gaing system         Utactor       SC       SHGC       Rel Ht Gain       Tvic       Keff       Layer 1 Keff       Gaing system         Utactor       SC       SHGC       Rel Ht Gain       Tvic       Keff       Layer 1 Keff       Gaing system         Utactor       SC       SHGC       Rel Ht Gain       Tvic       Keff       Layer 1 Keff       Gaing system         Utactor       SC       SHGC       Rel Ht Gain       Tvic       Keff       Layer 1 Keff       Gaing system         Utactor       SC       SHGC       Rel Ht Gain       Tvic       Keff       Layer 1 Keff       Layer         Name       Ficture       Name       Res 1000 mm       Name       Relazing system       The U-value for the glazing system in the window         Height       1000 mm       Name       Sign system       Sign system </td <td></td> <td></td> <td>·</td> <td></td> <td></td> <td></td> <td></td> <td>Create lo</td> <td>og file</td> <td></td> <td></td>			·					Create lo	og file		
NFRC default being one meter (1000 mm).       Wonal vindow height: 1000.000 mm         Center of Glass Result       Temperature Data       Opical Data       Angular Data       Color Properties       Radiance Results         Ulactor       SC       SHGC       Rel. Ht. Gain       Tvis       W/m.K       W/m.K       W/m.K         Ulactor       SC       SHGC       Rel. Ht. Gain       Tvis       W/m.K       W/m.K       W/m.K         Ulactor       SC       SHGC       Rel. Ht. Gain       Tvis       W/m.K       W/m.K       W/m.K         Name       Criter of Glass       Baba Still       0.741       0.0754       1.0000       0.0494       11         Name       Folder       Provide Ministry       District on a component to display characteristics baba       Citick on a component to display characteristics baba       Library until the Calc button is citicked, because the U-value is dependent on the height of the glazing system in the window.         Height       1300 m2       Tria       Store       Provide Store       Provide Store       Citick on a component to display characteristics baba         Ulactor       ?       W/m2.K       Store       ?       W/m2.K       Name       Citick on a component to display characteristics baba         Ulactor       ?       Name       Store								Use Nor	ninal Heights		
Image: Control of Glass Result       Temperature Data       Optical Data       Angular Data       Color Properties       Radiance Results         Utactor       SC       SHGC       Rel. Ht. Gain       Tvis       Kelf       Layer 1 Kelf       Gap 1 Kelf       Layer         Utactor       SC       SHGC       Rel. Ht. Gain       Tvis       Kelf       Layer 1 Kelf       Gap 1 Kelf       Layer         Utactor       SC       SHGC       Rel. Ht. Gain       Tvis       Kelf       Layer 1 Kelf       Gap 1 Kelf       Layer         Utactor       SC       SHGC       Rel. Ht. Gain       Tvis       Kelf       Layer 1 Kelf       Gap 1 Kelf       Layer         Name       Picture       Win2k       Win2k       The U-value for the glazing system in the Window       Library until the Calc button is clicked, because the U-value is dependent on the height of the glazing system in the window.         Videot       Total Window Results       Users       2       SC       ?       Win2k         Utactor       ?       Win2k       St C       ?       Win2k       Ekk on a component to display characteristics below         Utactor       ?       Win2k       St C       ?       Win2k       Ekk on a component to display characteristics below         Vi								Glazing sys	tem height: 100	0.000 mm	1
Certer of Glass Results       Temperature Data       Optical Data       Angular Data       Color Properties       Radiance Results         Ufactor       SC       SHGC       Rel Ht. Gain       Tvis       Keff       Layer 1 Keff       Gap 1 Keff       Layer         W/m2K       W/m2K       W/m2K       W/m2K       W/m4K       The U-value for the glazing system is "2" in the Window       Library until the Calc button is clicked, because the U-value is dependent on the height of the glazing system is "2" in the Window.         Width       1200 mm       Radia       Environmental Conditions       Flating System       System is "2" in the Window.         Vidtor       7       W/m2K       Click on a component to display characteristics below       Edge area       Distring System       Edge area       Distring System       Edge area			gonom					Nominal wi	ndow height: 100	0.000 mm	l i
Utactor       SC       SH6C       Rel Ht. Gain       Tvis       Keft       Layer 1 Keft       Gap 1 Keft       Layer         Wm2X       SC       SH6C       Rel Ht. Gain       Tvis       W/mX       User       Setter       Setter <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>Use Nor</td> <td>ninal Glass Thicki</td> <td>ness</td> <td></td>								Use Nor	ninal Glass Thicki	ness	
Utactor       SK       SK6C       Rel HL Gain       Tvie       Keft       Layer1 Keft       Gap 1 Keft       Layer         Win2X       SC       SK6C       Rel HL Gain       Tvie       Keft       Layer1 Keft       Gap 1 Keft       Layer         Win2X       SC       SK6C       Rel HL Gain       Tvie       Keft       Layer1 Keft       Gap 1 Keft       Layer         1335       0.789       0.686       S11       0.741       0.0754       1.0000       0.0434       1.0         10 H       Image: State 1       Image: State 1       0.741       0.0754       1.0000       0.0434       1.0         None       Felue       Image: State 1       0.741       0.0754       1.0000       0.0434       1.0         None       Felue       Image: State 1       Image: State 1 <td></td> <td></td> <td></td> <td></td> <td></td> <td></td> <td>L</td> <td></td> <td></td> <td></td> <td></td>							L				
W/m2       W/m2       W/mK       Uitor       Uitor <td>Center of Glass Results Temperature Data</td> <td>a Optical Data</td> <td>Angular Dat</td> <td>a Color F</td> <td>roperties</td> <td>Radiano</td> <td>e Results</td> <td></td> <td></td> <td></td> <td>1</td>	Center of Glass Results Temperature Data	a Optical Data	Angular Dat	a Color F	roperties	Radiano	e Results				1
W/m2       W/m2       W/mK       Uitor       Uitor <td></td> <td>1</td>											1
1.335       0.789       0.686       511       0.741       0.0754       1.000       0.0494       1.1         In the light of the glazing system is "?" in the Window Library until the Cale button is clicked, because the U-value is dependent on the height of the glazing system in the window.         Width 1200 mm         Mane Picture         Width 1200 mm         Height 1500 mm         Area 1.800 m2         Environmental Conditions         Name Sample GitSys         D         Uractor ?         V/m2K         Click on a component to display characteristics below         D         Name Sample GitSys         D         Name Sample GitSys         D         Name Sample GitSys         D         Name Sample GitSys         Click on a component to display characteristics below         Name Sample GitSys         D       0         Name Sample GitSys         Click on a component to display characteristics below         Name Sample GitSys </td <td></td> <td>SHGC</td> <td></td> <td>n</td> <td>Tvis</td> <td></td> <td></td> <td></td> <td>· · ·</td> <td></td> <td>1</td>		SHGC		n	Tvis				· · ·		1
Image: Contract of the constraint o						_					1
Name       Picture         Mode       NERC         Type       Fixed (picture)         Widh       1200 mm         Height       1500 nm         Area       1.800 m2         The       90         Environmental Conditions       Environmental Conditions         Name       Click on a component to display characteristics below         Utactor       ?         VT       ?         D       8         Utactor       ?         Name       Sample GLSSys         D       8         Utactor       ?         VT       ?         Area       1.271 m2         SHGC       ?         VT       ?         VT       ?         VT       ?         VT       ?         VT       ?         VT       ?         SHGC       0.005 m2         Vt       0.000 m2         SHGC       0.000 m2         SHGC       0.000 m2         VT       0.648         CR       49         VT       0.648         CR       49	1.935 0.789	0.686	511		0.741	0	1.0754	1.0000	0.0494	1.1	
Total Window Results         Click on a component to display characteristics below         Ufactor       ?       W/m2.K         Glazing System       >>         ID       8       Ucenter       ?       W/m2.K         VT       ?       D       8       Ucenter       ?       W/m2.K         VT       ?       D       8       Ucenter       ?       W/m2.K         CR       ?       W/m2.K       Click on a component to display characteristics below       Click on a component to display characteristics below         The calculated center-of-glazing U-value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System       Name       Sample Glazing Sys	Mode NFRC  Type Fixed (picture)  Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 30						/	clicked, beca dependent o	ause the U-va n the height	alue is of the	
SHGC       ?         VT       ?         UD       8       Ucenter         ID       97       W/m2-K         Glazing System       Name         Name       Sample GlzSys         VT       0.648         CR       49         VT       0.648         CR       49         Nagers       2         SHGC       0.603		Click on a d	component to	display cha	aracteristics	below					
SHGC       r         VT       ?         VT       ?         CR       ?         ID       8         ID       <	U-factor ? W/m2-K	- Glazing System				1_				<b>≝</b> ↓	
VT       ?         CR       ?         ID       8       Ucenter       ?         Nlayers       2       SC       ?         Area       1.271 m2       SHGC       ?         Edge area       0.305 m2       Vtc       ?         Click on a component to display characteristics below         The calculated center-of-glazing U-value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library       Ufactor       1.997       W/m2-K       Glazing System         VT       0.648       VT       0.648       Name       Sample GlzSys       >>         VT       0.648       CR       49       Name       Sample GlzSys       >>         Naleyers       2       SC       0.788       Area       1.271 m2       SHGC       0.685	SHGC ?	Name Sam	ple GizSys	_			J				
CR       ?       SC       ?         Area       1.271 m2       SHGC       ?         Edge area       0.305 m2       Vtc       ?         Click on a component to display characteristics below         The calculated center-of-glazing U-value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library       Ufactor       1.97       W/m2-K       Glazing System         VT       0.648       VT       0.648       Name       Sample GlzSys       >>         VT       0.648       CR       49       VI       0.685       Area       1.271 m2       SHGC       0.685		ID	8	Ucen	er	? W/m	n2-K				
Area       1.271 m2       SHGC       ?         Edge area       0.305 m2       Vtc       ?       Click on a component to display characteristics below         The calculated center-of-glazing U-value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library       U-factor       1.997       W/m2.K       Glazing System         VT       0.648       VT       0.648       Name       Sample GlzSys       >>         VT       0.648       CR       49       VI       0.685       Area       1.271 m2       SHGC       0.685		Nlayers	2	9	SC	?					
Ufactor       1.997       W/m2-K       Glazing System         The calculated center-of-glazing U-value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library       Ufactor       1.997       W/m2-K         VT       0.648       Name       Sample GlzSys       >>         VT       0.648       Nawe       Sample GlzSys       >>         CR       49       Y       Nawe       Sample GlzSys       >>	un ,	Area	1.271 m2	SHO	iC	_					
Name Sample GizSys       Value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library     VT 0.648       VT     0.648     VI     0.648       CR     49     Area     1.271 m2		Edge area	0.305 m2	۷	tc	?	Clic	k on a component t	o display character	istics below	
SHGC     0.603     Name     Sample GizSys       value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library     VT     0.648     Name     Sample GizSys       VT     0.648     VI     0.648     Name     1.913     W/m2-K       VI     0.648     VI     0.648     Name     1.913     W/m2-K		U	-factor	1.997	W	/m2-K	Glazing	System			
value in the Window Library is based on the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library	The calculated center-of-glazing			_			Name	Sample GlzSys		• [>>	
the 1500 mm window height rather than the default 1000 mm height in the Glazing System Library								8	-> Ucenter	1.913 W/r	m2-K
Glazing System Library	the 1500 mm window height rath	her than		_			Nlayer	s 2	SC		
Glazing System Library Edge area 0.305 m2 Vtc 0.741		ne	CR	49			Are	a 1.271 m2	SHGC	0.685	
	Giazing System Library						Edge are	a 0.305 m2	Vtc	0.741	

Figure 18-2. WINDOW Glazing System Library.

# 18.3 Frames

THERM files can be imported into the WINDOW Frame and Divider Libraries in order to calculate the whole product values in WINDOW.

The **Source** field in the **Frame Library** indicates whether the files were imported from THERM, as shown in the following figure.

File Edit Librarie	s Re	cord	Tools View Help									
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Detailed View	Frame I	Library	(C:\Users\Public\LBNL\WIND	DW7.7\w7	.mdb)							
Update		ID	Name	Source	Туре	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs	Color
New						W/m2-K	W/m2-K		mm	mm		
		1	Al w/break	ASHRAE	N/A	5.680	N/A	Class1	N/A	57.2	0.90	
Сору		2	Al flush	ASHRAE	N/A	3.970	N/A	Class1	N/A	57.2	0.90	
Delete		3	Wood	ASHRAE	N/A	2.270	N/A	Class1	N/A	69.8	0.90	
Find		4	Vinyl	ASHRAE	N/A	1.700	N/A	Class1	N/A	69.8	0.90	
ID 🔻		5	sample-head.THM	Therm	Head	2.007	2.350	N/A	26.5	42.9	0.30	
		6	sample-jamb.THM	Therm	Jamb	1.995	2.343	N/A	26.5	42.9	0.30	
	•	7	sample-sill.THM	Therm	Sill	2.001	2.344	N/A	26.5	42.9	0.30	
Advanced												
7 records found.												
Export												
Report												
Print												

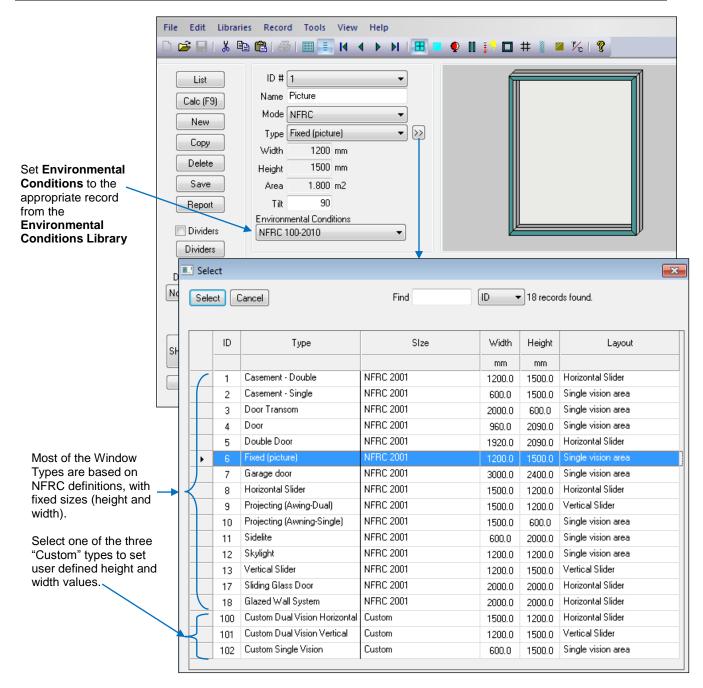
Figure 18-3. WINDOW Frame Library with records imported from THERM.

# 18.4 Windows

When the THERM results have been imported into the WINDOW **Frame** and **Divider Libraries**, and the needed glazing systems have been defined in the **Glazing System Library** (also needed for the THERM simulations), the whole product values for U-factor, SHGC, VT and CR can be calculated in the **Window Library**.

In the **Window Library Detail View**, set the appropriate values on the left-hand side of the screen, which depend on the type of fenestration product. The **Mode** field does not affect the results; the **Type** field should be set to the appropriate choice for the fenestration product being modeled. The complete list of choices can be viewed by clicking on the double arrow next to the **Type** pulldown list. All the choices are sizes (height and width) defined by the National Fenestration Rating Council (NFRC) except for the last three custom sizes, which allow user input for the height and width. The **Environmental Conditions** field can be set to the appropriate value (from the Environmental Conditions library).

On the right-hand side of the screen, for each cross section component, select the appropriate records from the **Frame** and **Divider** libraries. When the frame cross sections and the glazing systems are specified, click on the **Calc** button and WINDOW will calculate the total product U-factor, SHGC, VT and CR, shown in the lower left corner of the main screen. In addition, for obtaining NFRC rating values, the program calculates the SHGC<sub>0</sub>, SHGC<sub>1</sub>, VT<sub>0</sub> and VT<sub>1</sub>, discussed in detail in the following section.



*Figure 18-4. Window Library Detail View – Select the type to determine the height and width of the window.* 

Once the values have been calculated, the results are displayed in the **Total Window Results section**, as shown below. The **Detail** button next to the **SHGC** and **VT** results can be used to view the SHGC<sub>0</sub>, SHGC<sub>1</sub>,  $VT_0$  and  $VT_1$  values, and the **Detail** button next to the **CR** result is used to view the intermediate values used to determine the overall CR result.

File Edit Librarie	s Record Tools View	Help						
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List Calc (F9) New Copy Delete Save Report Dividers Dividers	ID # 1 Name Picture Mode NFRC Type Fixed (picture) Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 90 Environmental Conditions NFRC 100-2010		•					
Display mode: Normal SHGC/VT Detail CR Detail CR Detail See the next section for a detailed description of the information in the SHGC /	Total Window Results U-factor 1.997 SHGC 0.603 VT 0.648 CR 49 CR 49		V/m2-K		ssing the U-factor SHGC ( VT (Visi	Calc butt Solar Hea ble Trans	at Gain Cc mittance) n Resistar	pefficient)
VT Detail button.								
		ID	Area	@30%RH	@50%RH	@70%RH	Overall	
	CR		1.800	78.27	49.22	36.37	48.97	
	CRg		1.271	100.00	86.88	46.49	62.71	
	CRe		0.305	78.27	49.22	36.37	48.97	
	CRf		0.224	87.79	73.87	62.52	71.11	
	COG 1	8	1.271	0.0000	0.0023	0.1533	0.0518	
	Header	5	0.050	0.0001	0.0126	0.0428	0.0185	
	Header Edge	5	0.067	0.0004	0.0568	0.1772	0.0781	
	Left Jamb	6	0.062	0.0017	0.0177	0.0527	0.0240	
	Left Jamb Edge	6	0.086	0.0072	0.1320	0.2634	0.1342	
	Right Jamb	6	0.062	0.0017	0.0177	0.0527	0.0240	
	Right Jamb Edge	6	0.086	0.0072	0.1320	0.2634	0.1342	
	Sill	7	0.050	0.0038	0.0234	0.0625	0.0299	
	Sill Edge	7	0.067	0.0278	0.2023	0.3230	0.1844	
	Dewpoint (C)			2.9	10.3	15.4		

Figure 18-5. Window Library Detail View where the whole product results are calculated and displayed.

## 18.4.1. Individual Product SHGC and VT (SHGC 0 & 1, VT 0 & 1) for NFRC calculations

It is not necessary to calculate the SHGC and VT for all individual products and associated model sizes. *NFRC 200* outlines a procedure for determining SHGC<sub>0</sub>, SHGC<sub>1</sub>, VT<sub>0</sub>, VT<sub>1</sub> values which can then be used to calculate the SHGC and VT of any individual product. This procedure is used to obtain NFRC rating values.

These values are calculated in WINDOW for the best glazing option modelled with the highest combined frame and edge heat loss (i.e., the option with the lowest center-of-glass U-factor and the highest total product U-factor), as outlined in *NFRC 200*, Section 4.2.3.A. The values calculated from that one case are then used to calculate the SHGC and VT for any other glazing options using Equations 4-1 and 4-2 in *NFRC 200*.

For domed skylights (see Chapter 8 of this manual), it is necessary to use the tested value for the center-ofglass value, with the modelled frame and edge values. The values are calculated for the product using the best glazing system, for three cases:

- No dividers
- Dividers < 25.4 mm (1"), modelled at 19 mm (0.75")</li>
- Dividers ≥ 25.4 mm (1"), modeled at 38 mm (1.50")

WINDOW automatically calculates these values for all records in the Window Library, using the U-factor for the default divider as defined in NFRC 200. The values can be displayed by clicking on the Details button next to the whole product results for SHGC and VT, as shown in the figure below.

File Edit Librarie	Record Tools View Help	
🗅 🚅 🖬   👗 🖻	🛍   🍜   🎟 🗐 🛤 🔺 🕨 🖻 🖪 🗶 🖩 👬 🗖 🗰 🦉	
List Calc (F9) New Copy Delete Save Report Dividers Dividers	ID # 1 Name Picture Mode NFRC  Type Fixed (picture) Vidth 1200 mm Height 1500 mm Area 1.800 m2 Tit 90 Environmental Conditions NFRC 100-2010	
Display mode: Normal 💌	Total Window Results Click on a component to display characteristics below	
SHGC/VT Detail CR Detail	U-factor 1.997 W/m2-K SHGC 0.603 VT 0.648 CR 49	

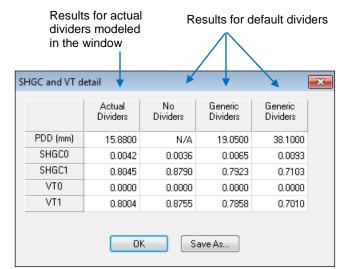
Click on the Detail button next to SHGC and VT to get the SHGC 0 &1 and VT 0 & 1 calculated for No Dividers, Dividers < 25.4 mm (1"), and Dividers  $\geq 25.4$  mm (1")

.

	No Dividers	Generic Dividers	Generic Dividers
PDD (mm)	N/A	19.0500	38.1000
SHGCO	0.0036	0.0065	0.0093
SHGC1	0.8790	0.7923	0.7103
VTO	0.0000	0.0000	0.0000
VT1	0.8755	0.7858	0.7010

Figure 18-6. Click on the Detail button to get the SHGC 0 & 1 and VT 0 & 1 results.

If the product has real dividers, the program will calculate the SHGC 0 & 1 and VT 0 & 1 values for the generic dividers as well as for the actual dividers, as shown below. For NFRC simulations, the default divider results should always be used.



*Figure 18-7. The SHGC 0 & 1 and VT 0 & 1 results are shown for the actual dividers if they are modeled.* 

	SHGC and VT de	etail				x									
		No Dividers	Generic Dividers	Generic Dividers											
	PDD (mm)	N/A	19.05000	38.10000											
	SHGCO	0.00353	0.00647	0.00925											
	SHGC1	0.87899	0.79228	0.71025											
	VTO	0.00000	0.00000	0.00000											
	VT1	0.87546	0.78581	0.70099											
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into a text f	ave the resul	Its	AngularCa	alcDetailedRepo	rt-Glazing	10/23/2	2012 4:53	PM	Text Docu	ment					
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			File name:							Save	-				
		4	Save as type:	Text files (*.txt)					•	Cancel					
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*Figure 18-8.* The SHGC 0 & 1 and VT 0 & 1 results can be saved to a text file which can be imported into other applications, such as a spreadsheet or word processing program.

## 18.4.2. Whole Product U-factor With Dividers for NFRC Calculations

The generic dividers used to calculate the  $SHGC_0$ ,  $SHGC_1$ ,  $VT_0$ , and  $VT_1$  values are NOT used to calculate the whole product U-factor, if the whole product is manufactured with dividers. In that case, the actual divider geometry is modeled in THERM, the THERM file is imported into the WINDOW Divider Library, and used in a record (different from those used for the SHGC<sub>0</sub>, SHGC<sub>1</sub>,  $VT_0$ ,  $VT_1$  calculations) in the Window Library.

## **18.5 Project Databases**

WINDOW 6 databases can be quite large. For example, the default database, w6.mdb, that is included in the program installation package, is approximately 27 MB. One of the main reasons for the large size is the records in the Glass Library – there are 3500+ records in that library as of this writing. Each entry in the Glass Library contains spectral data for that glass layer, hence the large database size. For any given modeling project, only a few of these glass layers are used.

It is possible to make a much smaller WINDOW6 project database by saving only the records in each library (particularly the Glass Library) that are used in the defined glazing systems and windows. For example, saving a project database in this fashion would mean that only the glass layers referenced by the glazing system would be saved in the Glass Library, rather than the entire Glass Library that is installed with the program. A database with only the referenced glass layers can be less than 1 MB.

Saving a smaller database in this manner is referred to in this manual as a "Project Database", meaning it contains only the needed entries for the project being modeled. In the List View of each library there is an "Export" button, which can be used to export selected records to another database. This "Export" feature is what can be used to generate a Project Database.

Many of the libraries reference other libraries for some of their values. Therefore, when a record is Exported from a library, WINDOW also has to export any other records that are referenced from the exported record. Figure 7-11 shows how each library is referenced from other libraries. The Gas, Glass, Frame, Divider and Environmental Conditions libraries are stand-alone libraries, meaning they do not reference any other libraries. However, the Glazing System and Window Libraries reference many of the other libraries.

So, for example, in order to export to another database all the information for a glazing system, WINDOW6 must also import the referenced records from the Gas Library, Glass Library and Environmental Conditions Library. But the important point is that only the needed records in each of these referenced libraries are needed in the exported database. So there might only be two or three entries in the Glass Library, i.e., those used in the Glazing System, instead of the 3500 entries that are in the entire database. This will then make the database these records are imported into much smaller.

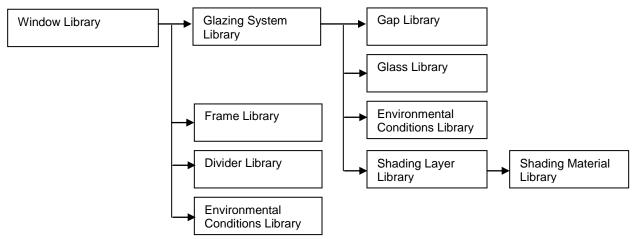


Figure 18-9. The database hierarchy in the WINDOW project database.

The steps to save a WINDOW database in this manner are the following:

Select the Library "level" that the export should start from – in general, the most complete "level" to export from will be the Window Library.

**Start from the Window Library:** this will mean that records from all the libraries that are used either directly or indirectly from those libraries will be included in the project database:

- **Glazing System Library:** All the glazing systems referenced in the Window Library entries
- **Frame Library:** All the frames referenced in the Window Library entries
- **Divider Library:** All the dividers referenced in the Window Library entries, if dividers are modeled.
- **Glass Library:** All the glass layers referenced from the glazing systems used in the Window Library entries
- **Gas Library:** All the gases referenced from the glazing systems used in the Window Library entries
- **Environmental Conditions Library:** All the environmental conditions referenced from the glazing systems and the Window Library entries.
- Shading Layer Library: Any records in the Shading Layer Library that are referenced from the glazing systems that are exported to the Project Database.
- Shade Material Library: Any shade material records that are referenced from the Shading Layer Library if Shading Layers are modeled in the exported glazing system.

**Start from the Glazing System Library:** this will mean that records from the libraries used to define the glazing systems will be written into the project database, and no other entries:

- **Glazing System Library:** All the glazing systems referenced in the Window Library entries
- **Glass Library:** All the glass layers referenced from the glazing systems used in the Window Library entries
- **Gas Library:** All the gases referenced from the glazing systems used in the Window Library entries
- **Environmental Conditions Library:** All the environmental conditions referenced from the glazing systems and the Window Library entries.
- Shading Layer Library: Any records in the Shading Layer Library that are referenced from the glazing systems that are exported to the Project Database.
- Shade Material Library: Any shade material records that are referenced from the Shading Layer Library if Shading Layers are modeled in the exported glazing system.

Note that when you create a project database the program may display a message saying that some records already exists (based on detecting duplicate record ID numbers), and ask if you want to overwrite it.

March 2019

## 18. TOTAL PRODUCT CALCULATIONS

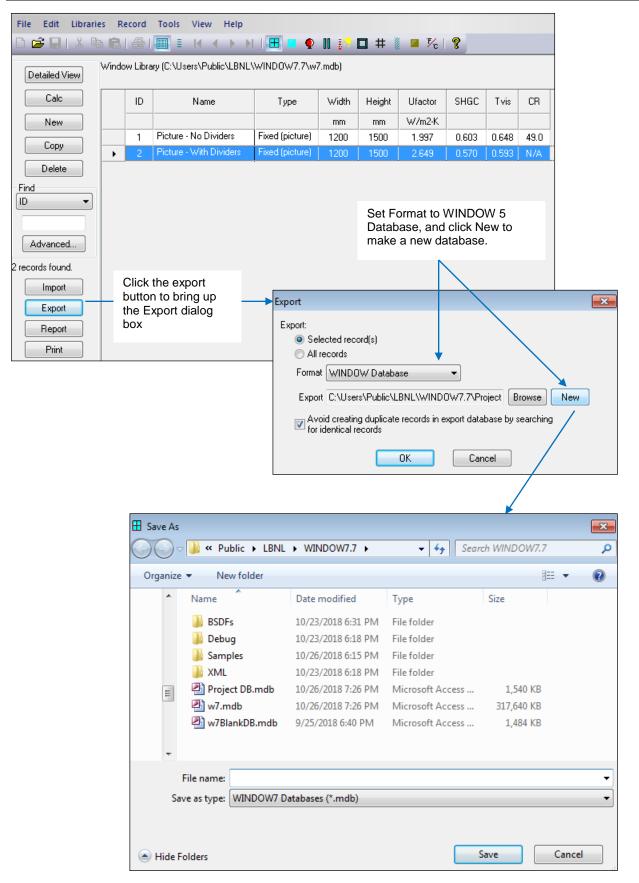


Figure 18-10. Creating a Project Database.

## 19.1. Overview

This section contains general modeling guidelines that should be followed for modeling shading systems, as well as details for modeling the following:

- Louvered Blinds
- Woven Shades
- Insulating Shade Layers with Non-Standard Geometry
  - Cellular and Pleated Shades
  - Roller Shutters
  - Insulated Quilts
- Perforated Screens
- Homogeneous diffusing shades

# 19.2. Shading System Modeling in General

## 19.2.1. Shading System States

Many shading systems, such as venetian blinds, cellular shades, pleated shades, vertical slat blinds, and roller shades, fall into the category of a dynamic shading product that can be in both open and closed states. If you are using WINDOW and THERM to model shading systems for NFRC ratings, consult the NFRC 100 and 200 technical documents, as well as the *NFRC THERM/WINDOW Simulation Manual*, for definitions of what needs to be modeled for different shading systems.

It is suggested that for calculating U-factor, SHGC, and Visible Transmittance, different "states" of the shading system should be modeled. Different standards organizations (such as NFRC and AERC) will have definitions for what should be modeled for these states, and their documentation should be consulted for details. For example, both organizations require modeling the shading system in the "Open" and "Closed" position, with definitions for those states defined in their documentation.

Outside of those standards, the different "states" for modeling can be expanded, depending on the type of information needed. The states to be modeled might include:

• **Open** – The shading system in it's most "transmitting" state

The Open state could be defined in a few different ways, depending on the shading system.

- **Retractable / Open:** Shading systems that retract up to the top of the glazing system. Even though the shading system is retracted, many times the hardware associated with the shading system will need to be modeled. There is an example of such a system in the section about Venetian blinds.
- **Non-Retractable / Open:** Shading systems that are fixed at the bottom (do not retract up). For example, the "open" state for a non-retractable Venetian blind could be defined as having the blind slats horizontal (perpendicular) to the plane of the glass. For other systems, such as roller shades, this case may be the same as the closed state.
- **Closed** The shading system in it's least "transmitting" state. For example, with Venetian blinds, this would be a fully deployed blind with the slats in the vertical, "closed" position.
- Off Angles or other states For a shading system with control over the shading mechanism, modeling at the different states besides Open and Closed should be considered in order to fully understand the energy impacts of each state. For example, Venetian blinds with slats that can be controlled at different angles, could be modeled with the slats at least at a 45 degree angle, and possible other angles, depending on the results desired.

## 19.2.2. Modeling a Glazing System with a Shading System

This section describes, in general, how to model a glazing system with a shading system. This method applies to all shade systems. By describing it once here, it will not be repeated to this level of detail in the sections that pertain to specific shading system types.

#### In WINDOW

#### Preferences

It is important to set the values correctly in the Preferences dialog box in order to produce reasonable results in WINDOW. The settings should be as follows:

#### Thermal Calcs Tab

- Calculation standard: **ISO 15099**
- Integral Model: ISO 15099

			for Int	<b>nvection Model</b> egral Venetian o "ISO 15099" I
	Options Thermal	Calcs Optical Calcs Optical	Data Updates	
Set Calculation Standard to "ISO 15099"	<ul> <li>Thermal calcula</li> <li>Calculation star</li> </ul>	ation options Indard ISO 15099	•	
	Convection mod	dels Model Outside	Model Integral	Inside Model
	Venetian blinds	ISO 15099 💌	ISO 15099	▼ ISO 15099 ▼
	Woven shades	ISO 15099 🗨	ISO 15099	▼ ISO 15099 ▼

Figure 19-1. Preferences settings for Thermal Calcs Tab for Integral Venetian Blind

## **Optical Calcs Tab**

- Use matrix method for specular systems (glazing systems without shading devices): **unchecked**
- Spectral data: Condensed spectral data
- Number of visible bands: 5
- Number of IR bands: **10**
- Generate full spectrally-averaged matrix for Solar Band: unchecked
- Generate full spectrally-averaged matrix for Visible Band: unchecked
- Angular basis: W6 quarter-size
- Solar/Visible range: Directional diffuse
- FIR range: Directional diffuse
- # of segments: 5

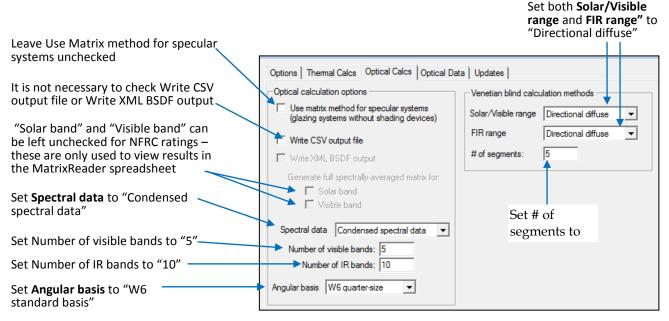


Figure 19-2. Preferences settings for Optical Calcs Tab for Integral Venetian Blind

## Glazing System Library

Once the Shade Layer has been defined in the Shade Layer Library (which is decribed in detail in each shading type section), that layer can be added to a glazing system. The layer can be placed, on the inside of the glazing system, between the glass layers, or on the outside of the glazing system.

- **# layers**: Set the layers to the total number of glass + shading system layers.
- Depending on the position of the shade, set the appropriate **Layer** to "Shade" (from pulldown arrow to the left in the first column). For example, in a double glazed system:
  - If the shading layer is on the outside of the glazing system, set Layer 1 to "Shade".
  - If the shading layer is between the glass layers of the glazing system, set Layer 2 to "Shade".
  - If the shading layer is on the room side of the glazing system, set Layer 3 to "Shade"
- Select the appropriate shading layer from the Shading Layer library for the "Shade" layer.

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Radiance																
		ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
		3110	SGSN68C6.grd	#	5.6		0.381	0.299	0.446	0.757	0.060	0.050	0.000	0.840	0.039	0.997
	Gap 1	<b>→</b> 9	Air (10%) / Argon (90%)	t	12.7											
	<ul> <li>Glass 2</li> </ul>	► 103	CLEAR_6.DAT	#	5.7		0.771	0.070	0.070	0.884	0.080	0.080	0.000	0.840	0.840	1.000
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	<ul> <li>Shade 3</li> </ul>	•• 29	1" horizontal VB (white)	•	18.0											
							111									
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	Ufactor	SC	SHGC	Bel	Ht. Gai	n	т	vis		Keff		ayer 1 Ki	∍ff	Gap 1	Keff	Layer
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Set Layer 3 to "Shade" using the pulldown for an interior shade; Set Layer 1 to "Shade" for an exterior shade, and so forth

T

Click on the double arrow to see the Shading Layer Library list

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Selec	t Ca	ncel Find		ID • 28	7 records found.			
	ID	Name	ProductName	Manufacturer	Туре	Material	PermeabilityFacto	
	19	Woven shade. Gray. 25% open area		Generic	Woven	Woven Shade Material	0.250	
	20	Off White Blind 24 mm slat at 45 degrees		Generic	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.993	
	21	Dark Blue Blind 24 mm slat at 45 degrees		Generic	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.993	
	22	Clear Frit (no pigment)		Generic	Fritted glass			
	23	Woven shade. Gray. 3% open area		Generic	Woven	Woven Shade Material	0.030	
	24	Woven shade. Gray. 10% open area		Generic	Woven	Woven Shade Material	0.100	
	28	Perforated screen. 8.7% open area		Generic	Perforated Screen	Slat Metal A	0.087	
F	29	1" horizontal VB (white) - 45 deg		Generic	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.992	
	30	3" horizontal VB (white) - 45 deg		Generic	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.997	
-	31	3" vertical VB (white) - 0 deg (open)		Generic	Venetian (vertical)	White Venetian Blind Slat (white.txt)	0.998	

Figure 19-3.For the third layer in the Glazing System (Layer #2), select the venetian blind from the Shading System Library.

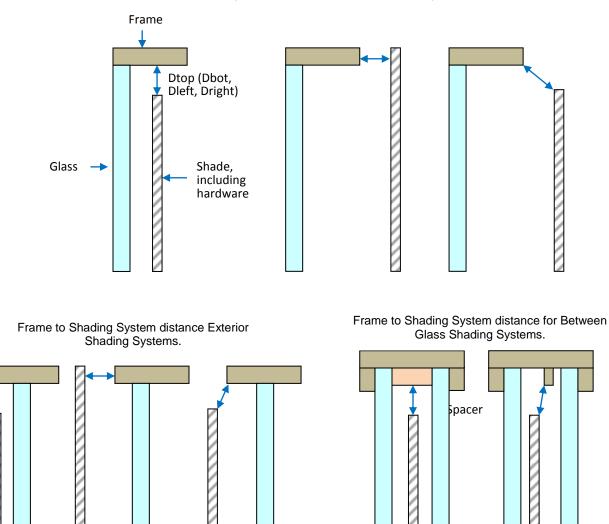
• Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the shading system geometry.

In the WINDOW Glazing System Library, the values for Dtop, Dbot, Dleft and Dright represent the space between the edge of the shading system (*including hardware*) and the top (bottom, left or right) of the glazing system cavity, as shown in Figure 19-5. These values are used to define the convection that will occur between the shading system and the glazing system. These values are used for the glazing system thermal calculations in WINDOW. However they are not used to place interior and exterior shading systems in THERM, which is controlled by the "Sight line to Shade edge" input when inserting the glazing system into THERM

It will be necessary to make a separate glazing system for each frame that has a different Dtop/Dbot/Dleft/Dright. These values from WINDOW are not used in THERM when a glazing system is imported, and therefore must be redefined when importing a glazing system. In the example below, there is no space at the top or the bottom of the Venetian blind, but there is a 3 mm space on the left and the right side of the blind.

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		ID	Name	Mode	Thick	Flip	Rvis2	Tir	E1	E2	Cond	Dtop (mm)	Dbot (mm)	Dright (mm)	Dleft (mm)
	Glass 1 ▶	3110	SGSN68C6.grd	#	5.6		0.050	0.000	0.840	0.039	0.997				
	Gap 1 🕨	• 9	Air (10%) / Argon (90%) I		12.7										
	Glass 2 ▶		CLEAR_6.DAT	#	5.7		0.080	0.000	0.840	0.840	1.000				
	Gap 2 🕨		Air		12.7										
	▼ Shade 3 ►	29	1" horizontal VB (white)		18.0							0.000	0.000	3.000	3.000
	•								111					(	4
Center of Glass Results Temperature Data Optical Data Angular Data Color Properties Radiance Results									s	Set values for Dtop, Dbot, Dleft, Dright					
	Ufactor	SC	SHGC	Rel.	Ht. Gai	n	T	/is		Keff	L	ayer 1 Keff.	Gap 1	Keff L	ayer 2 Keff
	W/m2-K				V/m2	-			_	//m-K		W/m-K	W/m		W/m-K
	1.243	0.303	0.264		200		0.1	47	C	.0542		0.9969	0.023	34	1.0000

Figure 19-4. Define a Dtop, Dbot, Dleft and Dright in the Glazing System Library.



Frame to Shading System distance for Interior Shading Systems.

*Figure 19-5.* Determine the distance from the frame/spacer and the shading system at the top, bottom, left and right of the window.

### In THERM

## Sightline

The shading system hardware can define the sightline rather than the frame, depending on the geometry of both the frame and the shade. The sightline is used in the Tvis and SHGC calculations.

## **Representation of the Shading System**

In THERM, the shading system is not explicitly modeled. When a WINDOW glazing system with a shading system is inserted into a THERM file, THERM draws a graphic representation of the shade, but does not create a polygon for it. The space between the shade and the glazing system or frame is not modeled as a frame cavity, and the effect on the glazing system or frame is accounted for by assigning a **Shading Modifier** when defining the boundary conditions. The **Shading Modifier** is automatically created when the glazing system is inserted, and will be available from the "Shading system modifier" pulldown menu in the Boundary Condition Type dialog box.

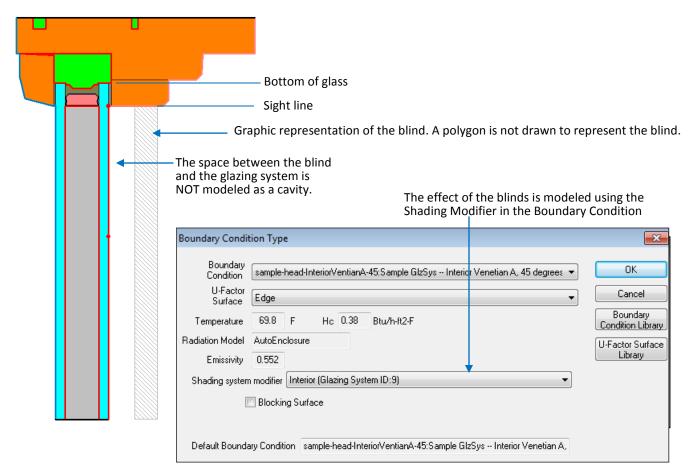
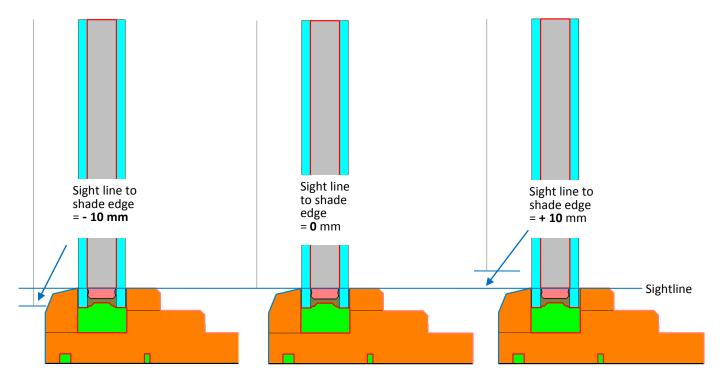


Figure 19-6. The shading system is not explicitly modeled in THERM.

## Sightline to Shade Edge

When importing a WINDOW glazing system with a shading system into a THERM file, the "Sight line to shade edge" input in the Insert Glazing System dialog box will determine where the shade starts (or stops) relative to the glazing system and frame. These values should correspond to the Dtop, Dbot, Dleft and Dright input in WINDOW; however the user has to input the value for every glazing system that is inserted into the THERM file, as THERM does not read those values from WINDOW.

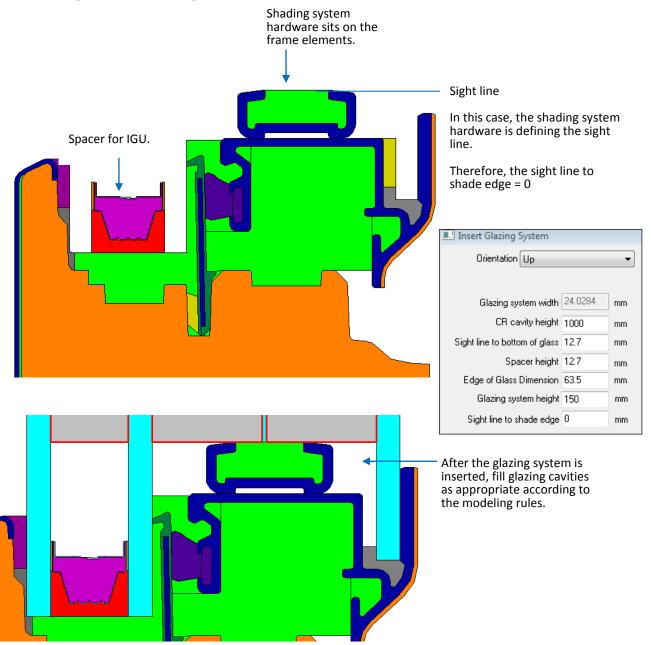
🔜 Insert Glazing System									
Orientation Up 🗸									
Glazing system width	24.0284	mm							
CR cavity height	1000	mm							
Sight line to bottom of glass	12.7	mm							
Spacer height	12.7	mm							
Edge of Glass Dimension	63.5	mm							
Glazing system height	150	mm							
Sight line to shade edge	10	mm							



*Figure 19-7.* The Sight line to shade edge input determines where the shade sits relative to the frame.

For a shading system that sits in a panel next to an insulated glazing unit (IGU), where the shading system dictates the hardware, the following guidelines can be used when importing the glazing system:

- Sightline to bottom of glass = spacer height
- Sight line to shade edge = 0



*Figure 19-8.* The relationship of sightline to spacer height, bottom of glass, and shade edge, for a shading system that has the hardware defining the sightline.

For a shading system where the hardware is not modeled, such as a jamb, or a head or sill that has hardware that is isolated from the frame (and is therefore not modeled), the diagram below shows how to define the input variables when importing a glazing system.

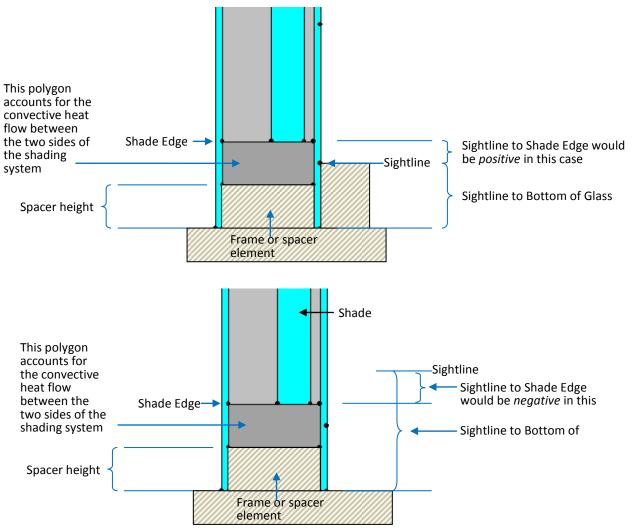


Figure 19-9. The relationship of sightline to shade edge when shading system hardware is not modeled.

#### Linking Glazing System Cavities to other cavities

Cavities associated with a shading system that are not modeled in the WINDOW Glazing System but which touch the WINDOW Glazing System cavities, such as cavities around hardware in the THERM file can be linked to the glazing system cavity following the 5 mm rule described in Chapter 9 of the THERM User Manual.

In the example below, the frame cavities that have a throat adjacent to the glazing cavity greater than 5 mm are linked to the glazing cavity, and those that are less than or equal to 5 mm are modeled as frame cavities.

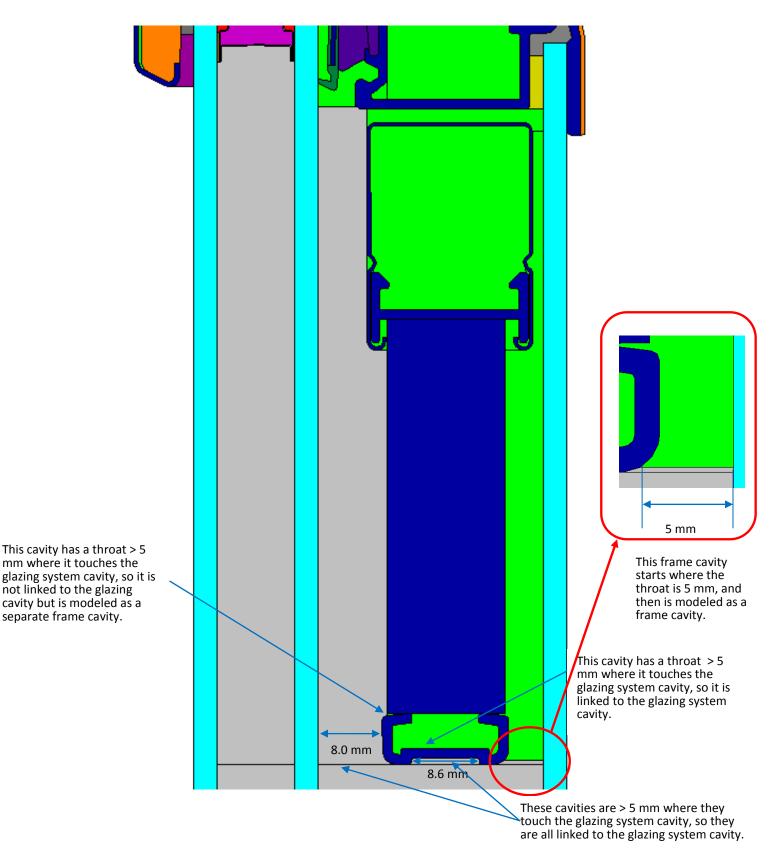


Figure 19-10. Determine which cavities around the Venetian blind can be linked to the Glazing System Cavity

### Modeling Shading System Hardware

Do not model the hardware:

• If the hardware is isolated from the frame or other shading system hardware. For example, if the hardware that the roller in a shade is attached to is not continuously connected to the shading system housing, it does not need to be modeled, such as the roller for a roller shade which is only attached at each jamb but not continuously along the head.

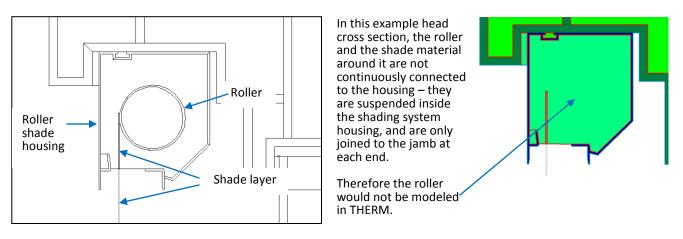
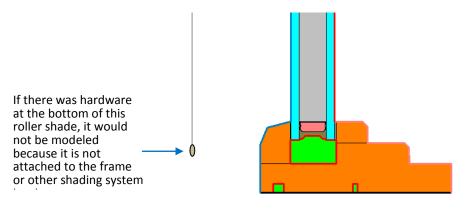


Figure 19-11. If the roller shade is not continuously connected to the shading system housing, it is not modeled in THERM

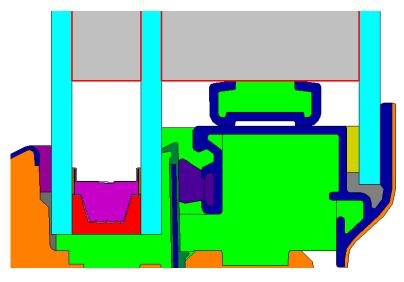
• This would also apply to hardware at the bottom of a shading system that is deployed, if that hardware does not touch the frame or other shading system hardware.



*Figure* 19-12. Do not model shading system hardware that is not attached to the frame or other shading system hardware.

Model the hardware:

- If the hardware is continuous and attached to the frame or other shading system hardware.
- For example, in a shading system housing, if the shade was a folded or pleated system, the hardware in the housing would be modeled if it was attached to the housing and continous.



#### Frame cavities inside the shading system housing:

When modeling an exterior shading system, such as a woven shade, there are three possibilities for how to model the shading system housing:

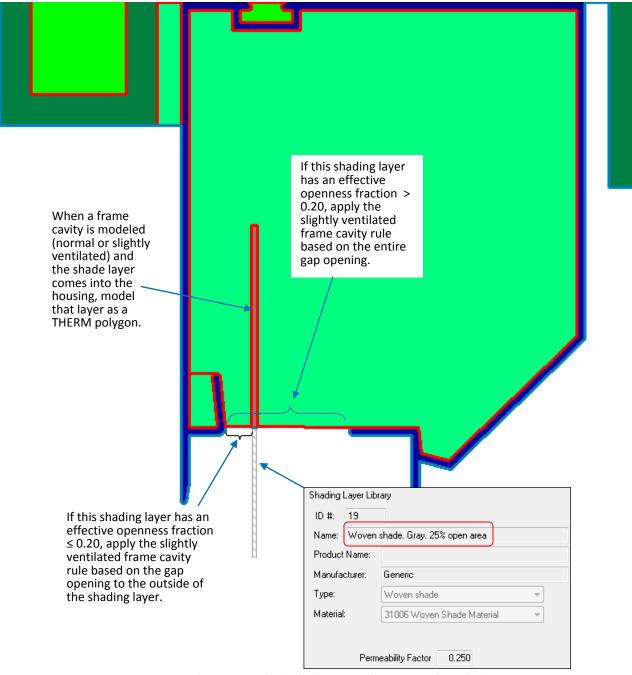
- NFRC Frame Cavity
- Slightly Ventilated Cavity
- No Cavity Modeled

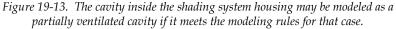
The guidelines below are used to determine which model to use, depending on the housing geometry.

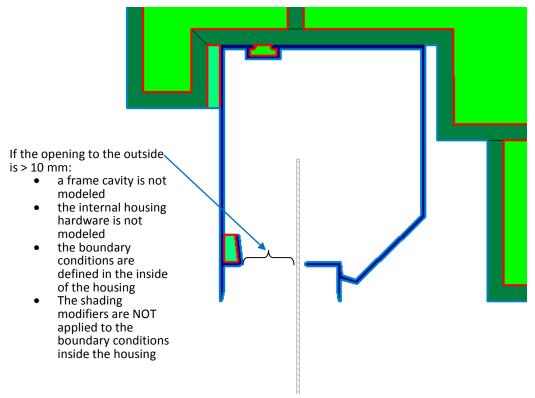
Shading system hardware usually has openings where the shading system intersects it. How to model these openings depends on the following rules:

- If the openness factor of the shading layer is ≤ 0.20, apply the slightly ventilated cavity rule (see Chapter 9 of the THERM User Manual) to the opening that is to the outside of the shading layer
- If the openness factor of the shading layer is > 0.20, consider the whole width of the opening to apply the slightly ventilated cavity rule.
- If the slightly ventilated rule does not apply because the opening is too small (< 2 mm):
  - o model the cavity as the NFRC Frame Cavity
- If the slightly ventilated rule does not apply because the opening is too large (> 10 mm)
  - o Do not model a frame cavity
  - Do not model the internal housing hardward

- Bring the boundary conditions into the inside of the shading system housing
- For the frame cavities (either the NFRC Frame Cavity or the slightly ventilated cavity) inside the shading system housing, break them up as needed according to the 5 mm rule. The cavity type stays the same even if the cavity is broken up into smaller polygons.







*Figure 19-14.* The cavity inside the shading system housing is not modeled as a *frame cavity if the gap to the outside air is greater than 10 mm.* 

### Shading layer in the shading system housing

This is independent of the Permeability Factor of the shade.

- Bring shading layer from WINDOW into housing as built
- If Frame cavities are modeled, draw polygon over shade layer into housing

In the case where a frame cavity (either normal or slightly ventilated is modeled inside the shading system housing), if the shading layer comes into the shading system housing, for either the open or closed instances of the shading system, model that shading layer as a real polygon, and do not have the shade layer graphic element go into the housing.

• If Frame cavities are not modeled, keep as is.

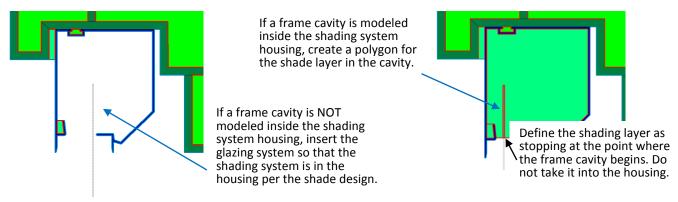
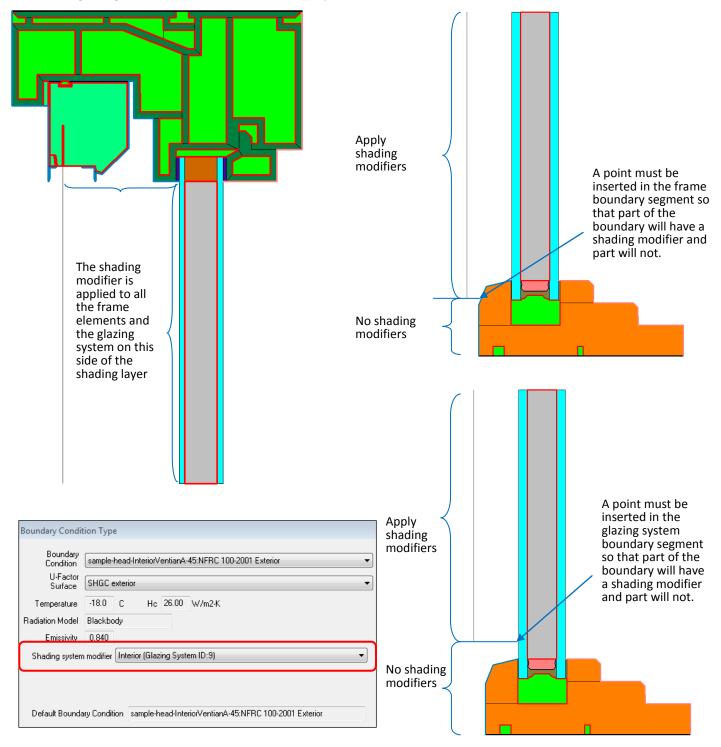


Figure 19-15. Modeling the shade layer in the shading system housing.

# **Shading System Modifiers**

Apply the shading system modifiers, shown in the Boundary Condition Type dialog box, to all glazing and frame surfaces based on a projection of the shade onto those elements.

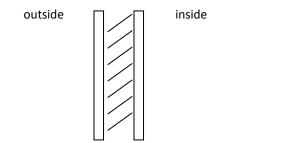


*Figure 19-16. Apply shading modifiers from the Boundary Condition Type dialog box.* 

# **19.3. Louvered Blinds: Venetian Blinds – Between Glass (Integral)**

This section contains a detailed description for how to model a Venetian blind between glass layers.

Venetian blinds between glass (venetian blinds between two glazing layers in a glazing system) fall into the category of a dynamic glazing product. In the example below, the blind is modeled in it's fully open and fully closed positions. In the case of modeling retractable integral venetian blinds as part of a dynamic glazing product, the fully open position is when the venetian blind is completely retracted. However, even when completely retracted, the stacked venetian blind slats become a "block" of material that must be modeled.



*Figure 19-17. Venetian Blind Between Glass is a blind between two pieces of glass* 

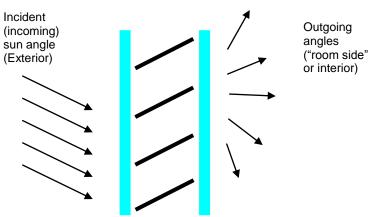


Figure 19-18. Incoming and outgoing light angles are modeled based on the angular "basis" specified.

In this example, the following "states" are modeled for each venetian blind configuration:

- **OPEN** -- Venetian blind fully retracted, ie, the most transmitting state
  - There is an example for both a retractable and a non-retractable Venetian blind
- CLOSED -- Venetian blind fully deployed, ie, the least transmitting state

# 19.3.1. Open Venetian Blind

There are two scenarios for Open venetian blinds:

• Retractable / Open: Venetian blinds that retract up to the top of the glazing system

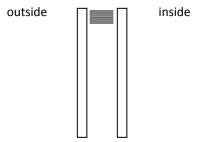


Figure 19-19. Retractable / Open Venetian Blind

• **Non-Retractable / Open:** Venetian blinds that are fixed at the bottom (do not retract up) – the "open" state is defined as having the blind slats horizontal (perpendicular) to the plane of the glass.

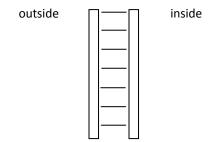


Figure 19-20. Non-Retractable / Open Venetian Blind

For **Retractable / Open**, two examples will be illustrated:

- The venetian blind fully retracted inside a double glazed system.
- The venetian blind fully retracted between an IGU and a third glazing layer (such as, but not limited to, an add-on panel).

For **Non-Retractable / Open**, one example will be illustrated:

• The venetian blind inside a double glazed system with the venetian blind slots in a horizontal (open) position.

# 19.3.1.1. Fully Retracted / Open Venetian Blind Inside a Double Glazed System

The following section discusses how to model a fully retracted venetian blind that has a stack of blind slats at the top of the glazing system. The following figure shows the Head cross section for a venetian blind in the fully-retracted position inside a double-glazed system.

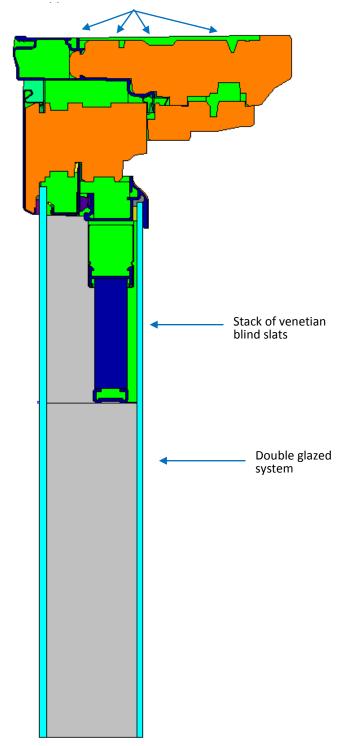
In this example, only the Head section will be shown. For Vertical Sliding windows where the lower sash contains a venetian blind between glass, the lower sash portion of the Meeting Rail section will be modeled with the same venetian blind considerations as the Head section. The other cross sections (Jambs, Sills and Meeting Stiles) are modeled normally, without any venetian blind considerations.

#### In WINDOW:

1. **Glazing System Library:** Create the appropriate glazing system in the Glazing System Library. In this case, it is not necessary to model a venetian blind in that glazing system in WINDOW, because the blind is fully retracted.

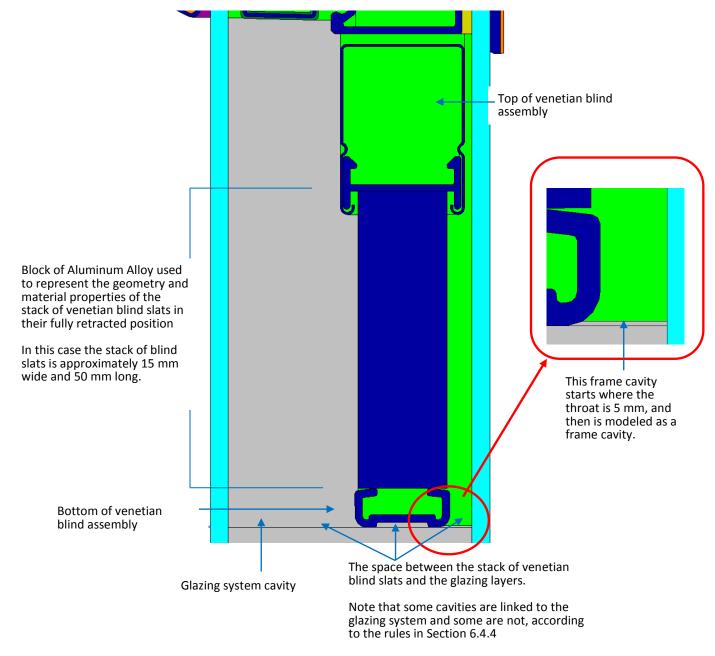
#### In THERM

- 1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
- 2. **Glazing System:** Import the glazing system defined in WINDOW (no venetian blind modeling needed) into the frame geometry. Make sure that the **Sight line to bottom of glass** value includes the height of the block representing the closed venetian blind, so that the Frame and Edge of Glass boundary conditions and U-factor tags are defined automatically by THERM.
- 3. **Boundary Conditions:** Define the Boundary Conditions in the normal manner; no venetian blind was modeled in WINDOW, so the Boundary Conditions in THERM do not need to be modified for a Shading System



Use the proper modeling technique where the frame meets the surround panel, ie, model these voids as air

Figure 19-21. Head cross section with fully retracted venetian blind inside a double-glazed system.



*Figure 19-22.* The Head cross section with the retracted venetian blind, including the stacked slats, and the top and bottom assemblies for the blind that are continuous across the section.

Follow these steps to model a fully retracted venetian blind:

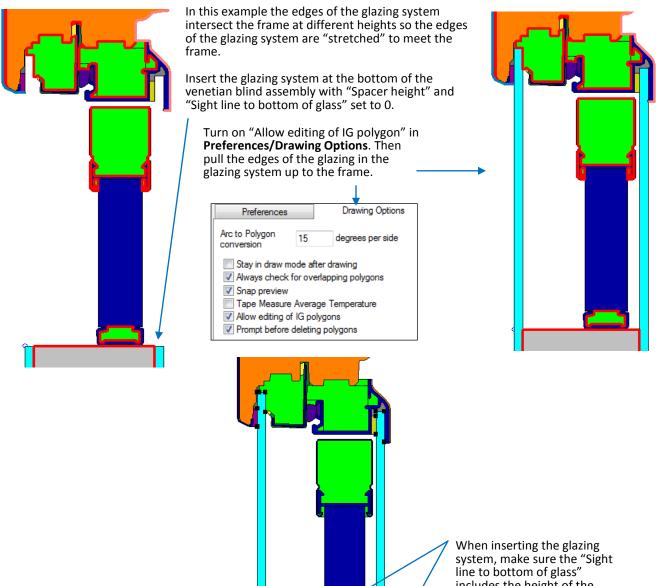
(Note: This example was done for Aluminum slat blinds. If the material of the blinds is not Aluminum, use the appropriate material properties for the stack of retracted venetian blind slats; define a new material in THERM if needed.)

- 1. Draw the Head cross section of the product frame.
- 2. Draw the geometry of the retracted venetian blind, including the length and width of the stacked venetian blind slats and any continuous hardware that holds the blind in place (top and bottom). (*Note: In this case, the system seems to be "floating" because non-continuous hardware is used to attach the blind to the fenestration system.*)

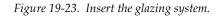
3. Insert the glazing system.

The example shown below has glazing layers that intersect the frame at two different heights. There are numerous methods for modeling this. The method shown is to "stretch" the glazing layers to meet the frame at the appropriate place, and this method also necessitates inserting points on the glazing system for the correct boundary conditions segments.

*Note:* Another method would be to insert "float glass" polygons for the glazing layer extensions – this method eliminates the need to insert the points in the glazing system for the boundary condition segments.

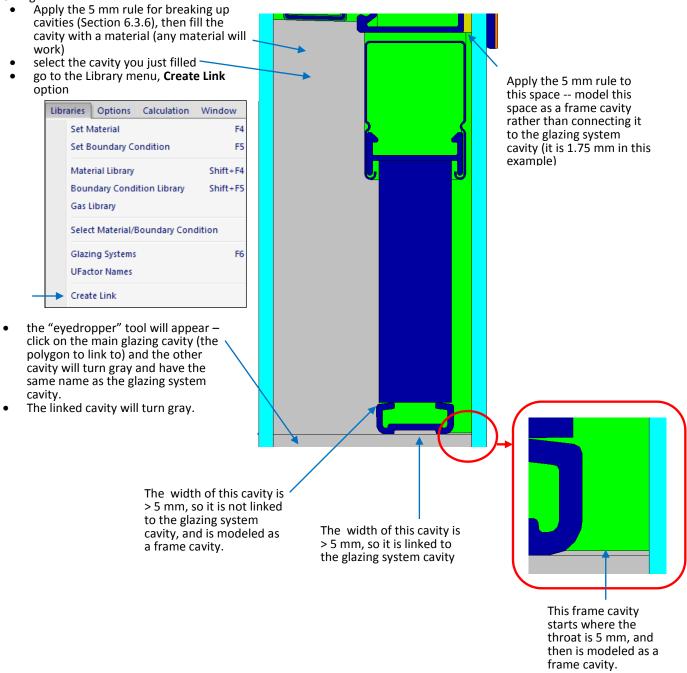


system, make sure the "Sight line to bottom of glass" includes the height of the entire Venetian blind assembly, so that points will be inserted in the proper places to define the boundary conditions and U-factor tags. Insert a point on the outside glass



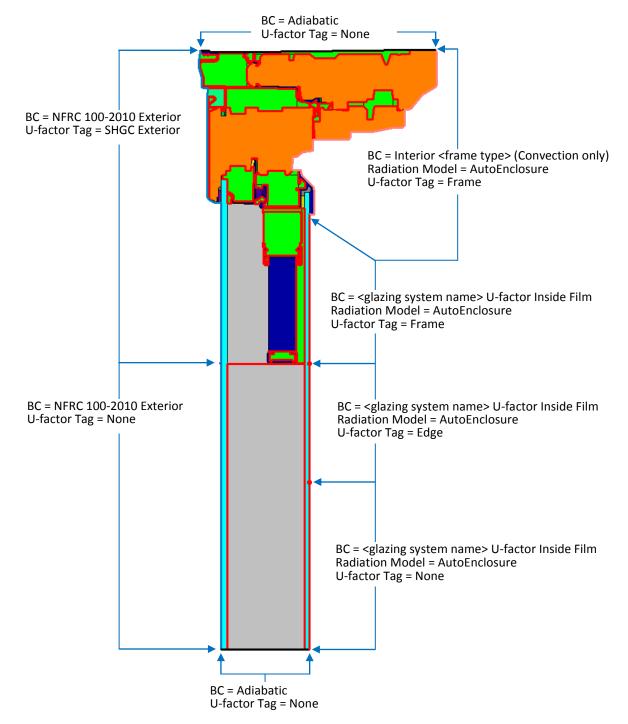
4. Fill the cavities around the venetian blind with a material, and then link that material to the cavity of the main glazing system. There may be several cavities to be linked, as shown in the figure below.

To link the left-hand cavity next to the venetian blind to the main glazing system cavity, do the following:



*Figure* 19-24*. Fill the cavity next to the venetian blind by linking it to the main glazing cavity.* 

5.



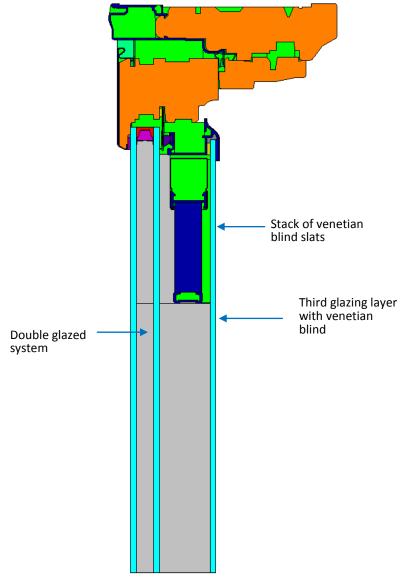
Generate the Boundary Conditions. The section of the warm side of the glazing system adjacent to the retracted venetian blind should be defined with a U-factor Surface tag of "Frame".

Figure 19-25. Define the boundary conditions for the cross section

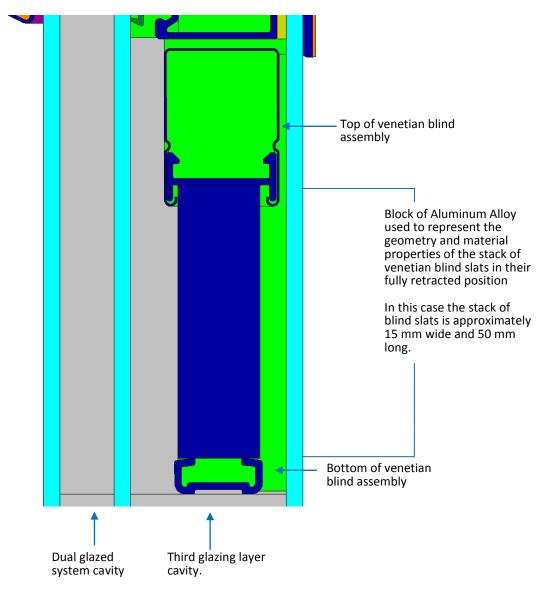
- 6. Calculate the results for this cross section.
- 7. Complete the calculations for the other product cross sections (Sill, Jambs and Meeting Rails / Stiles as appropriate).
- 8. Import all the cross sections into the WINDOW Frame Library and calculate the total product U-value, SHGC and VT.

# 19.3.1.2. Fully Retracted / Open Venetian Blind Between a Double-Glazed System and a Third Glazing Layer

The following figure shows the Head cross section for a venetian blind in the fully-retracted position between a double-glazed system with a third glazing layer, such as, but not limited to, an add-on panel.



*Figure 19-26. Head cross section with fully retracted venetian blind between a double-glazed system and a third glazing layer.* 



*Figure 19-27. The Head cross section with the retracted venetian blind, including the stacked slats, and the top and bottom assemblies for the blind that are continuous across the section.* 

Follow these steps to model a fully retracted venetian blind between a double glazed system and a third glazing layer:

(Note: This example was done for Aluminum slat blinds. If the material of the blinds is not Aluminum, use the appropriate material for the stack of retracted venetian blind slats. It is possible to make a new material if needed.)

- 1. In THERM, draw the Head cross section of the product frame.
- 2. In THERM, draw the geometry of the retracted venetian blind, including the length and width of the stacked venetian blind slats and any continuous hardware that holds the blind in place (top and bottom).
- 3. In WINDOW, make the appropriate glazing system (in this case a triple glazed system that represents the double glazed system and a third glazing layer (such as an add-on panel)).

4. In THERM, insert the glazing system.

The example shown below has glazing layers that intersect the frame at two different heights. There are numerous methods for modeling this. The method shown is to "stretch" the glazing layers to meet the frame at the appropriate place, and this method also necessitates inserting points on the glazing system for the correct boundary conditions segments. Another method would be to insert "float glass" polygons for the glazing layer extensions – this method eliminates the need to insert the points in the glazing system for the boundary condition segments.

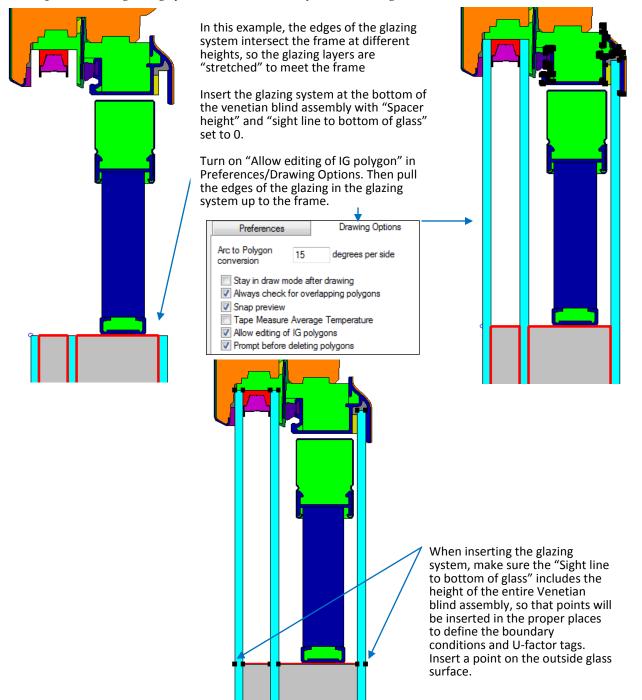


Figure 19-28. Insert the glazing system and edit it if necessary to bring the glazing layers to the frame.

5. Fill the cavities in the double glazing system and around the venetian blind in the third glazing layer with a material (any material), and then link that material to the appropriate cavity – the double glazing system cavity to the double glazing system and the third glazing layer cavity to the third glazing layer. There may be more than one area that is linked to a cavity, so make sure to link them all.

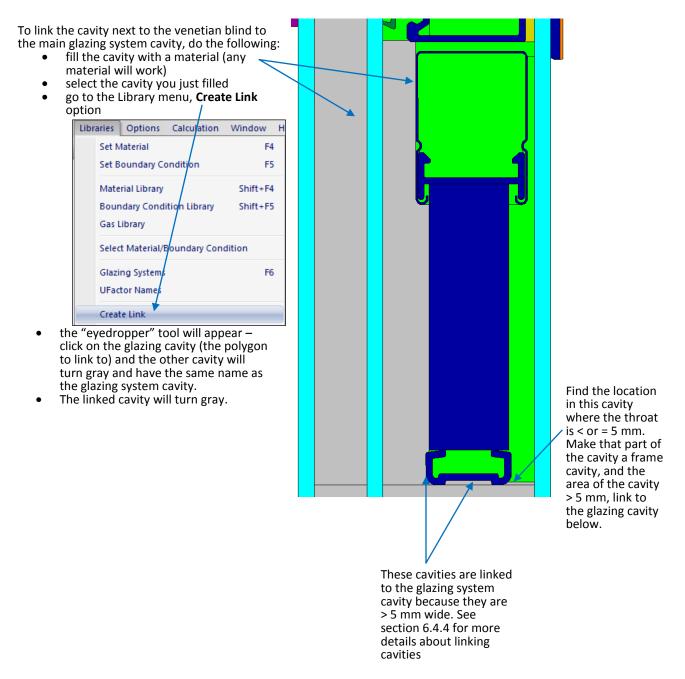


Figure 19-29. Fill the cavity next to the venetian blind by linking it to the main glazing cavity.

6. Generate the Boundary Conditions. The section of the warm side of the glazing system adjacent to the retracted venetian blind should be defined with a U-factor Surface tag of "Frame".

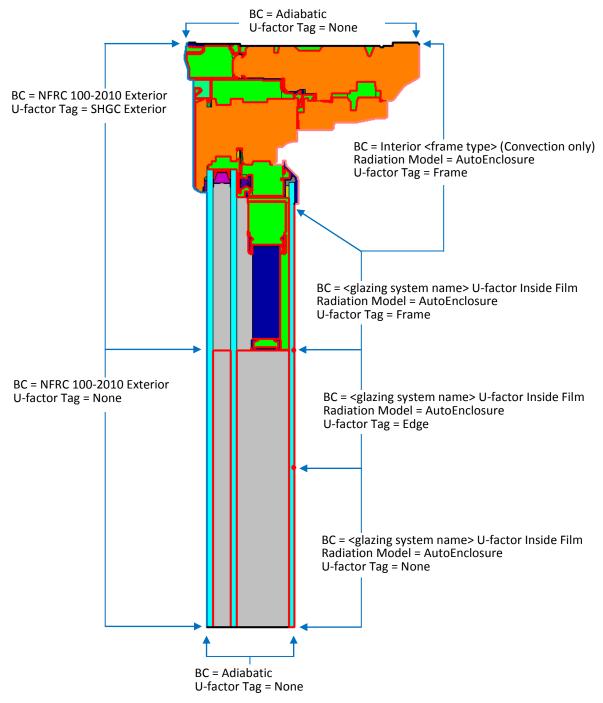


Figure 19-30. Define the boundary conditions for the cross section

- 7. Calculate the results for this cross section.
- 8. Complete the calculations for the other product cross sections (Sill, Jambs and Meeting Rails / Stiles as appropriate).
- 9. Import all the cross sections into the WINDOW Frame Library and calculate the total product Uvalue, SHGC and VT.

#### 19.3.1.3. Non-Retractable / Open Venetian Blind Inside a Double Glazed System

Non-Retractable / Open Venetian Blind are systems that are fixed at the bottom (do not retract up), and the "open" position is defined as the blind slats set to a horizontal position, perpendicular to the plane of the glass.

outside	inside

#### In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB). If the product is not in the CGDB, the manufacturer will need to have the blind slat material measured and added to the CGDB before the product can be simulated.

The Shading Layer should be defined with the venetian blind slats in a horizontal position, or as "open" as the blind geometry allows.

- 2. **Shade Material Library:** When the Shading Layer Library is imported from the CGDB, WINDOW will also import the associated Shade Material record for that Shade Layer into the Shade Material Library. In general, this should be automatic and you should not have to manipulate the records in the Shade Material Library.
- 3. **Glazing System Library:** Define the glazing system with the venetian blind between two layers of glass

#### In THERM:

- 1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
- 2. **Glazing System:** Import the glazing system defined with the venetian blind (horizontal slats) into the frame geometry
- 3. Boundary Conditions: For Integral Venetian Blinds, set "Shading System Modifier" to "None"
- 4. Simulate the model, save the results

#### In WINDOW:

- 1. **Frame Library:** Import the THERM files into the Frame Library
- 2. **Window Library:** Construct the window using the THERM files from the Frame Library and the glazing system defined in Glazing System Library

These steps are illustrated in more detail in the following discussion.

# In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB).

In the CGDB Shading Layer Library, for Venetian blinds that are defined as Type "Venetian" (not Type "BSDF", which are currently not allowed in NFRC certification), there may be one or more definitions for the same Venetian blind product. These different records will represent different geometries of the Venetian blind, such as slat thickness, width, slat spacing and slat tilt. If you are modeling the same Venetian blind product, but with a different slat thickness, width, slat spacing or slat tilt, you can make a new Shading Layer Library and change the slat geometry.

In this example, the Venetian blind has three records in the CGDB Shading Layer Library, representing three different slat tilts – "Closed", "45 degrees" and "Open".

ondan	ig Edyor Er						
	ID	Name	ProductName	fanufacture	Туре	Material	PermeabilityFactor
	3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.955
	3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.989
	3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.992
	3003	Slim Marine Closed	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992
	3004	Slim Marine 45	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.989
	3005	Slim Marine Open	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992

Shading Layer Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

Figure 19-31. Import the appropriate records from the CGDB Shading Layer Library

If only one slat geometry is represented in the CGDB (such as open or closed), import that record into the working database, and then make new records for the missing slat geometries, so that there is a separate Shading Layer record for both the Open and Closed geometries.

Shading I	Layer Lib	rary				
ID #:	3002					
Name:	Slim Wł	nite Open		]		
Product	Name:	Slim White Venetian Blind		]		The Meterial references a
Manufa	cturer:	Pella		]		The Material references a record in the Shade
Туре:		Venetian blind, horizontal	~			Material Library, which is
Material	:	31100 White Venetian Blin	d Slat (whit 👻 🗲			automatically created when the Shading Layer is
						imported from the CGDB.
Venetian		eability Factor 0.992				
venetian						
Slat widt	th:	14.800 mm				This record defines the
Spacing	j:	11.989 mm			-	<ul> <li>geometry for the "Open"</li> </ul>
Tilt:		fully open (0°) 🔍 👻				state of the Venetian blind
Tilt angle	e:	0.00000 degrees				
Blind thi	ckness:	14.800 mm				
Rise:		0.838 mm				
Help	D					

Figure 19-32. Define the venetian blind geometry for the "open" (horizontal) slats

- **Type**: Venetian blind, horizontal
- **Material**: White Venetian Blind Slat; this pulldown references the record in the Material Library that is associated with this Shading Layer. When a Shading Layer is imported from the CGDB, the associated record for the material is automatically added to the Shade Material Library. If you need to make a new Shading Layer record for a different slat geometry, make sure to reference the same material record in the Shade Material Library.
- Effective Openness Fraction: If a Shading Layer is imported from the CGDB, this value will automatically be set. If you are making a new record, the Effective Openness Fraction = 1 for the "Open" blind case.
- Slat Width: appropriate value, in this example 14.8 mm
- **Spacing** = spacing between each slat, in this example 12 mm

• **Tilt:** "fully open (0°)" for a slat in the horizontal position

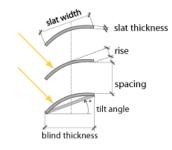


Figure 19-33. Venetian blind geometry definition

- **Blind thickness**: This value is not editable, and shows the width of the blind "assembly" based on the slat tilt. In this "Open" case, the blind thickness will equal the slat width. At any other slat angle, this value will be less than the slat width.
- **Rise:** this value defines the curve of the slat, and is defined in the CGDB for each Venetian blind product. It can be changed if it does not represent the slat curvature being modeled this would be necessary if the slat width was changed, for example.
- 2. **Shade Material Library:** When a Shading Layer record is imported from the CGDB, the Shad e Material is automatically imported, and therefore it is not necessary to add or change records in the Shade Material Library. However, you may need to reference existing records in the Shade Material Library if you are defining a new Shading Layer record (for example to define a differen slat geometry for a product).

Shad	le Materia	al Library (C:\Users\Public\LBNL\WINDC	)W7.7\w7.mdb)			
	ID	Name	ProductName	Manufacturer	Source	Mode
	31100	White Venetian Blind Slat (white.txt)	White Venetian Blind Slat	Pella	CGDB	
	31107	Marine Venetian Blind Slat (marine.txt)	Marine Venetian Blind Slat	Pella	CGDB	#

Figure 19-34. Shade Material Library records are automatically created when Shading Layers are imported from the CGDB.

	ID #: 62		me: Double low-e (a			_										
	ayers: 3			à Height:	1000.0	10 m	m [	~			222					
Cond	nental itions: NFRC	100-201	0 <b>v</b> I	G Width:	1000.0	10 mi	m			\$///	/8					
Com	ment:									\$///						
								×	*****	\$111.	//※					
erall thick	(ness: 46.900	m	m Mode: #	E Me	odel De	flecti	on	1		2	3					
<u> </u>	2		, .													
Set Lay	/er 2 to "S	hade'	using													
the pu	lldown															
		ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Co
• /	Glass 1 🕨	9801	CLEAR3.LOF	#	3.0	$\mathbf{X}$	0.876	0.078	0.078	0.907	0.082	0.082	0.000	0.840	0.840	1.
	Gap 1 🕨	1	Air		21.9											
-	Shade 2 🕨	3002	Slim White Open	#	14.8											
	Gap 2 🕨	1	Air		4.2											
-	Glass 3 🕨	9921	EnAdvLE3.LOF	#	3.0		0.740	0.119	0.112	0.842	0.111	0.106	0.000	0.164	0.840	1.
•			11													
enter of G	lass Results	Temper	ature Data Optical	Data Ang	ular Da	ta (	Color Pro	perties	Radiano	e Resul	ts					
Ufac		SC	SHGC		Ht. Gai	n	T	vis		Keff	L	ayer 1 Ki		Gap11		L
W/m		0.835	0.727	V	√/m2 541		0.1	732		√/m-K .0864		W/m-K		W/m 0.128		
1.8								137		пара –				11128	sa 🛛	

#### Glazing System Library: Define the glazing system with the venetian blind between two layers of glass

	🛛 Se	elect					X
Click on the double arrow to see the <b>Shading</b>	Se	lect Car	icel	Find	ID ▼ 287 re	ecords found.	
Layer Library list		ID	Name	ProductName	Manufacturer	Туре	^
		3000	Slim White VB Close	Slim White Venetian Blind	Pella	Venetian (horizontal)	
		3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)	_
L	 •	3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)	
		3003	Slim Marine Closed	Slim Marine Blue Venetian Blin	Pella	Venetian (horizontal)	
		3004	Slim Marine 45	Slim Marine Blue Venetian Blin	Pella	Venetian (horizontal)	
		3005	Slim Marine Open	Slim Marine Blue Venetian Blin	Pella	Venetian (horizontal)	
		3500	Dickson Orchestra ‡	Dickson Orchestra #0681 Dun	Goodearl and Bailey	BSDF	
		4000	Uniview Charcoal	Uniview Charcoal	Uniline	BSDF	-
	•						•

Figure 19-35. For the middle layer in the Glazing System (Layer #2), select the venetian blind from the Shading System Library.

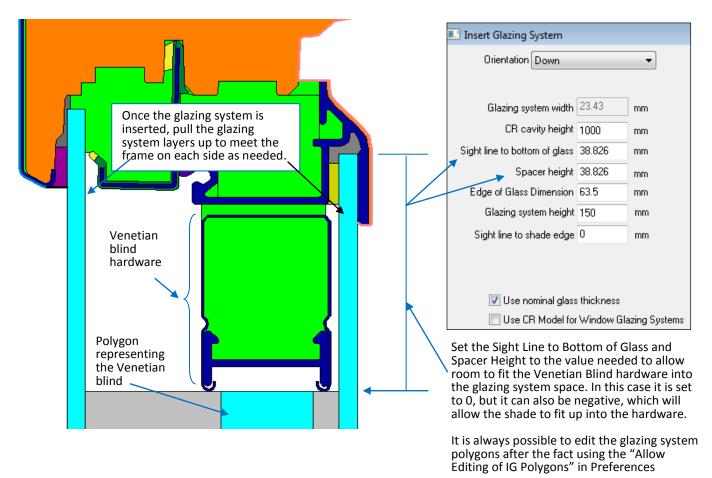
- Set Number of layers = 3
- Set Layer #2 to "Shade" (from pulldown arrow to the left in the first column)
- Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the venetian blind geometry. These distances are based on the distance between the top of the venetian blind (including hardware) and the top (or left, right, bottom) of the glazing system.

Enviro Cor Co	ID #: 62 Layers: 3 nmental nditions: NFI omment: ickness: 46.3		00-201	me: Double low-e (argor Tilt: 90 ° IG H 0 • IG W m Mode: #	eight: /idth:	ntVB Op 1000.0 1000.0	0 mr	n	1		2	3				
			ID	Name	Mode	Thick	Flip	Rvis2	Tir	E1	E2	Cond	Dtop (mm)	Dbot (mm)	Dright (mm)	Dleft (mm)
-	Glass 1	**	9801	CLEAR3.LOF	#	3.0	$\mathbf{X}$	0.082	0.000	0.840	0.840	1.000	 			
	Gap 1	÷	1	Air		21.9										
-	Shade 2	**	3002	Slim White Open	#	14.8							0.000	0.000	3.000	3.000
	Gap 2	₩	1	Air		4.2										
-	Glass 3	÷	9921	EnAdvLE3.LOF	#	3.0		0.106	0.000	0.164	0.840	1.000			$\langle$	
✓ Glass 3 →> 9921 EnAdvLE3.LOF       # 3.0       0.106       0.000       0.164       0.840       1.000         ✓       ✓       ✓       ✓       ✓       ✓       ✓         ✓       ✓       ✓       ✓       ✓       ✓         ✓       ✓       ✓       ✓       ✓       ✓         ✓       ✓       ✓       ✓       ✓       ✓         ✓       ✓       ✓       ✓       ✓       ✓         ✓       ✓       ✓       ✓       ✓       ✓         ✓       ✓       ✓       ✓       ✓       ✓																
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Uf-	actor		SC	SHGC	Rel.	Ht. Gai	n	T	vis		Keff		Layer 1 Keff	Gap 1	Keff L	ayer 2 Keff
W/	/m2-K				١	√/m2				V	//m-K		W/m-K	W/m	ŀК	W/m-K

*Figure* 19-36. *Define a Dtop, Dbot, Dleft and Dright in the Glazing System Library.* 

#### In THERM:

- 1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
- 2. **Glazing System:** Import the glazing system defined with the venetian blind (horizontal slats) into the frame geometry. For this example, the Head cross section, the following settings were used in the Insert Glazing System dialog box:
  - Orientation: Down (for the Head cross section
  - Cross Section Type: Head
  - **Spacer Height:** 0 or 38.826 mm You can use the spacer height value to make room for the Venetian blind hardware, or you can set it to zero and pull the glass layers into the frame (make sure Options/Preferences/Drawing Options has "Allow Editing of IG Polygons" checked).
  - **Sight Line to bottom of glass:** The sightline is defined by the edge of the venetian blind hardware.



• **Sight line to shade edge:** In this case the value = 0.

Figure 19-37. Insert the glazing system with the Venetian blind

Fill in the remaining cavities and either model them as NFRC Frame Cavities or link them to the appropriate glazing system cavity.

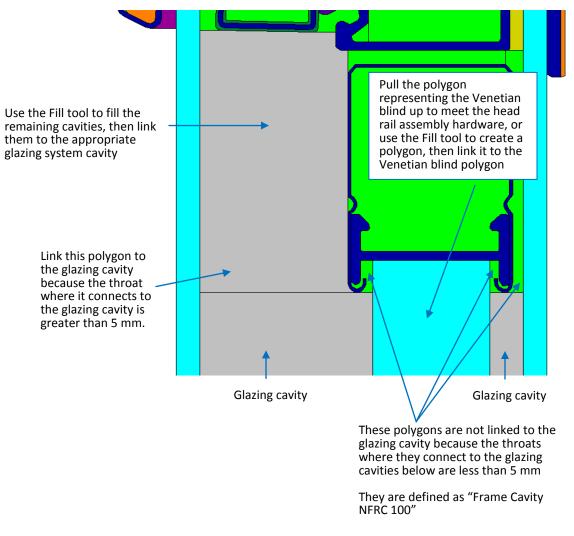


Figure 19-38. Fill the remaining cavities and link to the appropriate glazing system cavities.

3. Create the other cross sections in this manner.

In the case of the Head and Sill cross sections, the Sight Line to Shade Edge is zero. However, for the Jamb cross section, the blind does not touch the edge of the frame, but rather is 3 mm off the frame, so the Sight Line to Shade Edge is non-zero.

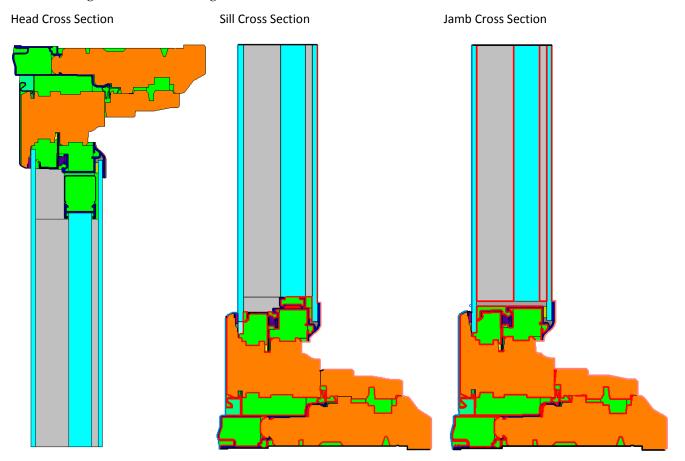


Figure 19-39. Head, Sill and Jamb cross sections for Non-retractable Open Venetian Blind between glass layers (Integral)

4. **Boundary Conditions:** The program will not automatically insert a point in the exterior glass layer for the SHGC Exterior U-factor tag, so you will need to do that by hand by editing the glazing system. For Integral Venetian Blinds, the **Shading System Modifier** choice will automatically be set to "None"

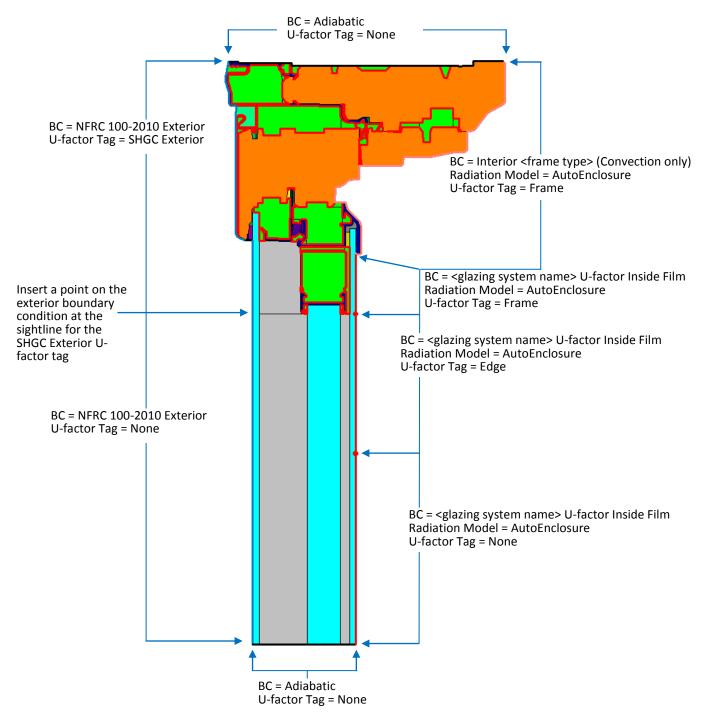


Figure 19-40. Define the boundary conditions for the Head Non-Retractable Open Venetian Blind cross section

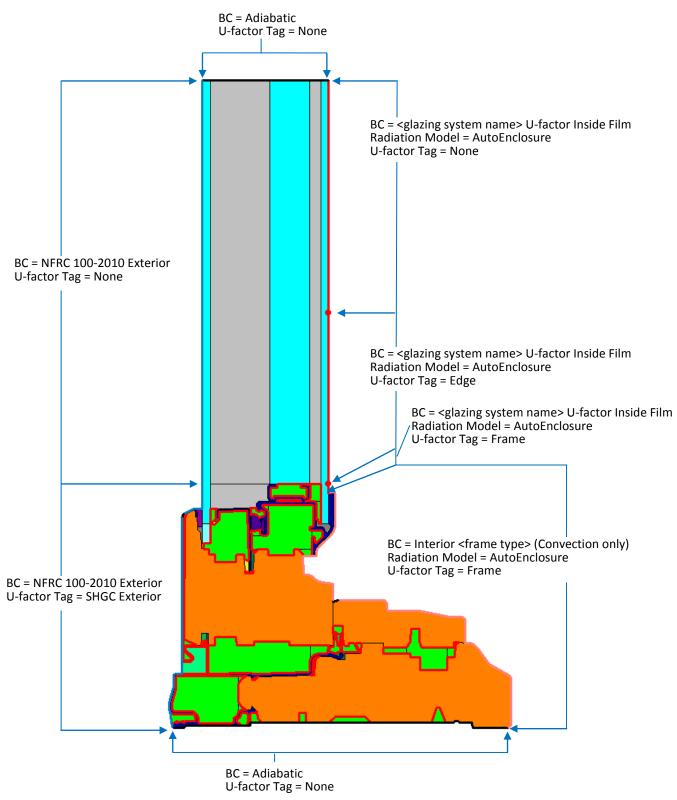


Figure 19-41. Define the boundary conditions for each Sill Non-Retractable Open Venetian Blind cross section

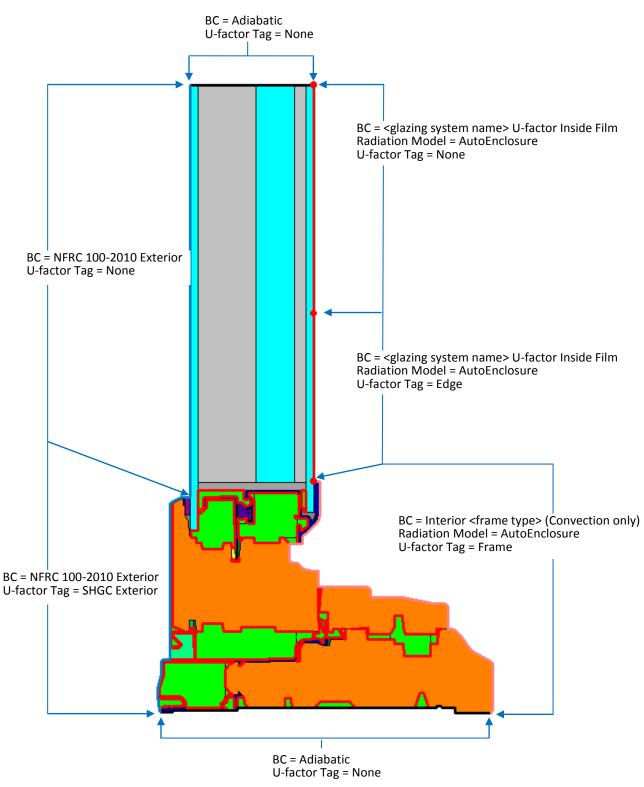


Figure 19-42. Define the boundary conditions for each Jamb Non-Retractable Open Venetian Blind cross section

5. Simulate each cross section and save the results.

#### In WINDOW:

1. **Frame Library:** Import the THERM files into the Frame Library

Frame Library (C:\Users\Public\LBNL\WINDOW7.7\w7.mdb)

	ID	Name	Source	Туре	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs
					W/m2-K	W/m2-K		mm	mm	
	1	Al w/break	ASHRAE	N/A	5.680	N/A	Class1	N/A	57.2	0.90
	2	Al flush	ASHRAE	N/A	3.970	N/A	Class1	N/A	57.2	0.90
	3	Wood	ASHRAE	N/A	2.270	N/A	Class1	N/A	69.8	0.90
	4	Vinyl	ASHRAE	N/A	1.700	N/A	Class1	N/A	69.8	0.90
	5	sample-head.THM	Therm	Head	2.007	2.350	N/A	26.5	42.9	0.30
	6	sample-jamb.THM	Therm	Jamb	1.995	2.343	N/A	26.5	42.9	0.30
	7	sample-sill.THM	Therm	Sill	2.001	2.344	N/A	26.5	42.9	0.30
•	9	VenetianFixedOpenJamb.THM	Therm	Jamb	2.766	2.143	N/A	46.9	87.6	0.30
	10	VenetianFixedOpen-Sill.THM	Therm	Sill	2.991	2.138	N/A	46.9	90.8	0.30
	11	VenetianFixedOpen-Head.THM	Therm	Head	2.850	2.012	N/A	46.9	114.8	0.30

*Figure 19-43. Import the THERM files into the WINDOW Frame Library* 

2. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library

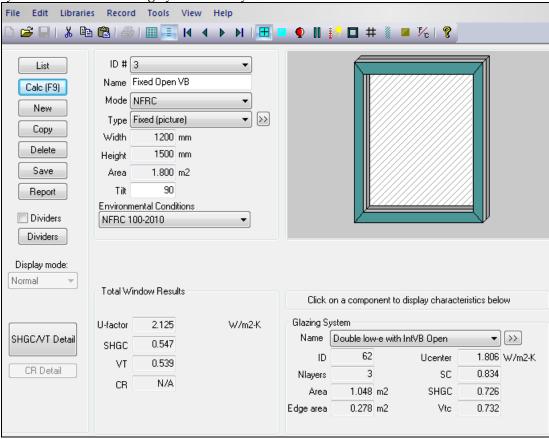


Figure 19-44. Define and calculate the window.

#### 19.3.2. Closed Venetian Blind

This section describes modeling a Venetian blind in it's closed position. The modeling procedures presented here will apply to either a retractable or non-retractable Venetian blind.

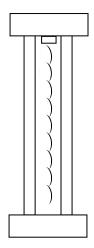


Figure 19-45. A closed Venetian blind between two glass layers.

#### In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB). If the product is not in the CGDB, the manufacturer will need to have the blind slat material measured and added to the CGDB before the product can be simulated.

The Shading Layer should be defined with the venetian blind slats in a vertical position, or as "closed" as the blind geometry allows.

- 2. **Shade Material Library:** When the Shading Layer Library is imported from the CGDB, WINDOW will also import the associated Shade Material record for that Shade Layer into the Shade Material Library. In general, this should be automatic and you should not have to manipulate the records in the Shade Material Library
- 3. **Glazing System Library:** Define the glazing system with the venetian blind between two layers of glass

#### In THERM:

- 1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
- 2. **Glazing System:** Import the glazing system defined with the venetian blind (vertical "closed" slats) into the frame geometry
- 3. Boundary Conditions: For Integral Venetian Blinds, set "Shading System Modifier" to "None"
- 4. Simulate the model, save the results

## In WINDOW:

- 5. Frame Library: Import the THERM files into the Frame Library
- 6. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library

These steps are illustrated in more detail in the following discussion.

#### In WINDOW:

1. **Shading Layer Library:** If the appropriate venetian blind product is not already in the Shading Layer Library, import it from the Complex Glazing Database (CGDB).

In the CGDB Shading Layer Library, for Venetian blinds that are defined as Type "Venetian" (and not Type "BSDF"), there may be one or more definitions for the same Venetian blind product. These different records will represent different geometries of the Venetian blind, such as slat thickness, width and slat spacing. However, if you are modeling the same Venetian blind product, but with a different slat thickness, width or slat spacing, you can make a new Shading Layer Library and change the slat geometry.

In this example, the Venetian blind has three records in the CGDB Shading Layer Library, representing three different slat tilts – "Closed", "45 degrees" and "Open". For NFRC certification, the 45 degree geometry is not needed, and therefore only the "Closed" and "Open" records are imported from the CGDB, as shown in the figure below.

Shadin	ig Layer Li	brary (C:\Users\Public\LBN	NL\WINDOW7.7\w7.mdb)				
	ID	Name	ProductName	1anufacture	Туре	Material	PermeabilityFactor
•	3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.955
	3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.989
	3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)	White Venetian Blind Slat (white.txt)	0.992
	3003	Slim Marine Closed	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992
	3004	Slim Marine 45	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.989
	3005	Slim Marine Open	Slim Marine Blue Venetian Blind	Pella	Venetian (horizontal)	Marine Venetian Blind Slat (marine.txt)	0.992

Figure 19-46. Import the appropriate records from the CGDB Shading Layer Library

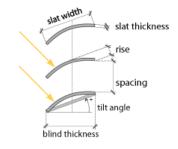
If only one slat geometry is represented in the CGDB, import that record into the working database, and then make new records for the missing slat geometries, so that there is a separate Shading Layer record for both the Open and Closed geometries.

Shading	Layer Lib	rary			
ID #:	3000				
Name:	Slim Wł	nite VB Closed		]	
Product	Name:	Slim White Venetian Blind		]	
Manufa	cturer:	Pella		]	The Material references a
Туре:		Venetian blind, horizontal			record in the Shade Material — Library, which is
Material	:	31100 White Venetian Blin	d Slat (whit 💌		automatically created when the Shading Layer is
					imported from the CGDB.
Venetian		neability Factor 0.957			
Slat wid	th:	14.808 mm	<b>.</b>	\	The geometry for this record
Spacing	<b>j</b> :	12.700 mm			<ul> <li>represents the blind with</li> </ul>
Tilt:		Custom angle 🔹 👻		Y	the slats in a closed position
Tilt angl	e:	-80.000( degrees		4	
Blind thi	ckness:	2.571 mm		1	
Rise:		0.838 mm		J .	
				}	
Help	<b>D</b>				

Figure 19-47. Define the venetian blind geometry for the "closed" (vertical) slats

- Type: Venetian blind, horizontal
- **Material**: White Venetian Blind Slat; this pulldown references the record in the Material Library that is associated with this Shading Layer. When a Shading Layer is imported from the CGDB, the associated record for the material is automatically added to the Shade Material Library. If you need to make a new Shading Layer record for a different slat geometry, make sure to reference the same material record in the Shade Material Library.
- Effective Openness Fraction/Permeability Factor: The value is calculated based on the geometry of the layer
- Slat Width: appropriate value, in this example 14.8 mm
- **Spacing** = spacing between each slat, in this example 12 mm

• Tilt: "closed (-90)" or "closed (+90)" depending on the product geometry. If the shade is not capable of reaching 90 at full tilt then the appropriate maximum achievable tilt is entered under "Custom angle".



*Figure 19-48. Venetian blind geometry definition* 

- **Blind thickness**: This value is not editable, and shows the width of the blind "assembly" based on the slat tilt. In this "Closed" case, the blind thickness is very small.
- **Rise:** this value defines the curve of the slat, and is defined in the CGDB for each Venetian blind product. It can be changed if it does not represent the slat curvature being modeled this would be necessary if the slat width was changed, for example.
- 2. **Shade Material Library:** When a Shading Layer record is imported from the CGDB, the Shade Material is automatically imported, and therefore in general, it is not necessary to add or change records in the Shade Material Library. However, you may need to reference existing records in the Shade Material Library if you are defining a new Shading Layer record (for example to define a differen slat geometry for a product).

Shad	e Materia	al Library (C:\Users\Public\LBNL\WINDC	)W7.7\w7.mdb)			
	ID	Name	ProductName	Manufacturer	Source	Mode
•	31100	White Venetian Blind Slat (white.txt)	White Venetian Blind Slat	Pella	CGDB	
	31107	Marine Venetian Blind Slat (marine.txt)	Marine Venetian Blind Slat	Pella	CGDB	#

*Figure 19-49. Shade Material Library records are automatically created when Shading Layers are imported from the CGDB.* 

	ID #: 63		Na		low-e with Ir	ntVB Clo	sed											
	#Layers: 3			1.00	)° lG H∉	eight:	1000.0	10 mi	m [									
En	vironmental Conditions: NFF	RC 1	00-201	0	👻 lG W	/idth:	1000.0	10 mi	m				Š.					
	Comment:											XX/	81					
												XX / (	8					
)veral	l thickness: 34.6	671	m	nm Mo	de: #	M M	odel De	flecti	on		1	2	3					
-																		
	Set Layer 2	2 to	o "Sha	ade" usir	ng													
	the pulldo	wn	l		-													
			ID	N	ame	Mode	Thick	Elin	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	
-	Glass 1	••		CLEAR3.L		#	3.0	X		0.078		0.907	0.082	0.082	0.000	0.840	0.840	-
	Gap 1			Air			21.9		0.010	0.010	0.010	0.001	0.002	0.002	0.000	0.010	0.010	
-	Shade 2			Slim White	VB Closed	#	2.6											
	Gap 2	••	1	Air			4.2											
-	Glass 3	_	9921	EnAdvLE3	LOF	#	3.0		0.740	0.119	0.112	0.842	0.111	0.106	0.000	0.164	0.840	
	2																	
			1															
Cente	r of Glass Result	8	Temper	ature Data	Optical Dat	a Ang	ular Da	ta (	Color Pro	perties	Radiano	• Bacul	te					
			remper		opicarba				50101110	portios [	maalahe	o mosui						-
	Ufactor		SC		SHGC	Rel.	Ht. Gai	in	Т	vis		Keff	L	ayer 1 Ko	eff	Gap 1	Keff	
	W/m2-K					\	√/m2				V	√/m-K		W/m-K		W/m	-K	
							152			042		.0934		1.0000		0.118		

# Glazing System Library: Define the glazing system with the venetian blind between two layers of glass

	🛛 Sele	ect					x
Click on the double arrow to see the <b>Shading</b> Layer Library lis	Sele	ect Can	cel	Find	ID	<ul> <li>287 records found.</li> </ul>	
		ID	Name	ProductName	/lanufacture	Туре	
	 •	3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian (horizontal)	
		3001	Slim White VB 45	Slim White Venetian Blind	Pella	Venetian (horizontal)	
		3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian (horizontal)	
		3003	Slim Marine Closed	Slim Marine Blue Venetian Blin	Pella	Venetian (horizontal)	
		3004	Slim Marine 45	Slim Marine Blue Venetian Blin	Pella	Venetian (horizontal)	
		3005	Slim Marine Open	Slim Marine Blue Venetian Blin	Pella	Venetian (horizontal)	-
	•	4	III			4	

Figure 19-50. For the middle layer in the Glazing System (Layer #2), select the venetian blind from the Shading System Library.

- Set Number of layers = 3
- Set Layer #2 to "Shade" (from pulldown arrow to the left in the first column)
- Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the venetian blind geometry

	ID #: 6	3	Na	me: Double low-e with Ir	ntVB Clo	osed									
	# Layers: 3		*	Tilt: 90 ° IG He	eight:	1000.0	)0 mr	n _					1		
Env 1	ironmental Conditions:	FRC	100-201	0 🔻 IG W	/idth:	1000.0	)0 mr	n				XI.			
	Comment:											8			
											XX / )	8			
erall	thickness: 3	1.671	m	nm Mode: #	М	odel De	flectio	on	-	1	2	3			
			ID	Name	Mode	Thick	Flip	Tir	E1	E2	Cond	Dtop (mm)	Dbot (mm)	Dright (mm)	Dleft (m
•	Glass	1 🕨	9801	CLEAR3.LOF	#	3.0	×	0.000	0.840	0.840	1.000				
	Gap	1 🕨	1	Air		21.9									
-	Shade	2 🕅	3000	Slim White VB Closed	#	2.6						0.000	0.000	3.000	3.0
		o la s	1	Air		4.2									
	Gap														
•	Gap Glass		9921	EnAdvLE3.LOF	#	3.0		0.000	0.164	0.840	1.000		$\gamma$		
			9921	EnAdvLE3.LOF	#	3.0		0.000	0.164		1.000	Set value	es for Dto	p. Dbot. [	Dleft.
•			9921	EnAdvLE3.LOF	#	3.0		0.000	0.164	0.840	1.000	Dright ba	ased on t	p, Dbot, I he geome	
			9921	EnAdvLE3.LOF	#	3.0		0.000	0.164		1.000	Dright ba		he geome	
			9921	EnAdvLE3.LOF	#	3.0		0.000	0.164		1.000	Dright ba	ased on t	he geome	
•		3 ••		EnAdvLE3.LOF		3.0	ta (	0.000 Color Pro			1.000	Dright ba the blinc	ased on t	he geome	
enter	Glass of Glass Res	3 ••	Temper	ature Data Optical Dat	a Ang	ular Da		Color Pro	perties		ce Resul	Dright ba the blinc	ased on ti I product	he geome	try of
enter	Glass	3 ••			a Ang Rel.			Color Pro		m		Dright ba the blinc ts Layer	ased on t	he geome	

Figure 19-51. Define a Dtop, Dbot, Dleft and Dright in the Glazing System Library.

### In THERM:

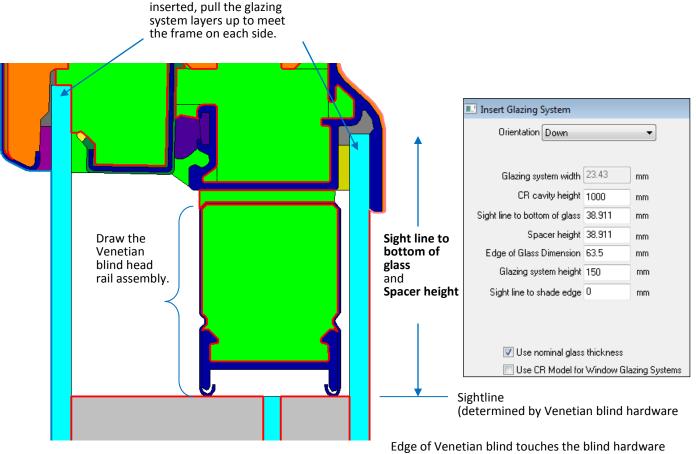
- 1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
- 2. **Glazing System:** Import the glazing system defined with the venetian blind (horizontal slats) into the frame geometry. For this example, the Head cross section, the following settings were used in the Insert Glazing System dialog box:
  - Orientation: **Down** (for the Head cross section
  - Cross Section Type: Head

Once the glazing system is

Setting the Cross Section Type to the approriate value allows THERM to automatically insert a polygon in the correct place for the Dtop (for Head), Dbottom (for Sill), Dright (for Right Jamb) and Dleft (for Left Jamb).

• Spacer Height: 0

In this case, it was easiest to set the spacer height to 0 and pull the sides of the glazing sysetm layers up to the frame on each side (make sure Options/Preferences/Drawing Options has "Allow Editing of IG Polygons" checked).



(which defines the sightline) so in this case the Sightline to shade edge value = 0.

Figure 19-52. Insert the glazing system with the Venetian blind

**Add Venetian Blind Hardware:** Add the head rail assembly of the venetian blind between the polygon representing Dtop and the polygon representing the Venetian blind.

Fill in the remaining cavities by linking them to the appropriate glazing system cavity.

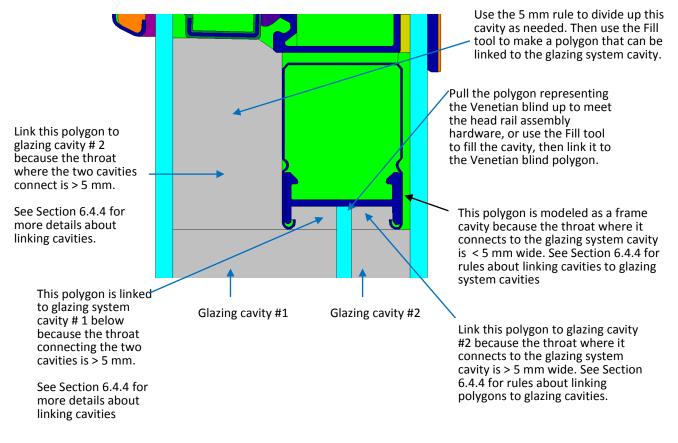
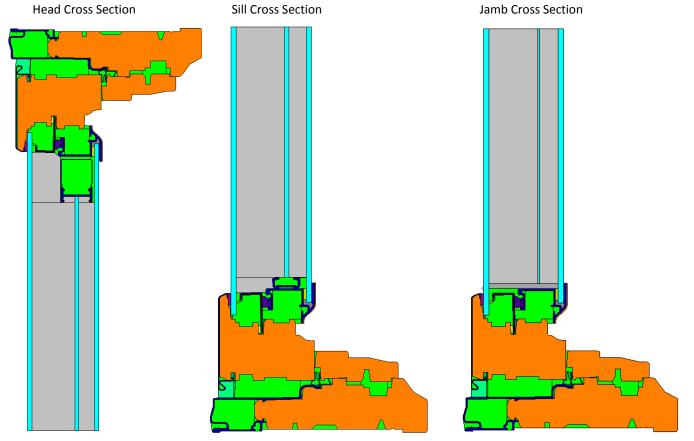


Figure 19-53. Fill the remaining cavities and link to the appropriate glazing system cavities.



Create the other cross sections in this manner.

Figure 19-54. Head and Sill cross sections for Closed Venetian Blind between glass layers (Integral)

Boundary Conditions: For Integral Venetian Blinds, set "Shading System Modifier" to "None"

Boundary Condit	tion Type	×
Boundary Condition U-Factor Surface	sample-jamb-IntegralVentianA-45:Sample GlzSys Integral Venetian A, 45 degree 💌	OK Cancel
Temperature	69.8 F Hc 0.50 Btu/h-ft2-F	Boundary Condition Library
Radiation Model	AutoEnclosure	U-Factor Surface
Emissivity	0.840	Library
Shading system	n modifier None 👻	
	Blocking Surface	
Default Bounda	ary Condition sample-jamb-Integral/VentianA-45:Sample GlzSys Integral Venetian A	

Figure 19-55. For Integral Venetian blinds, set the Shading System Modifier to "None".

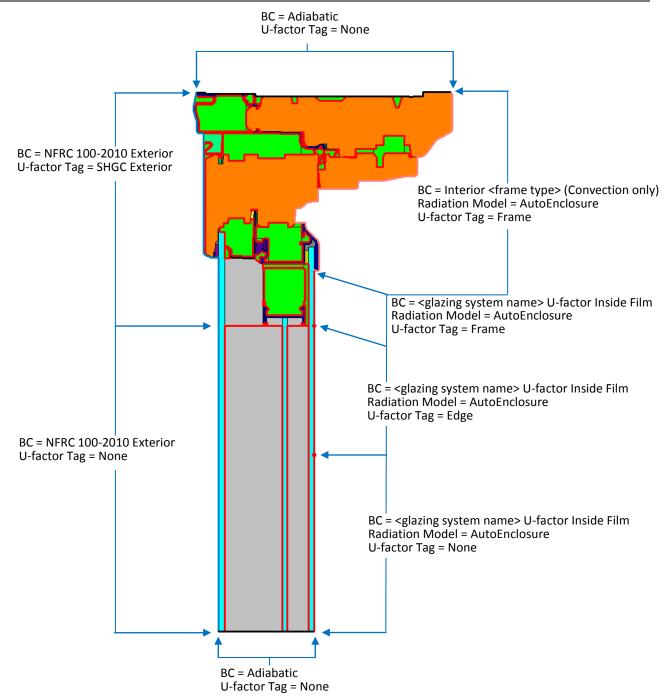


Figure 19-56. Define the boundary conditions for Head Non-Retractable Closed Venetian Blind section

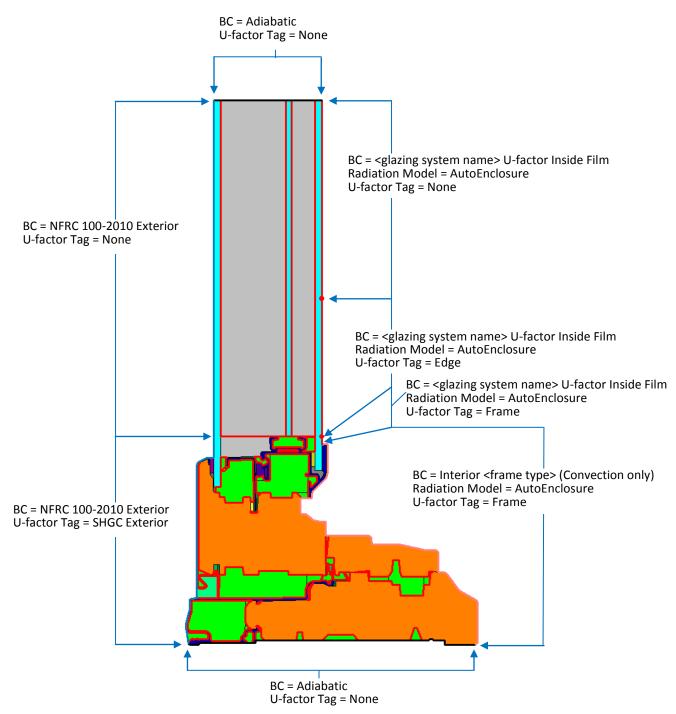


Figure 19-57. Define the boundary conditions for Sill Non-Retractable Closed Venetian Blind section

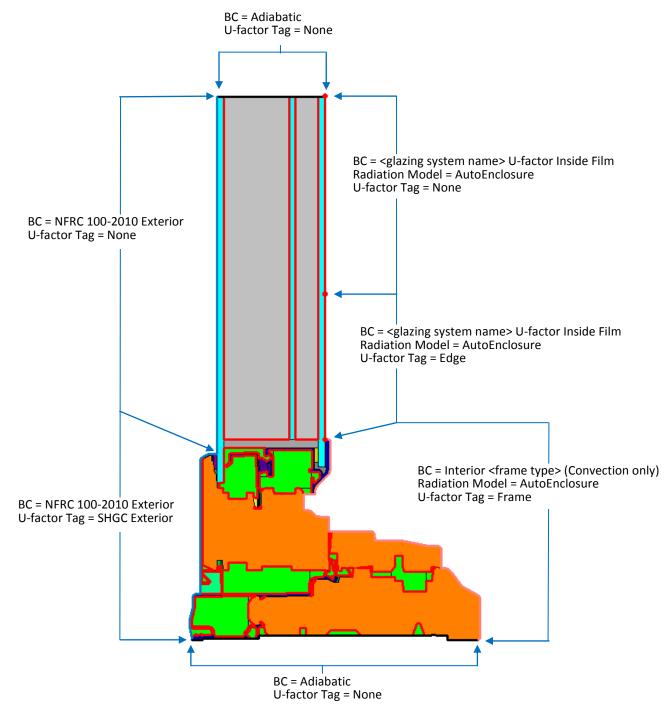


Figure 19-58. Define the boundary conditions for Jamb Non-Retractable Closed Venetian Blind section

Simulate each cross section and save the results

# In WINDOW:

File Edit Librarie	s Re	ecord	Tools View Help												
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Detailed View	Frame	Library	(C:\Users\Public\LBNL\WINDOW7	7\w7.mdb)									Â		
Update	ID INVALUE Uvalue Uvalue Correlation Thickness Tid Abs Color														
New						W/m2-K	W/m2-K		mm	mm					
		1	Al w/break	ASHRAE	N/A	5.680	N/A	Class1	N/A	57.2	0.90				
<u>C</u> opy		2	Al flush	ASHRAE	N/A	3.970	N/A	Class1	N/A	57.2	0.90				
Delete		3	Wood	ASHRAE	N/A	2.270	N/A	Class1	N/A	69.8	0.90		Ξ		
Find		4	Vinyl	ASHRAE	N/A	1.700	N/A	Class1	N/A	69.8	0.90				
[ID		5	sample-head.THM	Therm	Head	2.007	2.350	N/A	26.5	42.9	0.30				
		6	sample-jamb.THM	Therm	Jamb	1.995	2.343	N/A	26.5	42.9	0.30				
		7	sample-sill.THM	Therm	Sill	2.001	2.344	N/A	26.5	42.9	0.30				
Advanced		9	VenetianFixedOpen-Jamb.THM	Therm	Jamb	2.766	2.143	N/A	46.9	87.6	0.30				
13 records found.		10	VenetianFixedOpen-Sill.THM	Therm	Sill	2.991	2.138	N/A	46.9	90.8	0.30				
		11	VenetianFixedOpen-Head.THM	Therm	Head	2.850	2.012	N/A	46.9	114.8	0.30				
	•	12	VenetianClosed-Head.THM	Therm	Head	2.780	1.700	NZA	47.1	114.8	0.30				
Export		13	VenetianClosedJamb.THM	Therm	Jamb	2.661	1.809	N/A	47.1	87.6	0.30				
Rep <u>o</u> rt		14	VenetianClosed-Sill.THM	Therm	Sill	2.732	1.852	N/A	47.1	87.6	0.30				
<u>Print</u>	•				111							Þ	Ŧ		

1. Frame Library: Import the THERM files into the Frame Library

Figure 19-59. Import the THERM files into the WINDOW Frame Library

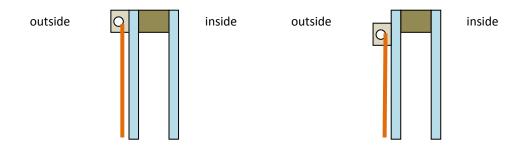
2. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library and calculate the results.

File Edit Librarie	ries Record Tools View Help	
🗅 🚅 🔲   👗 🖻	🗈 🛍   🍜   🎟 📑 🙌 🔺 🕨 🕅 🎛 💻 🌒 🖩 👫 🗖 🗮 🦉 👘	
List Calc (F9) New Copy Delete Save Report Dividers Dividers	ID # 4 Name Fixed Closed VB Mode NFRC Type Fixed (picture) Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 90 Environmental Conditions NFRC 100-2010	
Display mode: Normal	Total Window Results Click on a component to display characteristics	below
CR Detail	V1         0.541         Source         2         Edge area         0.0           CR         N/A         Ufactor         2.732         W/m2-K         PFD         87.9	▼ >> 352 W/m2-K 361 m2 397 300

Figure 19-60. Define the window.

# 19.4 Woven Shades: Outdoor

Outdoor woven shades fall into the category of a dynamic glazing product and can be modeled in both their fully open and fully closed positions in order to fully evaluate their performance. In the case of modeling retractable outdoor woven shades as part of a dynamic glazing product, the fully open position would be the state when the woven shade is completely retracted.



*Figure 19-61. Outdoor woven shade is located on the outside of the glazing system. The location of the shading system housing may or may not affect the sight line of the frame.* 

The following cases must be modeled for each outdoor woven shade configuration:

- **OPEN** Woven shade in it's most transmitting state
- CLOSED Woven shade in it's least transmitting state

### 19.4.1. Open Woven Shade

There is one scenario for Open woven shades:

• **Retractable / Open:** Woven Shades that retracts up into an enclosure on the exterior of the frame.

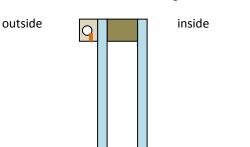


Figure 19-62. Retractable / Open Woven Shade

For **Retractable / Open** woven shades, one example will be illustrated:

• A woven shade fully retracted with a double glazed system.

# 19.4.1.1. Fully Retracted / Open Woven Shade With a Double Glazed System

The following section discusses how to model a fully retracted woven shade that has a housing at the top of the woven shade that holds the rolled up shading material on a roller. Figure 19-64 shows the Head cross section for a woven shade in the fully-retracted position with a double-glazed system.

In this example, only the Head section will be shown. All other cross sections (Jambs, Sills and Meeting Stiles) are modeled normally, without any woven shade considerations.

# In WINDOW:

1. **Glazing System Library:** Create the appropriate glazing system in the Glazing System Library. In this case, it is not necessary to model a woven shade in WINDOW, because the shade is fully retracted.

### In THERM

- 2. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
- 3. **Glazing System:** Import the glazing system defined in WINDOW (no woven shade modeling needed) into the frame geometry. Make sure that the Sight line to bottom of glass value includes the height of the block representing the closed woven shade, so that the Frame and Edge of Glass boundary conditions and U-factor tags are defined automatically by THERM.
- 4. **Boundary Conditions:** Define the Boundary Conditions in the normal manner; no woven shade was modeled in WINDOW, so the Boundary Conditions in THERM do not need to be modified for a Shading System

# Detailed Modeling Steps:

The following steps explain in detail how to create the Outdoor Woven Shade model.

### In WINDOW:

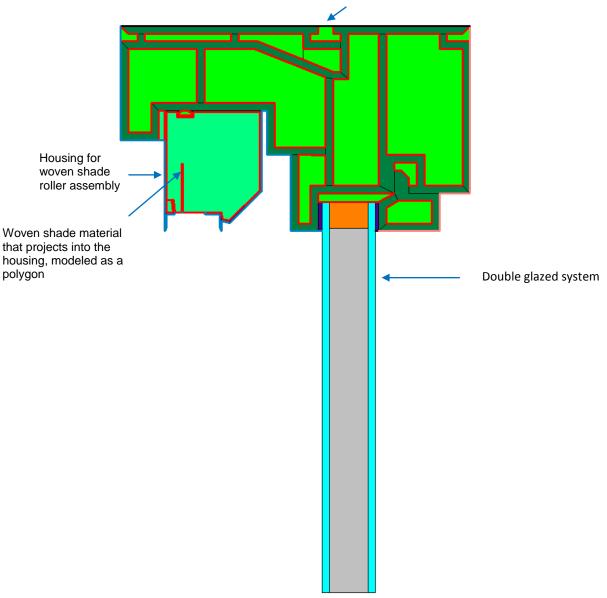
1. **Glazing System Library:** Define the glazing system and add the outdoor woven shade defined in the Shading Layer Library, in this example record 19, "Woven shade Gray, 25% open area" from the CGDB.

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List																
	ID #: 64		me: Double Low-E - Exterior Woven S	hade												
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Save	Overall thickness: 82	370 m	m Mode: # 📃 Model D	eflectior	n	1			2	3						
Report																
R <u>a</u> diance																
		ID	Name	Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond
	▼ Shade 1	▶ 19	Woven shade. Gray. 25% open area		2.0											
	Gap 1	▶ 1	Air		58.2											
	▼ Glass 2	▶ 2001	Clr-3.CIG	#	3.0		0.848	0.076	0.076	0.904	0.082	0.082	0.000	0.840	0.840	1.000
	Gap 2		Air (5%) / Argon (95%) Mix		16.2											
	▼ Glass 3	▶ 2154	LoE366-3.CIG	#	3.0	×	0.275	0.549	0.429	0.713	0.044	0.066	0.000	0.022	0.840	1.000
	•															•
	*Layer #1 do not hav															
	Center of Glass Resu	ts Temper	ature Data Optical Data Angular D	ata Co	olor Prop	pertie	s Radi	ance Re:	sults							
	Ufactor	SC	SHGC Rel. Ht. G	ain	Τv	/is		Keff		Layer 1	Keff	Gap	1 Keff	Lav	yer 2 Kel	if 🔤
	W/m2-K		W/m2					W/m-K		W/n		· ·	/m-K		w/m-K	
	1.053	0.150	0.131 102		0.1	69		0.1056	;	0.26	15	0.2	2896	-	1.0000	

*Figure 19-63. Construct the glazing system, adding the shading system as Layer 1, which is the outermost layer.* 

# In THERM:

- 2. Draw the Head cross section of the product frame. In this example, only the Head cross section needs to be drawn for the "Open" case, because the jambs and sill are the same as if there was not a shading system.
- 3. Draw the geometry of the housing for the woven shade, and the rolled up woven shade itself inside the housing if applicable. Model the hardware inside the housing according to the guidelines in the Shading System Modeling Overview section earlier in this manual.
- 4. Insert the glazing system.



Use the proper modeling technique where the frame meets the surround panel, ie, model this void as an air cavity

Figure 19-64. Head cross section with fully retracted woven shade with a double-glazed system.

5. Generate the Boundary Conditions.

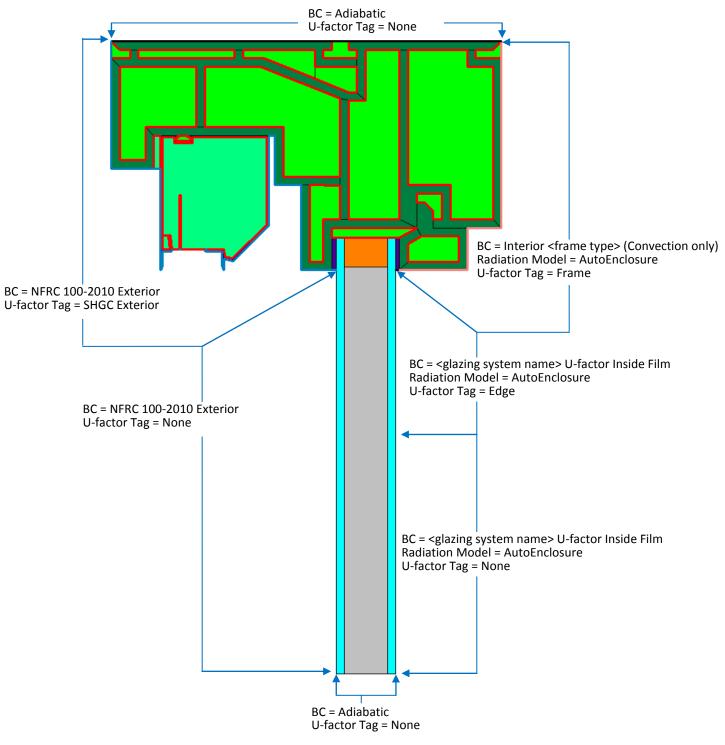


Figure 19-65 Define the boundary conditions for the cross section

- 6. Calculate the results for this cross section.
- 7. Complete the calculations for the other product cross sections (Sill, Jambs and Meeting Rails / Stiles as appropriate).
- 8. Import all the cross sections into the WINDOW Frame Library

Calculate the total product U-value, SHGC and VT in the Window Library.

# 19.4.2. Closed Exterior Woven Shade

According to NFRC 100 and 200, dynamic glazing products must be rated in both their fully open and fully closed positions. This section describes modeling an Exterior Woven Shade in the closed position.

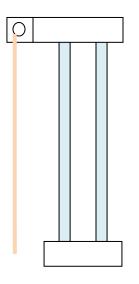


Figure 19-66. A closed Exterior Woven Shade.

# In WINDOW:

- 1. **Shade Material Library:** Make sure that the appropriate material is in the Shade Material Library. If it is not, contact the manufacturer to submit data to the CGDB. For this example, we are using the generic woven shade material called "Generic Woven Shade Material".
- 2. **Shading Layer Library:** Reference the "Generic Woven Shade" material and define the Woven Shade thread geometry in the Shading Layer Library
- 3. **Glazing System Library:** Define the glazing system with the closed woven shade on the exterior side of the glazing system.

# In THERM:

- 4. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate
- 5. Glazing System: Import the glazing system defined with the woven shade into the frame geometry
- 6. **Boundary Conditions:** For Exterior Woven Shades, set "Shading System Modifier" to "Exterior (Glazing System ID: <nn>)"
- 7. Simulate the model, save the results

# In WINDOW:

- 8. **Frame Library:** Import the THERM files into the Frame Library
- 9. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library

These steps are illustrated in more detail in the following discussion.

### In WINDOW:

- 1. **Glazing System Library:** Define the glazing system with the appropriate woven shade layer on the outside of the glazing system. See Shading System Overview section for detailed instructions for adding shading systems to glazing systems.
- 2. Set **Dtop**, **Dbot**, **Dright**, **Dleft** to the appropriate values for the woven shade.

### In THERM:

1. **Frame Geometry:** Draw the frame geometry, including Head, Sill, Jamb and Meeting Rail if appropriate. In this example, the hardware for the woven shade is only drawn for the Head cross section. The hardware on the bottom of the shade for the Sill is part of the shade layer and is not drawn.

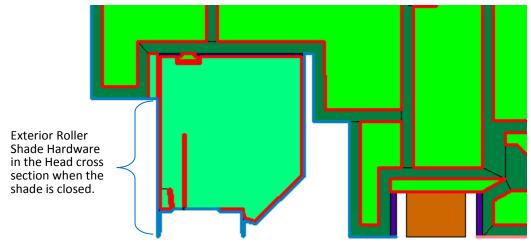
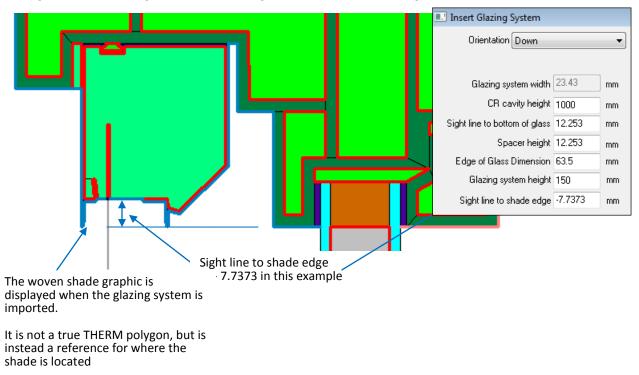


Figure 19-67. Draw the frame with the exterior woven shade continuous hardware, in this case for the Head cross section.

2. **Glazing System:** Import the glazing system defined with the woven shade into the frame geometry. The important input value for shading layers is the "Sight line to shade edge" value. In the Head cross section example below, the edge of the shade (at the bottom of the hardware) starts above the sight line, so the "Sight line to shade edge" value in this case is negative.



*Figure 19-68. Insert the glazing system with the Exterior Roller Shade into the Head cross section.* 

For the Sill and Jamb cross sections in this example, the woven shade extends below the sight line of the frame, so the "Slight line to shade edge" value is actually negative.

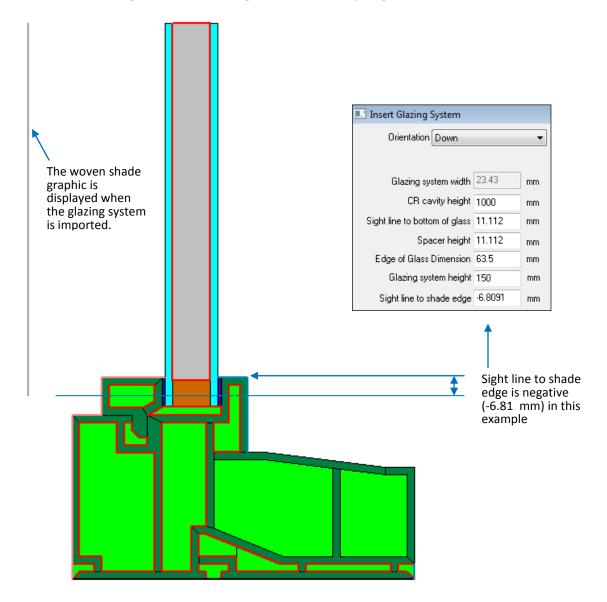


Figure 19-69. Insert the glazing system with the Exterior Roller Shade into the Sill and Jamb cross sections.



Figure 19-70. Head, Sill and Jamb cross sections for Closed Roller Shade on the exteropr of a glazing system

3. **Boundary Conditions:** For Outdoor Woven Shades, set "Shading System Modifier" to "Exterior (Glazing System ID: <nn>)" for the exterior boundary condition (NFRC 100-2010 Exterior) where the shade projects onto either the glazing system or the frame.

Boundary Condit	tion Type	×
Boundary Condition U-Factor Surface	NFRC 100-2010 Exterior	
Temperature	-18.0 C Hc 2.48 W/m2-K	Boundary Condition Library
Radiation Model	Blackbody	U-Factor Surface
Emissivity	0.789	Library
Shading system	n modifier Exterior (Glazing System ID:31)	
Default Bounda	ary Condition Head-Ext Shade-PV-NoRoller-RM:NFRC 100-2010 Exterior	

*Figure 19-71. For Outdoor Woven Shades, set the Shading System Modifier to "Exterior (Glazing System ID: <nn>)" where appropriate on the glazing system and frame.* 

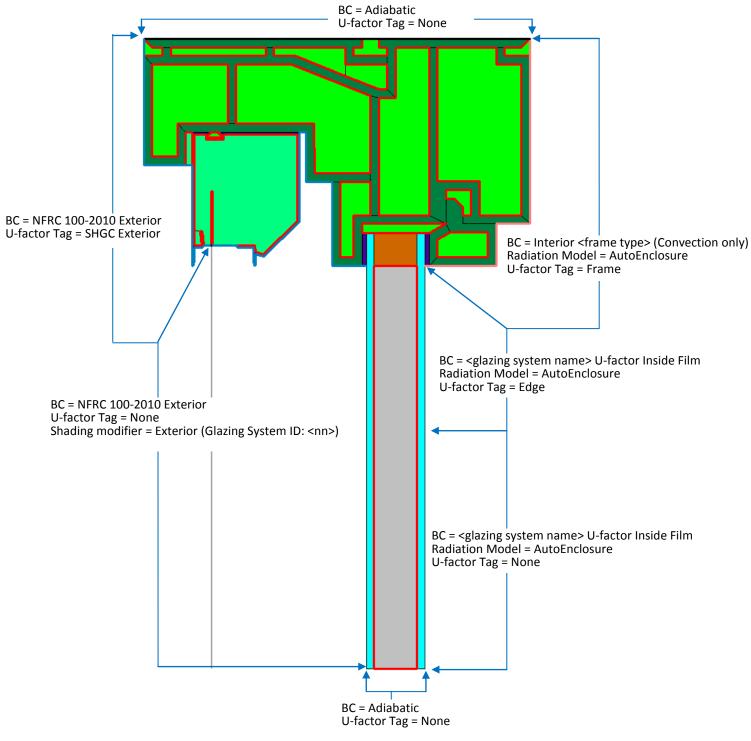


Figure 19-72. Define the boundary conditions for the Head cross section

19-72

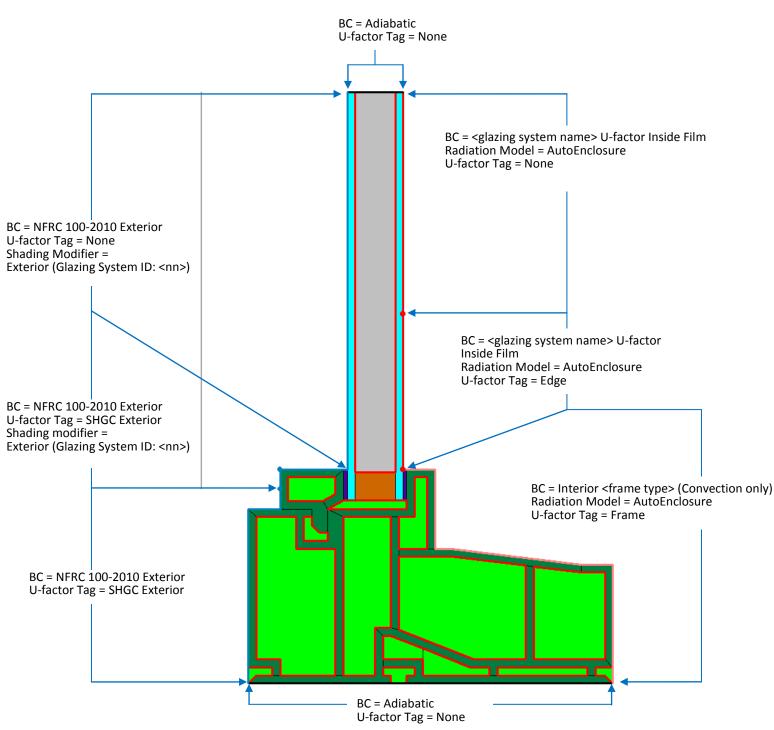


Figure 19-73. Define the boundary conditions for the Jamb and Sill cross section.

4. Simulate each cross section and save the results

# In WINDOW:

5. **Frame Library:** Import the THERM files into the Frame Library

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Update		ID	Name	Source	Туре	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs	Color	*
New						W/m2-K	W/m2-K		mm	mm			
- Comment		11	VenetianClosed-Jamb.THM	Therm	Jamb	2.641	1.735	N/A	47.1	87.6	0.30		
Copy		12	VenetianClosed-Sill.THM	Therm	Sill	2.662	1.744	N/A	47.1	87.6	0.30		
Delete		13	sample-head-VBInterior-FixedOpen.THM	Therm	Head	2.186	2.005	N/A	26.5	55.5	0.30		
Find		14	sample-Jamb-VBInterior-FixedOpen.THM	Therm	Jamb	2.118	2.146	N/A	26.5	42.9	0.30		
ID 🔻		15	sample-Sill-VBInterior-FixedOpen.THM	Therm	Head	2.167	2.068	N/A	26.5	42.9	0.30		
		16	sample-Head-VBInterior-Closed.THM	Therm	Head	2.200	1.879	N/A	26.5	55.5	0.30		
		17	sample-Jamb-VBInterior-Closed.THM	Therm	Jamb	2.188	2.023	N/A	26.5	42.9	0.30		
Advanced		18	sample-Sill-VBInterior-Closed.THM	Therm	Sill	2.197	2.015	N/A	26.5	42.9	0.30		
22 records found.	•	19	sample-Head-ShadeExterior-Closed.THM	Therm	Head	1.966	1.583	N/A	26.5	79.4	0.30		=
		20	sample-Jamb-ShadeExterior-Closed.THM	Therm	Head	1.706	1.866	N/A	26.5	42.9	0.30		
Impor		21	sample-Sill-ShadeExterior-Closed.THM	Therm	Head	1.719	1.878	N/A	26.5	42.9	0.30		
E <u>x</u> port		22	sample-Head-ShadeExterior-Open.THM	Therm	Head	2.005	2.367	N/A	26.5	42.9	0.30		
Rep <u>o</u> rt		23	sample-Jamb-ShadeExterior-Open.THM	Therm	Jamb	1.984	2.363	N/A	26.5	42.9	0.30		
<u>Print</u>		24	sample-Sill-ShadeExterior-Open.THM	Therm	Sill	1.992	2.364	N/A	26.5	42.9	0.30		-

Figure 19-74. Import the THERM files into the WINDOW Frame Library

6. **Window Library:** Construct the window using the THERM files in the Frame Library and the glazing system defined in Glazing System Library and calculate the results.

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Display mode: Normal V SHGC/VT Detail CR Detail	Total Window Results U-factor 1.500 SHGC 0.195 VT 0.173 CR N/A	W/m2-K	Click ( Glazing Sy Name ID Nlayers Area Edge area	vstem		osed 🔻	≫ W/m2-K

Figure 19-75. Define the window.

# **19.5. Insulating Shade Layers with Non-Standard Geometry**

THERM can be used to define the geometry and material properties for shading systems that are not otherwise easily characterized in WINDOW. This modeling method can be applied to:

- Cellular Shades
- Pleated Shades
- Roller Shutters
- Window Quilts
- Other shades with a complicated or mult-component geometry

This section will deal explicitly with how to model cellular shades and roller shutters. However, the methodology presented here can be used for other shading systems as well.

The modeling steps are as follows:

- In WINDOW:
  - Define the materials used for the shading layer in the Shade Material Library by either adding it directly or importing a record from the CGDB or the Optics User Database.
    - The optical properties of materials used to define the outer surfaces of the THERM model should be measured in a spectrophotometer, even if they are opaque, in order for Radiance to model the correct reflectance of the surface based on the geometry
- In THERM
  - Import the materials from the WINDOW Shade Material Library
  - In Radiance Mode, draw the geometry of the shading layer in THERM
  - Assign the materials defined in WINDOW to the geometry drawn in THERM
  - Assign special boundary conditions, including both the "front" and the "back" of each material
    - Assign the outside boundary conditions as Illuminated Surfaces
- In WINDOW:
  - Define the Shading System in the WINDOW Shading System Library, set the Type to "Therm File", and reference the THERM file in the BSDF file input box.
  - Calculate the Shading System and then use it in a glazing system and whole window.
    - THERM will run Radiance in the background to generate a "genBSDF" XML file with optical properties based on the materials and geometry of the THERM file

#### 19.5.1. WINDOW: Define Shade Layer Library Materials

The materials that will be used for the shading layer drawn in THERM are first defined in WINDOW, and then referenced from THERM.

The Shading Layer Materials that can be defined in WINDOW to be used to model the shading layer in THERM can be transmitting or opaque, and spectral or non-spectral.

These materials must be added to the WINDOW Shade Material Library, so that they can then be imported into the THERM Material library and used in the shading layer THERM model.

Records can be added to the WINDOW Shade Material Library either by directly making a new record in the library and entering the average spectral data values "by hand", or by importing a record from the CGDB or the Optics User Database (data measured in a spectrophotometer can be imported into Optics and then imported into the WINDOW Shade Material Library). See the WINDOW User Manual section on the Shade Material Library for details about adding records to that library.

Either approach results in records in the WINDOW Shade Material Library that can be assigned to the polygons in THERM that represent, for example, the cell walls in a cellular shade.

ID	Name	ProductName	Manufacturer	Source
31033	C23_innerwalls.txt	C23 White/Alumium back	Hunter Douglas	CGDB
31034	C22-951_innerwalls.txt	C22-951 Inner wall	Hunter Douglas	CGDB
31035	C22-951_outerwalls.txt	C22-951 Outer wall	Hunter Douglas	CGDB
31036	C22-951_glueline.txt	C22-951 Glue line	Hunter Douglas	CGDB
31037	C82_TransparentPlastic.txt	C82 Transparent plastic	Hunter Douglas	CGDB
31038	D2_WhiteWallMaterial.txt	D2 White wall	Hunter Douglas	CGDB
31039	D7_WhiteOnSilverBack.txt	D7 White on Silver back	Hunter Douglas	CGDB
31040	D8_WhiteSheer.txt	D8 - White sheer	Hunter Douglas	CGDB

Figure 19-76. The example materials above in the WINDOW Shade Material Library are used to define cellular shade surfaces in THERM

# **19.5.2. THERM: Therm Preference Settings**

In THERM, in the **Options** menu, **Preferences** tab, set the following options:

- Automatic XML Export on Save = Checked
  - This will cause THERM to automatically write out the <filename>.thmx XML format file, which WINDOW will use for the Radiance simulation to calculate the optical properties based on the THERM model.

Computer > OS (C:)	► Users ► Public	► LBI	NL > THERM7.7 >	Samples
Include in library 🔻	Share with 🔻	Burn	New folder	
Name			Date modified	Size
sample-sill.THM			1/11/2019 6:10 PM	216 KB
🖷 sample-sill.thmx			1/11/2019 6:10 PM	47 KB

Figure 19-77. THERM automatically creates the <filename>.thmx file when "Automaticl XML Export on Save" is checked in the Preferences tab

- Radiance Mode = Checked
  - o The THERM file background color is gray when Radiance mode is checked.
  - Radiance mode must be unchecked for standard THERM calculations, so make sure to uncheck when not modeling non-standard geometry insulating shade layers such as cellular shades, pleated shades or roller shutters.

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Them File Options Snap Settings Preferences Drawing Options	Updates Simulation
<ul> <li>Save program settings on exit</li> <li>Prompt for saving libraries on program exit</li> <li>Automatic WINDOW 4 Export on Save</li> <li>Automatic XML Export on Save</li> <li>Auto Recover every 5minutes</li> <li>Automatically display results after simulation</li> <li>Ask before automatically adjusting points</li> <li>Unit System</li> <li>Inch-Pounds</li> <li>SI</li> </ul>	
Conductivity Units  Conductivity Units  Btu/hrft-F  Btu-in/hrft2-F  Default vertical jamb cavity height 39.3701 inches  Allow editing of Frame Cavity heat flow and temperatures	
<ul> <li>Windows 95</li> <li>✓ Radiance Mode</li> <li>Results Display</li> <li>☐ Display R-Values instead of U-Factors</li> <li>☐ Heat Row</li> <li>☐ Heat Rux</li> </ul>	
Simulation directory: C:\Users\Public\LBNL\THERM7.3\Sim Use Therm 6 file format	
OK Cancel	Apply

Figure 19-78. THERM Options / Preferences

# 19.5.3. THERM: Add the WINDOW Shade Materials to the THERM Material Library

Once the appropriate materials have been defined in the WINDOW Shade Material Library, they need to be added to the THERM Material Library.

From the **Library** menu in THERM, select the **Material Library** option, which will open the **Material Definition** dialog box.

Libr	aries	Options	Calculation	Window	Η
	Set N	laterial		F4	
	Set B	oundary C	F5		
	Mate	Shift+F4			
	Boun	idary Cond	ition Library	Shift+F5	
	Gas L	ibrary			

Figure 19-79. In THERM, select the Libraries / Material Library option to add the WINDOW Shade Materials to the THERM Material Library

In the **Material Definitions** dialog box, click the **Load Shade Material** button to add a Shade Material record from WINDOW to be used to define the material properties in THERM.

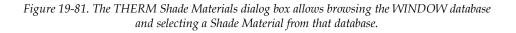
Material Definitions	<b>—</b> ×	
material.lib		
Silicone  Material Type Solid Frame Cavity Glazing Cavity	Close Cancel New Delete	
External Radiation Enclosure     Shading Material     Solid Properties     Conductivity 0.35     W/m-K     Emissivity 0.9     Edit Shade Material	Rename Color Save Lib As Load Lib	When THERM is in Radiance
Cavity Properties Radiation Model Cavity Model Gas Fill	Load Shade Material	mode, the Load Shade Materia button will be displayed in the Material Library
✓ Protected		

Figure 19-80. Click on the Load Shade Material button to add a

WINDOW Shade Material to the THERM Material Library (make sure THERM is in "Radiance" mode)

The THERM Shade Materials dialog box will appear. The WINDOW Database section allows browsing to the appropriate WINDOW database file where the shade materials have been defined. The Shade Material pulldown list will show all the records in the WINDOW Shade Material Library. The optical and thermal properties from the WINDOW Shade Material will be displayed below the Shade Material pulldown list.

					Use the Brow to select the appropriate	
Shade Materials					database wit	h the
	WINDOW Data	base			materials de	
C: \Users \Public \LBNL \WIN	IDOW7.7\W7.mdb			d material have spec pectral data are ed.	tral the Shade M Library	aterials
ID Name					The Shade N	
Shade Material 31033 C23_i	innerwalls.txt		•		pulldown lis all the recor	
					in the WIND	
		Solar	רי	/isible	Material Lib	rary.
	Beam	Diffuse	Beam	Diffuse	Select the a	ppropriate
Transmittance, front:	0.0000	0.0000	0.0000	0.0000	material for wall.	
Transmittance, back:	0.0000	0.0000	0.0000	0.0000		
Reflectance, front:	0.0000	0.8276	0.0000	0.8160	The optical	
Reflectance, back:	0.0000	0.8681	0.0000	0.8507	thermal pro displayed an WINDOW S	e from the
Emissivity, front: Emissivity, back: Material Definitions material.lib C23_innerwalls.txt Material Type Solid Frame Cavity Glazing Cavity External Radiation Enclo Shading Material Solid Properties Conductivity 0.12 Emissivity 0.784 Edit Shar Cavity Properties Radiation Model Cavity Model	0.7840 0.0400 Dosure W/m-K de Material	Close Cancel New Delete Rename Color Save Lib As Load Lib Load Shade Material	IR Transmittance: Conductivity: Click OK when t desired Shade N is defined, and material will no added to the TH Mateiral Library	Material this w be HERM	cel	
Gas Fill						



### 19.5.4. THERM: Define Shade Geometry Component in THERM

The next step is to define the geometry of the shade layer in THERM. If there are repeating components in the shading system, create one component and make sure that it will calculate before making a series of components.

The sections following this general discussion contain examples for cellular shades and roller shutters provide the details for creating these models.

#### 19.5.5. THERM: Generate Boundary conditions

Generate the boundary conditions for the model

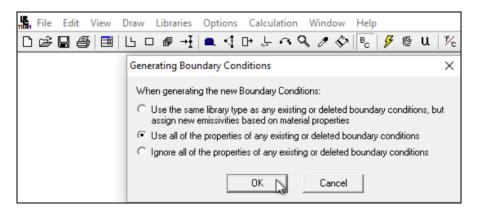


Figure 19-82. Generate the Boundary Conditions

For THERM models that will be imported into WINDOW for modeling shading systems, there are special rules for the boundary condition definitions.

The emissivity associated with a boundary condition is static to the material that was present when creating the boundary condition. If a material is changed after the boundary condition is created then the incorrect emissivity is displayed and the boundary conditions should be refreshed.

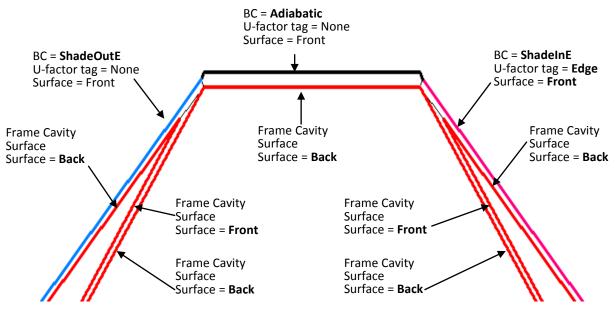


Figure 19-83. Setting the Boundary Conditions

# 19.5.6. THERM: Calculate the Model for Error Checking

Calculate the model before progressing to ensure there are no errors, such as voids in the mesh. If changes are required, ensure all polygon and boundary conditions are re-linked to shade materials.

### 19.5.7. THERM: Create an array of shade components as needed

Depending on the shading system being modeled, it may be necessary to draw multiple sets of the basic shading component.

For example, for cellular shades, a single cell is drawn and simulated, and once that model is found to be error-free, a series of 10 of those cells are drawn, stacked on top of each other.

When modeling roller shutters, only three of the main shutter components are needed in the model.

Determining the number of components needed for the complete THERM model will depend on the shading layer being modeled.

### 19.5.8. WINDOW: Create the Shading Layer

When the shading system model has been created in THERM, with the array of needed components, it is then used to define the shading layer in the WINDOW Shading Layer Library.

In WINDOW, go to the Shading Layer Library, and create a new record

Libr	aries	Record	Tools	View	Help	
Ħ	Wind	low			F2	
00	Glazi	ng System			F5	
	Glass				F3	
•	Gap	Gap				
	Fram	e			F7	
#	Divid	er			F8	
ŧ۶ <mark>,</mark>	Envir	onmental	Conditio	ons	F6	
	Shad	ing Layer			F11	
1	Shad	e Material			F12	

Figure 19-84. Select the Shading Layer Library

- Set Type to Therm File (\*.thmx)
- BSDF File: Browse to thmx file created in Term
- Click the Calculate button to calculate the BSDF file. NOTE: This calculation will take around 70 minutes.

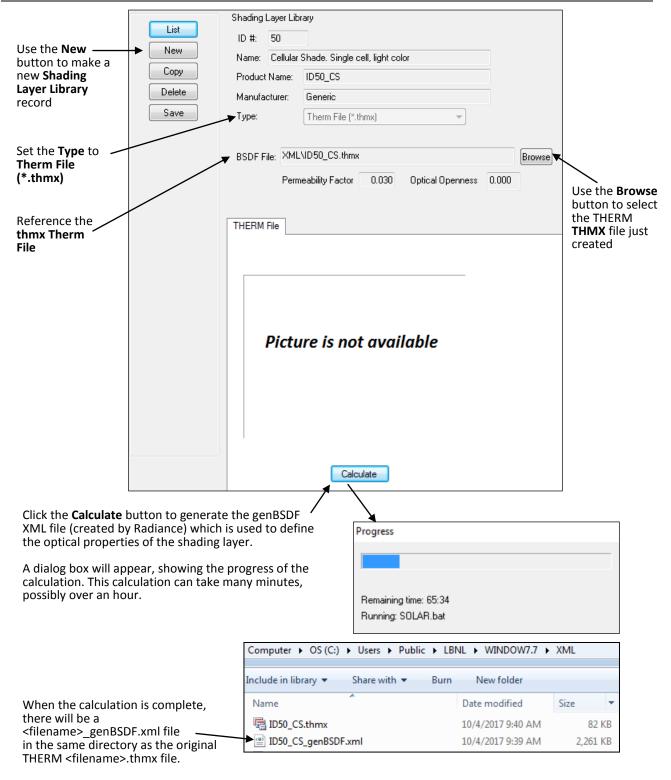
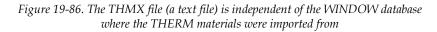


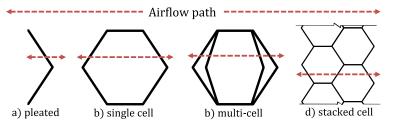
Figure 19-85. Create a new Shading Layer Library record, set the BSDF file to the THERM thmx file just created, then click the Calc button to create the genBSDF file.

The properties of the material from the WINDOW database are stored in the THMX file, meaning that once the file is saved, it is independent of any subsequent changes to the WINDOW database used to produce it. Therefore, if the properties of materials used in the WINDOW database change, the THMX file must also be regenerated in order to keep the properties up-to-date.

<pre>(Material Name="CS03:CS03_glueline.txt" Type="5" Conductivity="0.120000" Tir="0.000224" EmissivityFront="0.777410" EmissivityBack="0.781640" RGBColor="0x4951EB"&gt;</pre>
<property r="0.000000" range="Visible" side="Front" specularity="Direct" t="0.000000"></property>
<property r="0.711613" range="Visible" side="Front" specularity="Diffuse" t="0.269345"></property>
<property r="0.000000" range="Solar" side="Front" specularity="Direct" t="0.000000"></property>
<property r="0.686956" range="Solar" side="Front" specularity="Diffuse" t="0.267214"></property>
<property r="0.000000" range="Visible" side="Back" specularity="Direct" t="0.000000"></property>
<property r="0.689204" range="Visible" side="Back" specularity="Diffuse" t="0.269345"></property>
<property r="0.000000" range="Solar" side="Back" specularity="Direct" t="0.000000"></property>
<property r="0.665194" range="Solar" side="Back" specularity="Diffuse" t="0.267214"></property>



• Set the **Permeability Factor:** This is the airflow permeability for the material in the shading system. For single layer systems, such as pleated shades, the permeability factor of the single material is entered. For multiple layer systems, the shade material with the lowest permeability factor in the airflow critical path is used. The critical path for several systems is illustrated in the figure below.



*Figure 19-87. Airflow critical path through cellular shade sytems. The shade material with the lowest permeability factor in the airflow critical path determines the Permeability Factor.* 

 Set the Optical Openness: For perforated layers, where the perforations are independent of the material properties, an optical openness is entered. The optical openness is calculated using the methods described in XX.X Perforated Screens. (10/29/2018 RM – can we just say what it is here, ie, the ratio of open area to total area?)

### 19.5.9. WINDOW: Add the Shading Layer to a Glazing System

Now that the shading layer has been defined in the Shading Layer Library, it can be added to a glazing system in the Glazing System Library in the same manner as any Shading Layer.

## 19.6. Insulating Shade Layers with Non-Standard Geometry: Cellular Shades

The steps in this section describe modeling a cellular shade which has materials with non-zero transmittance (visible, solar, and/or infrared). This example is a cell-in-cell cellular shade.

#### 19.6.1. WINDOW: Define Shade Layer Materials

The cellular shade fabrics shown in the figure below were measured in a spectrophotometer, imported into Optics, and then imported into the WINDOW Shade Material Library.

ID	Name	ProductName	Manufacturer	Source
31033	C23_innerwalls.txt	C23 White/Alumium back	Hunter Douglas	CGDB
31034	C22-951_innerwalls.txt	C22-951 Inner wall	Hunter Douglas	CGDB
31035	C22-951_outerwalls.txt	C22-951 Outer wall	Hunter Douglas	CGDB
31036	C22-951_glueline.txt	C22-951 Glue line	Hunter Douglas	CGDB
31037	C82_TransparentPlastic.txt	C82 Transparent plastic	Hunter Douglas	CGDB
31038	D2_WhiteWallMaterial.txt	D2 White wall	Hunter Douglas	CGDB
31039	D7_WhiteOnSilverBack.txt	D7 White on Silver back	Hunter Douglas	CGDB
31040	D8_WhiteSheer.txt	D8 - White sheer	Hunter Douglas	CGDB

Figure 19-88. The example materials above in the WINDOW Shade Material Library are used to define cellular shade surfaces in THERM

#### **19.6.1. THERM: Therm Preference Settings**

In THERM, in the **Options** menu, **Preferences** tab, set the following options:

- Automatic XML Export on Save = Checked
- **Radiance Mode** = Checked

### 19.6.2. THERM: Add the WINDOW Shade Materials to the THERM Material Library

Import the WINDOW Shade Material Library records needed to define the cellular shade in THERM.

In the **Material Definitions** dialog box, click the **Load Shade Material** button to add a Shade Material record from WINDOW to be used to define the material properties in THERM. This button only appears if you have checked "Radiance Mode" in Options/Preferences.

When the materials from WINDOW have been imported, they will be available from the THERM pulldown list of materials when defining polygons for the THERM model.

Material Definitions	×	
material.lib		
Silicone	Close	
Material Type Solid Frame Cavity Glazing Cavity External Radiation Enclosure Shading Material Solid Properties Conductivity 0.35 W/m-K Emissivity 0.9 Edit Shade Material	Cancel New Delete Rename Color Save Lib As Load Lib	When THERM is in Radiance
Cavity Properties Radiation Model Cavity Model Gas Fill Protected	Load Shade Material	mode, the Load Shade Material button will be displayed in the Material Library

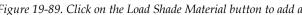


Figure 19-89. Click on the Load Shade Material button to add a WINDOW Shade Material to the THERM Material Library (this button only appears if "Radiance Mode"is checked)

					Use the Browse but to select the	
Shade Materials					appropriate WINDO	vv
	WINDOW Datab	Dase	/		materials defined in	
C:\Users\Public\LBNL\W	/INDOW7.7\W7.mdb	E		d material have spec bectral data are ed.	the Shade Materials Library	r.
ID Nam	ie				The Shade Materia	
Shade Material 31033 C2	3_innerwalls.txt		•		pulldown list will sl all the records defi	
					in the WINDOW Sh	
		Solar	) ( <b></b> '	/isible	Material Library.	
	Beam	Diffuse	Beam	Diffuse	Select the appropri	ate
Transmittance, front:	0.0000	0.0000	0.0000	0.0000	material for the cel	
Transmittance, back:	0.0000	0.0000	0.0000	0.0000		
Reflectance, front:	0.0000	0.8276	0.0000	0.8160	The optical and	
Reflectance, back:	0.0000	0.8681	0.0000	0.8507	thermal properties displayed are from WINDOW Shade	the
Emissivity, fron Emissivity, bac Material Definitions		X	IR Transmittance: Conductivity:	0.0000	Material Library	
material.lib				ОК Са	ancel	
C23_innerwalls.txt		✓ Close	Click OK when t	he		
Material Type			desired Shade N			
Solid		Cancel	is defined, and			
Frame Cavity		New	material will no added to the TH			
Glazing Cavity		Delete	Mateiral Library			
External Radiation Er	nclosure			,		
Shading Material		Rename				
Solid Properties		Color				
Conductivity 0.12	W/m-K	Save Lib As				
Emissivity 0.784		Load Lib				
	hade Material	Load				
Cavity Properties		Shade				
Radiation Model	-	Material				
Cavity Model						
Gas Fill	-					

Figure 19-90. Select the materials from the WINDOW database to be used to define the cellular shade fabric walls in THERM.

## 19.6.3. THERM: Define Shade Geometry

The next step is to define the geometry of the cellular shade in THERM.

### 19.6.4.1. Generate DXF File for Cell Geometry

In the CAD program of your choice, create the geometry of a single cell (repeating pattern), including the thickness for each cell wall, and save as a DXF file (\*.dxf). Center the cell at 0,0.

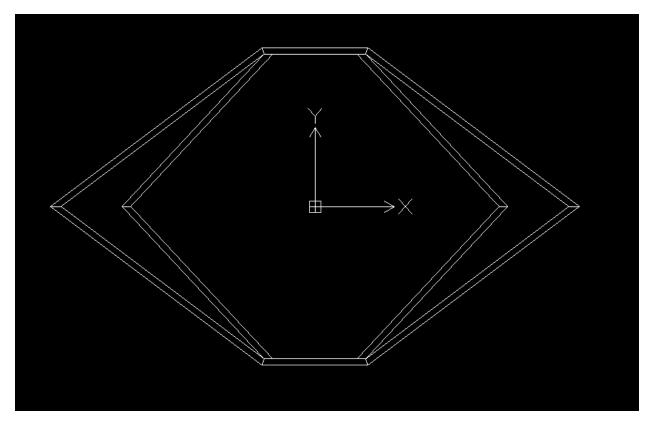


Figure 19-91. Draw the cell geometry in a CAD program and export as a DXF file.

#### 19.6.4.2. Import DXF as Underlay into THERM

Import the DXF as an underlay into THERM

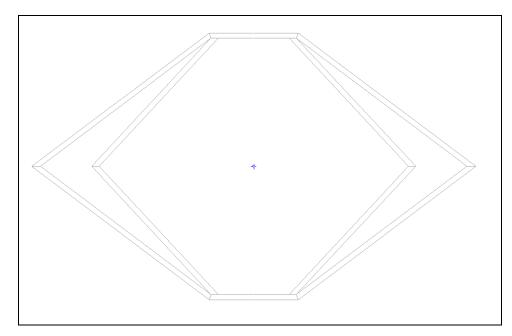
File	Edit	View	Draw	Libraries	Options	Calcula
С	New				Ctr	+N
	Open				Ctr	I+0 [
	Close					
	Save				Ct	rl+S
	Save /	As				
	Under	rlay	2			
	Export	t	45			
	Impo	rt				
	Prope	rties				

*Figure* 19-92. *Import the DXF file as an underlay.* 

From the Underlay dialog box, browse to the \*.dxf file and ensure that in the Scaling section, the units are match the \*.dxf correctly, i.e., SI (mm) or IP (inches).

Underlay	×
File C:\Users\roberthart\Desk	Browse Remove
Scaling Horizontal 100 % Vertic Units mm 💌	cal 100 %
AutoConvert	Set Color
Underlay Origin	DXF Filter
X: 0 units	ок N
Y: 0 units	Cancel

Figure 19-93. In the Underlay dialog box, make sure that Scaling has the correct setting for Units.



THERM will display the underlay as a light gray drawing

Figure 19-94. The underlay imported into THERM.

## 19.6.4.3. Create Polygons from the Underlay

Draw the polygons representing the walls of the cell(s) and specify the correct material for each polygon, from the materials created in WINDOW that are now available in the THERM Material Library.

Draw the polygons representing the walls of the cell(s), and select the appropriate material for the polygons, in this case the newly created material.

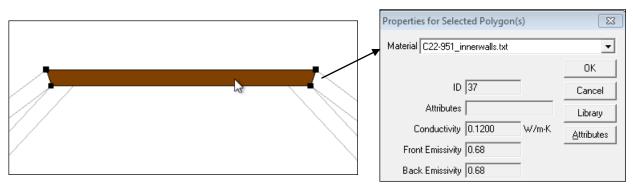


Figure 19-95. Draw the polygons, using the underlay

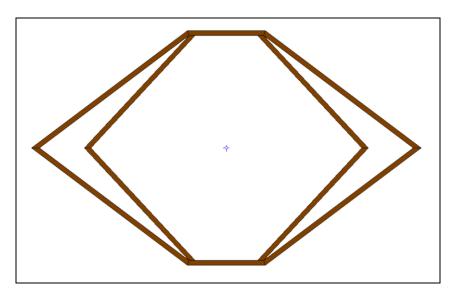
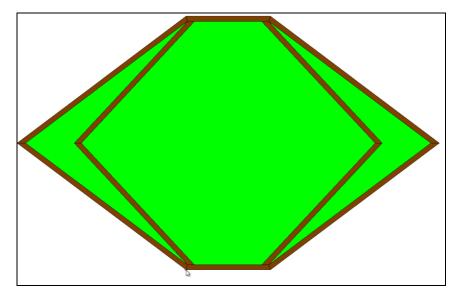


Figure 19-96. Draw all the polygons and assigne the materials as needed.



Create polygons for spaces between the cell walls and assign them to the "Frame cavity NFRC 100" material

Figure 19-97. Fill the spaces between the cell walls with Frame Cavity NFRC 100.

#### 19.6.4.4. Generate Boundary conditions

Generate the boundary conditions for the model

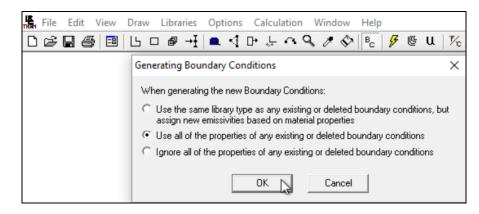
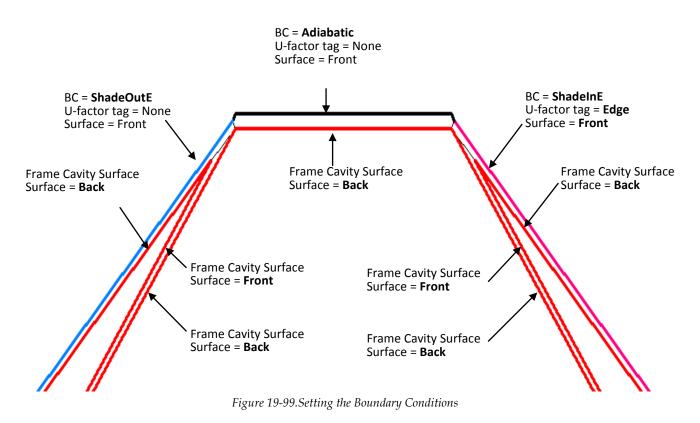


Figure 19-98. Generate the Boundary Conditions

The emissivity associated with a boundary condition is static to the material that was present when creating the boundary condition. If a material is changed after the boundary condition is created then the incorrect emissivity is displayed and the boundary conditions should be refreshed.



The boundary conditions should be set as follows:

There are two predefined boundary conditions for the interior and exterior boundary conditions of the cell geometry

• ShadeInE

Boundary Condi	tion Type		<b>—</b> X—
Boundary Condition	CellInCellExample:ShadeInE	•	OK
U-Factor Surface	Edge	•	Cancel
Temperature	20.7 C Hc 4.93 W/m2-K		Boundary Condition Library
Emissivity	0.720		U-Factor Surface Library
Shading syster	n modifier None	•	
⊙ Front ∩ Back ∏	Illuminated Surface		

Figure 19-100. ShadeInE Boundary Condition

• ShadeOutE

Boundary Condi	ition Type		<b>—</b> ×-
Boundary Condition	CellInCellExample:ShadeOutE	•	ОК
U-Factor Surface	None	•	Cancel
Temperature	1.7 C Hc 3.59 W/m2-K		Boundary Condition Library
Emissivity	0.720		U-Factor Surface Library
Shading system	n modifier None	•	
⊙ Front O Back □	Illuminated Surface		

Figure 19-101. ShadeOutE Boundary Condition

## 19.6.4.5. Calculate the Model for Error Checking

Calculate the model before progressing to ensure there are no errors. If changes are required, ensure all polygon and boundary conditions are re-linked to shade materials

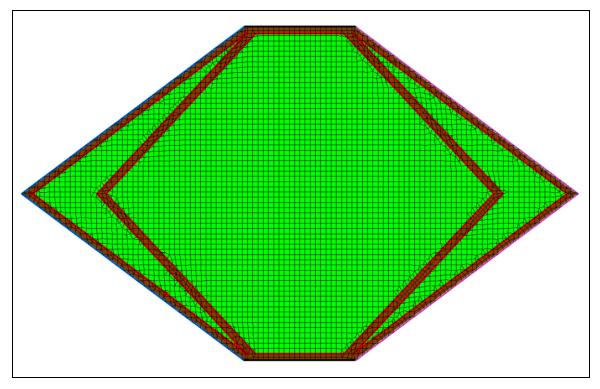


Figure 19-102. Calculate the model to make sure there are no meshing errors

### 19.6.4.6. Create an array of cells

To finish the model, create an array of cells with 5 cells above and 5 cells below the center cell

See the THERM User Manual for detailed instructions about how to copy and paste polygons within the same file or between different files.

Leave boundary conditions visible to ensure the boundary condition settings are copied along with the polygons.

• Set locator to reference point

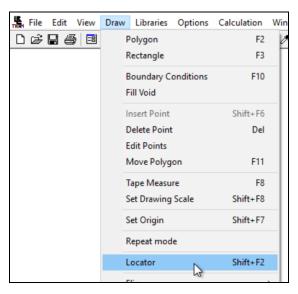


Figure 19-103. Select the Draw/Locator menu option to set the locator

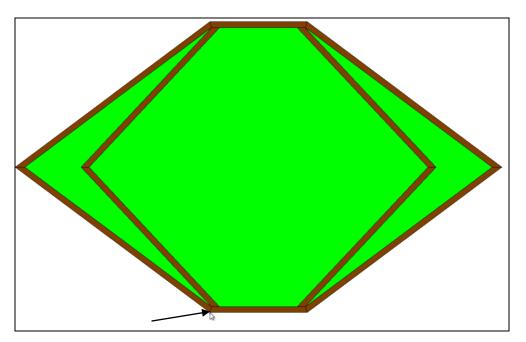
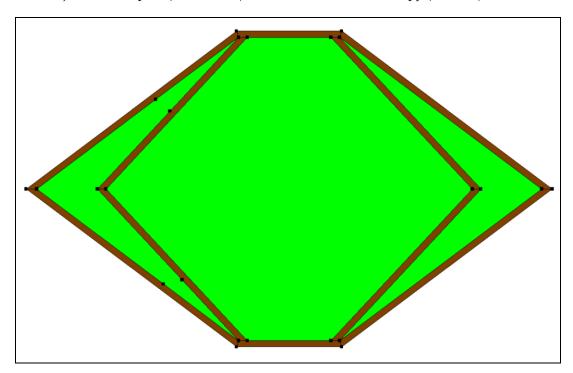


Figure 19-104. Set the locator in the lower left corner of the model



• Select objects to be copied (shift + click) until all are selected and copy (Ctrl + C)

Figure 19-105. Select the objects to be copied

• Set locator to destination point

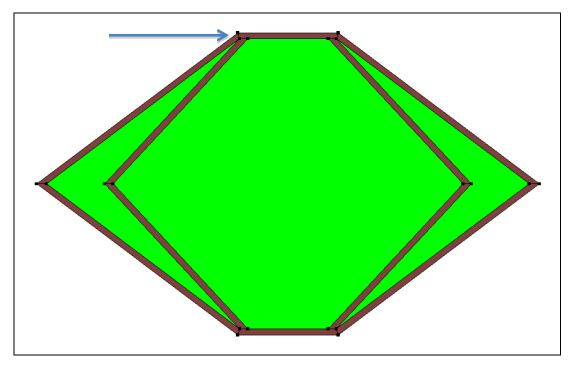


Figure 19-106.Set the locator to the destination point.

• Past the copied geometry (Ctrl + V)

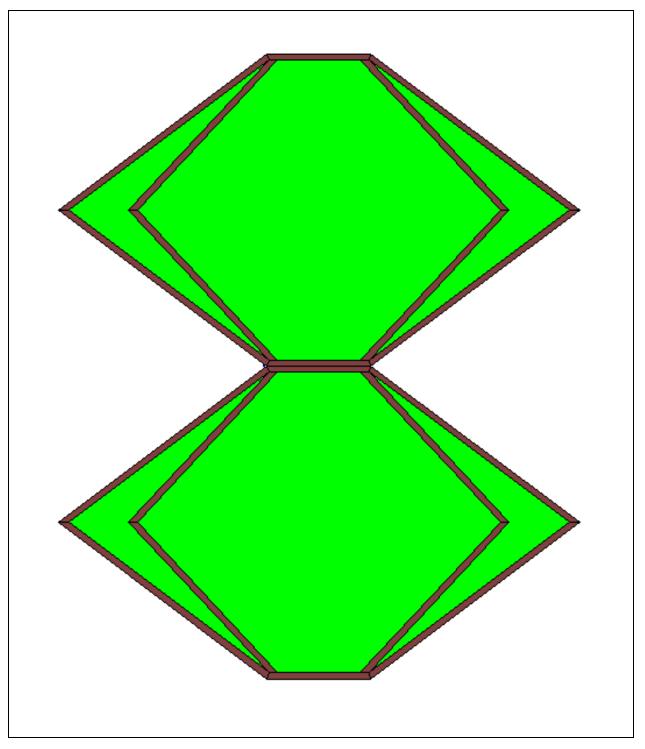


Figure 19-107. Paste the copied geometry

• Repeat until array of cells with 5 cells above and 5 cells below the center cell is created.

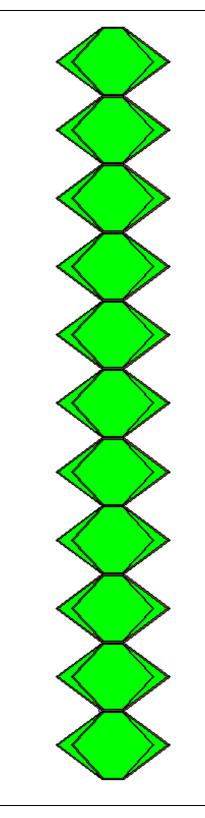


Figure 19-108. Repeat until there are 5 cells above and 5 cells below the center cell

$\bigotimes$			
	Boundary Condition Type Boundary Condition ShadelnE U-Factor U-Factor Edge Temperature 21.0 C Hc 1.00 W/m2-K Radiation Model AutoEnclosure Emissivity 0.900 Shading system modifier None Ø Blocking Surface	•	OK Cancel Boundary Condition Librar U-Factor Surfac Library
$\mathbf{X}$	Shade Material Test_outerwall.txt © Front C Back		Edit Shade Material Lib
	te Front € Back		

• Set entire **ShadeInE** boundary to U-Factor Surface: **Edge** 

Figure 19-109. Set the ShadeInE Boundary Condition to U-factor Surface Edge

	Boundary Condition Type				×	
	Boundary Journa of				т ок	
	Condition ShadeUutE			•		
	U-Factor Surface None			•	Cancel	
	Temperature -18.0 C	Hc 1.00 W/	m2-K		Boundary Condition Library	
	Radiation Model AutoEnclosu	re			U-Factor Surface	
	Emissivity 0.900				Library	
	Shading system modifier Nor	ne		•		
	✓ Blocking St	urface				
	Shade Material	Test_outerwall.txt			Edit Shade Material Lib	
	Front		🔿 Back			
	Shade Materials				×	
		WINDOW Databa	ase			
	C:\Users\roberthart\Desktop\cellShades.mdb Browse					
	ID Name					
	Shade Material 41003 Te	st_outerwall.txt		•		
		S	olar	Visi	ble	
		Beam	Diffuse	Beam	Diffuse	
	Transmittance, front:	0.0000	0.4590	0.0000	0.4529	
$\setminus \mathcal{I}$	Transmittance, back:	0.0000	0.4590	0.0000	0.4529	
	Reflectance, front:	0.0000	0.4573	0.0000	0.4940	
	Reflectance, back:	0.0000	0.4573	0.0000	0.4940	
For the left-most (outer) walls of the center cell,	Reflectance, back	1	1	1	1	
check Illumination Source						
	Emissivity, from	t: 0.7200		IR Transmittance:	0.1200	
$\mathbf{X}$					0.1200	
$\backslash$	Emissivity, bao	k: 0.7200		Conductivity:	0.1200	
$\backslash$						
$\mathbf{X}$	Front					
	C Back					
	$\mathbf{N}$					
	▼ Illumination Source		Remove	Link	K Cancel	

• For the center cell, check the "Illumination source" for the left most (outer) walls.

Figure 19-110. Check the "Illumination Source" for the left most (outer) walls of the center cell

## 19.6.5. WINDOW: Create the Shading Layer

Libr	aries <u>R</u> ecord Tools <u>V</u> iew	<u>H</u> elp
	Window	F2
	Glazing System	F5
	Glass	F3
	Gap	F4
	Frame	F7
	Divider	F8
	Environmental Conditions	F6
✓	Shading Layer	F11
	Shade Material	F12

In WINDOW, go to the Shading Layer Library, and create a new record

Figure 19-111. Select the Shading Layer Library

- Set Type to Therm File (\*.thmx)
- BSDF File: Browse to thmx file created in Term

		Shading Layer Library	
Use the <b>New</b> button to	List	ID #: 1003	
make a new Shading	▶ <u>N</u> ew	Name: CS03	
Layer Library record	<u>С</u> ору	Product Name:	
	<u>D</u> elete	Manufacturer:	
	Save	Type: Therm File (*.thmx)	
Set the <b>Type</b> to			
Therm File (*.thmx <del>)</del>		BSDF File: XML\CS03.thmx Brow	wse
		Use the <b>Browse</b> button to select the THERM <b>THMX</b> file just created	<b>I</b>

Figure 19-112. Create a new Shading Layer Library record and set the BSDF file to the THERM thmx file just created.

• Calculate BSDF file by clicking the Calculate button under the THERM File tab. NOTE: This calculation will take around 70 minutes.

Progress			
Remaining time: 65	34		
Running: SOLAR.b	at		

*Figure 19-113. Calculating the BSDF file can take over an hour, depending on the computer.* 

The properties of the material from the WINDOW database are stored in the THMX file, meaning that once the file is saved, it is independent of any subsequent changes to the WINDOW database used to produce it. Therefore, if the properties of materials used in the WINDOW database change, the THMX file must also be regenerated in order to keep the properties up-to-date.

<pre><material <="" conductivity="0.120000" emissivityback="0.781640" emissivityfront="0.777410" name="CS03:CS03_glueline.txt" pre="" rgbcolor="0x4951EB" tir="0.000224" type="5"></material></pre>
<property r="0.000000" range="Visible" side="Front" specularity="Direct" t="0.000000"></property>
<property r="0.711613" range="Visible" side="Front" specularity="Diffuse" t="0.269345"></property>
<property r="0.000000" range="Solar" side="Front" specularity="Direct" t="0.000000"></property>
<property r="0.686956" range="Solar" side="Front" specularity="Diffuse" t="0.267214"></property>
<property r="0.000000" range="Visible" side="Back" specularity="Direct" t="0.000000"></property>
<property r="0.689204" range="Visible" side="Back" specularity="Diffuse" t="0.269345"></property>
<property r="0.000000" range="Solar" side="Back" specularity="Direct" t="0.000000"></property>
<property r="0.665194" range="Solar" side="Back" specularity="Diffuse" t="0.267214"></property>

Figure 19-114. The THMX file (a text file) is independent of the WINDOW database where the THERM materials were imported from

• Set the **Permeability Factor**: For single layer systems, such as pleated shades, the permeability factor of the single material is entered. For multiple layer systems, the shade material with the lowest permeability factor in the airflow critical path is used. The critical path for several systems is illustrated in the figure below.

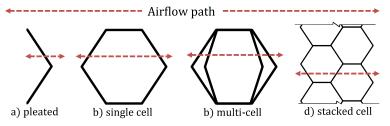


Figure 19-115. Airflow critical path through cellular shade sytems. The shade material with the lowest permeability factor in the airflow critical path determines the Permeability Factor.

• Set the **Optical Openness**: The ratio of area open to transmitted light compared to the total area of a material used in a shading system. For single layer systems, the Optical Openness of that material is entered. For multiple layer systems, the shade material with the lowest optical openness is used. See the figure above.

# 19.7. Insulating Shade Layers with Non-Standard Geometry: Roller Shutters

The example below shows the steps to use when the layer has materials with zero transmittance (visible, solar, and/or infrared), in this case a roller shutter, but these steps can be used for any non-standard shade geometry, with opaque materials, that is defined using THERM.

## 19.7.1. WINDOW: Define Shade Layer Library Materials

Even though the materials are opaque, define them in WINDOW (from data measured in a spectrophotometer, imported into Optics, and then imported into the WINDOW Glass Library) so that when they are imported into THERM, they will have more properties (such as spectral data) defined than ordinary THERM materials. These properties will be used in Radiance for reflectance calculations that will be influenced by the THERM model geometry.

There are two roller shutter examples presented here, one that is insulated and one that is not. The primary modeling difference is in the boundary condition definitions.

### **19.7.2. THERM: Therm Preference Settings**

In THERM, in the **Options** menu, **Preferences** tab, set the following options:

- Automatic XML Export on Save = Checked
- **Radiance Mode** = Checked

### 19.7.3. THERM: Add the WINDOW Shade Materials to the THERM Material Library

Once the appropriate materials have been defined in the WINDOW Shade Material Library, they need to be added to the THERM Material Library.

### 19.7.4. THERM: Define Shade Geometry for one shade segment

The next step is to define the geometry of the shade layer in THERM.

The THERM file will represent the geometry of the roller shutter. There are many ways to generate this geometry in THERM, but the most common method is to create the geometry in a CAD file, and export a DXF file that can be imported into THERM.

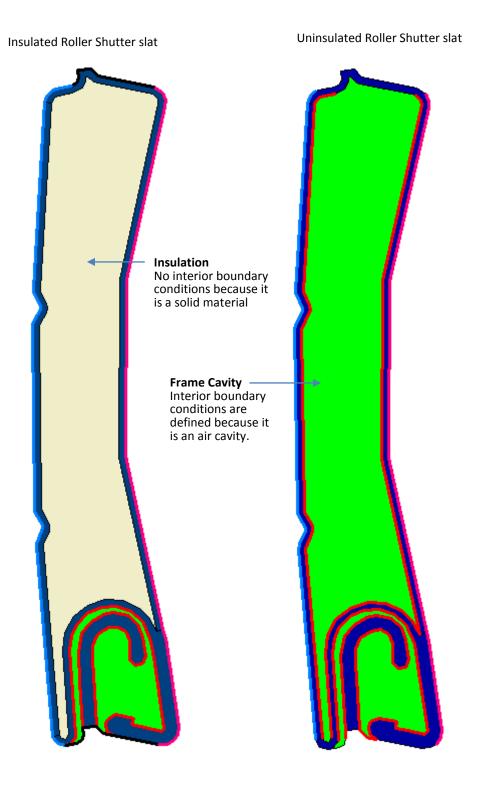
The DXF file can either be traced in THERM or, if created correctly, THERM can autoconvert the polygons.

The recommendation is to create one of the shading system components in THERM, generate boundary conditions and make sure it calculates before generating the multiple components that will be needed to define the final shading system.

When the polygons have been defined for the model, the materials imported from WINDOW into the THERM Shade Material Library should be assigned to the outer layers of the geometry. Inner polygons can be defined with the normal THERM Material Library.

In the case of this roller shutter example, the same material, White Aluminum, is used on both the inside and outside of the model. The following guidelines apply to modeling opaque materials

- For outer layers, always use materials that have been measured, even if the material is opaque. Therefore, these materials should be imported from the WINDOW Shade Materials Library
- For inner layers, if they are surround by opaque materials (such as in this example, the insulation), then those surrounded materials can be selected from the standard THERM Material Library, and do not need to be imported from the WINDOW Shade Material Library



*Figure 19-116. The boundary conditions will be defined differently depending on whether the roller shutter slat component is air filled (hollow) or uninsulated.* 

#### 19.7.5. THERM: Generate Boundary conditions for one shade segment

Generate the boundary conditions for the model

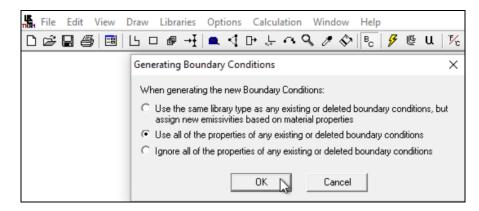


Figure 19-117. Generate the Boundary Conditions

The emissivity associated with a boundary condition is static to the material that was present when creating the boundary condition. If a material is changed after the boundary condition is created then the incorrect emissivity is displayed and the boundary conditions should be refreshed.

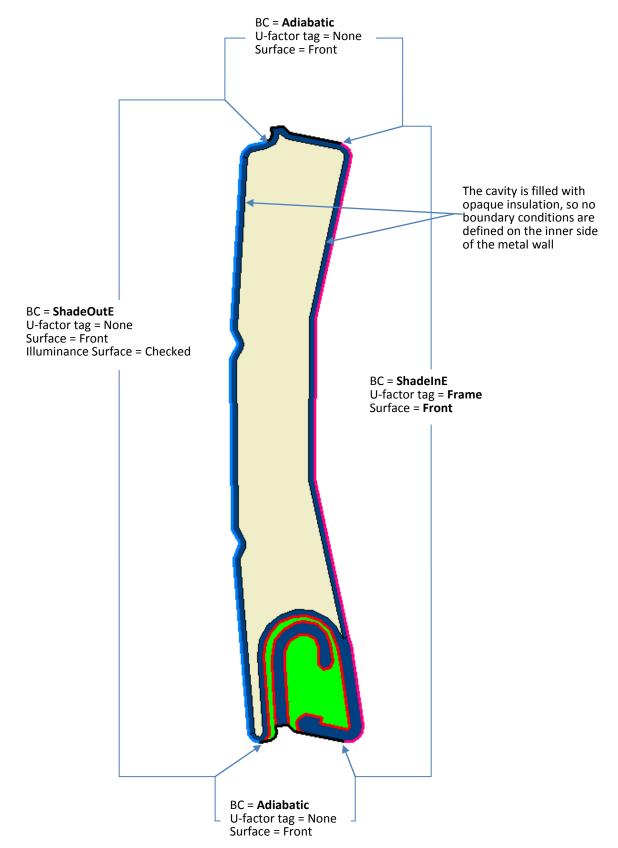


Figure 19-118. The Boundary Conditions for the insulated roller shutter case.

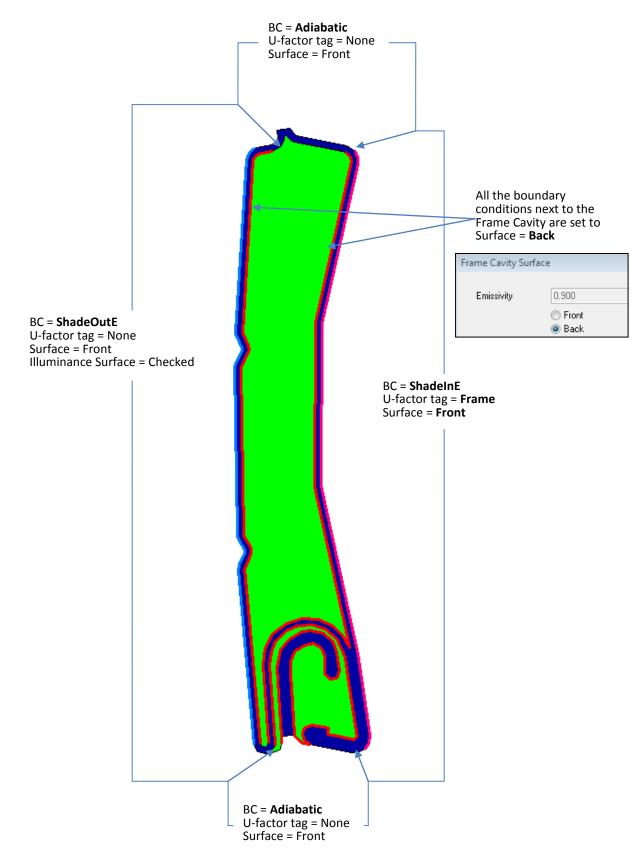


Figure 19-119. The Boundary Conditions for the uninsulated roller shutter case.

The boundary conditions should be set as follows:

There are two predefined boundary conditions for the interior and exterior boundary conditions of the cell geometry

• ShadeInE

Boundary Condi	tion Type	<b>-X</b> -
Boundary Condition	CellInCellExample:ShadeInE	ОК
U-Factor Surface	Edge	Cancel
Temperature	20.7 C Hc 4.93 W/m2-K	Boundary Condition Library
Emissivity	0.720	U-Factor Surface Library
Shading system	n modifier None	
☞ Front C Back □	Illuminated Surface	

Figure 19-120. ShadeInE Boundary Condition

• ShadeOutE

Boundary Condi	tion Type		×
Boundary Condition	CellInCellExample:ShadeOutE	•	ОК
U-Factor Surface	None	•	Cancel
Temperature	1.7 C Hc 3.59 W/m2-K		Boundary Condition Library
Emissivity	0.720		U-Factor Surface Library
Shading syster	n modifier None	•	
⊙ Front O Back □	Illuminated Surface		

Figure 19-121. ShadeOutE Boundary Condition

## 19.7.6. Calculate the Model for Error Checking

Calculate the model before progressing to ensure there are no errors. If changes are required, ensure all polygon and boundary conditions are re-linked to shade materials

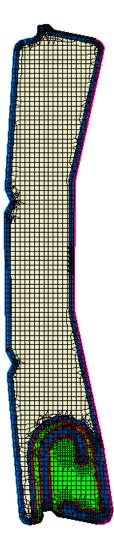


Figure 19-122. Calculate the model to make sure there are no meshing errors

### 19.7.7. Create an array of cells

Depending on the shading system, multiple shade component segments are generally defined for the complete THERM model. In the case of an opaque shading layer, it is not necessary to generate as many repeating segments as for a transmitting material (which will have light scattered in much more complex geometry).

For this roller shutter example, only three repeating segments are modeled, as shown in the figure below.

Create an array of component with 1 component above and 1 component below the center component.

See the THERM User Manual for detailed instructions about how to copy and paste polygons within the same file or between different files.

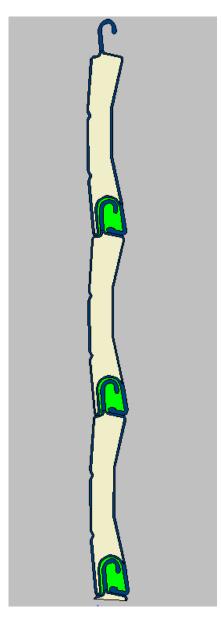


Figure 19-123. Repeat until there are 5 cells above and 5 cells below the center cell. The gray background indicates that "Radiance Mode" is checked.

## 19.7.8. Generate the boundary conditions for the complete array of segments

Leave boundary conditions visible to ensure the boundary condition settings are copied along with the polygons.

The exterior facing surface of the middle component should have the Illuminated Surface checked in the Boundary condition definition

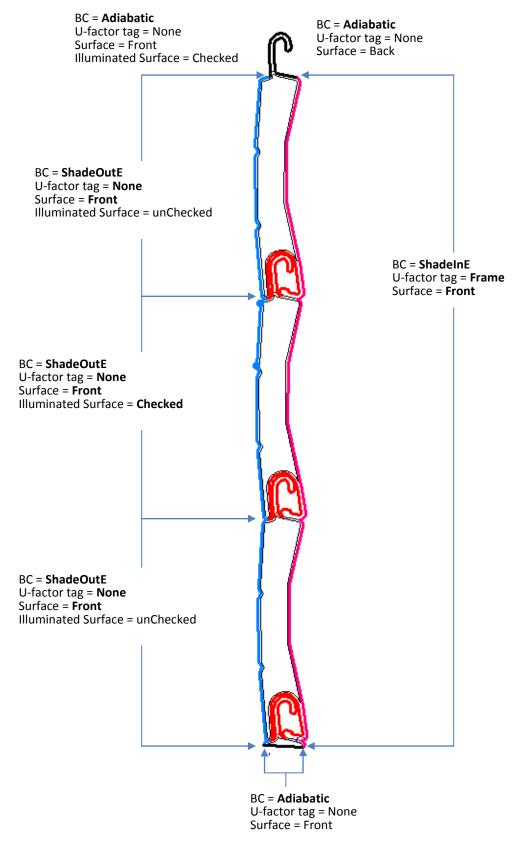


Figure 19-124. Check the "Illumination Source" for the left most (outer) walls of the center cell

### 19.7.9. WINDOW: Create the Shading Layer

Libr	aries <u>R</u> ecord Tools <u>V</u> iew	<u>H</u> elp
	Window	F2
	Glazing System	F5
	Glass	F3
	Gap	F4
	Frame	F7
	Divider	F8
	Environmental Conditions	F6
$\checkmark$	Shading Layer	F11
	Shade Material	F12

In WINDOW, go to the Shading Layer Library, and create a new record

Figure 19-125. Select the Shading Layer Library

- Set Type to Therm File (\*.thmx)
- BSDF File: Browse to thmx file created in Term

	Shading Layer Library
	ID #: 50001
	Name: RollerShutter_A150_AL_Light_Insul
	Product Name:
Set the <b>Type</b> to <b>Therm File (*.thmx)</b>	Manufacturer: generic
	Type: Therm File (*.thmx)
	BSDF File: .\ROLLAC A150_AI_Ins.thmx
	Permeability Factor 0.000 Optical Openness 0.000
	Use the <b>Browse</b> button to select the THERM <b>THMX</b> file just created

Figure 19-126. Create a new Shading Layer Library record and set the BSDF file to the THERM thmx file just created.

- Set the **Permeability Factor:** Because this is an opaque material with well sealed joints, the Permeability factor = 0.
- Set the **Optical Openness**: Because this is an opaque material with well sealed joints, the Optical Openness = 0.

• Click the Calc button to calculate the gen\_BSDF file. NOTE: This calculation will take around 70 minutes.

Progress		
Remaining time: 65:34		
Running: SOLAR.bat		

Figure 19-127. Calculating the BSDF file can take over an hour, depending on the computer.

The properties of the material from the WINDOW database are stored in the THMX file, meaning that once the file is saved, it is independent of any subsequent changes to the WINDOW database used to produce it. Therefore, if the properties of materials used in the WINDOW database change, the THMX file must also be regenerated in order to keep the properties up-to-date.

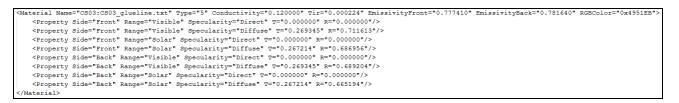


Figure 19-128. The THMX file (a text file) is independent of the WINDOW database where the THERM materials were imported from

This shading layer can now be used when defining a glazing system.

# **19.8. Perforated Screens**

Perforated screens are shading materials that have a uniform geometry. Perforations must be in a regular repeating pattern of a single shape (circular, square, or rectangular). Non-regular patterns can be approximated by determining the equivalent area.

Permeability Factor is calculated by WINDOW based on the geometry of defined perforations. To utilize this model, the referenced shade material properties must be the bulk material without perforations and should represent a perfectly Lambertian diffusing material.

#### 19.8.1. Shading Layer Library

The Shading Layer Library has an Type called "Perforated screen". When that type is selected, the program displays the input values for defining the type and geometry.

Shading	Layer Lib	1201	
ID #:	28	Taly	
	_	ted screen. 8.7% open area	
Produc			
Manufa	acturer:	Generic	
Туре:		Perforated screen	<b></b>
Materia	d:	30101 Slat Metal A	<b>v</b>
Geome	try:	Circular 👻	→−−Sx ─→
Dimens	ions		
Dian	neter:	6.350 mm	
Thic	kness:	0.600 mm	sy
Spacing	g		
Sx:		19.050 mm	
Sy:		19.050 mm	diameter -
			thickness -

Figure 19-129. Circular perforated screen model. Diameter, and distance between perforations is defined

In WINDOW, go to the Shading Layer Library, and create a new record.

Туре	Set to Perforated screen
Material	Select the appropriate record in the Shade Material Library
Permeability Factor	This value is calculated automatically by WINDOW based on the geometry of the defined perforations. To utilize this model, the referenced Shade Material properties must be the bulk material without perforations and should represent a perfectly Lambertian diffusing material.

Geometry

Select from the following options

#### Circular

- o Define diameter of typical perforation open area
- Define spacing between perforations in the x (Sx) and y (Sy) dimensions
- Eliptical shapes may be approximated as circular shapes using equvillent area where the diameter, D, is related to the semi-major and semi-minor axes of an ellipse as follows:

 $D = 2 \operatorname{sqrt}(AB)$ 

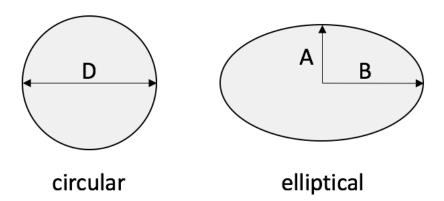
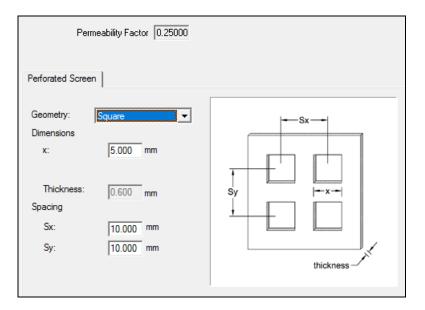
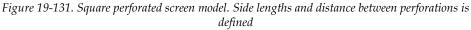


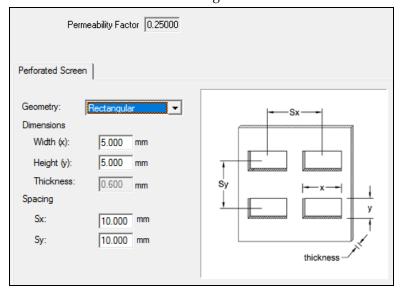
Figure 19-130. Elliptical perforations can be related to circular perforations by equivillent area

- Square
  - Define length of the typical perforation open area
  - o Define spacing between perforations in the x (Sx) and y (Sy) dimensions





- Rectangular
  - Define the Width (x) and Height (y) of the typical perforation open area
  - Define spacing between perforations in the x (Sx) and y (Sy) dimensions
  - Non-standard shapes may be approximated as rectangular shape using equvillent area where the smallest dimension of the shape is equal to the smallest dimension of the rectangle



*Figure 19-132. Rectangular perforated screen model. Width (x) and Height (y) side lengths, and distance between perforations (Sx and Sy) is defined* 

## **19.9. Homogeneous Diffusing shade**

The homogeneous diffusing shade option in shading layer library utilizes shade material properties of the bulk material without perforations and should represent a perfectly Lambertian diffusing material.

#### **19.9.1 Create the Shading Layer in WINDOW**

In WINDOW, go to the Shading Layer Library, and create a new record.

- Set Type to Homogeneous diffusing shade
- Set Material to record in the Shading Material database
- Set the Permeability Factor.

Shading Layer Libr	ary
ID #: 26005	
Name: Diffusing	) Shade
Product Name:	
Manufacturer:	Generic
Туре:	Homogeneous diffusing shade
Material:	31002 💌
Perm	eability Factor 0.00000

*Figure 19-133. Homogeneous diffusing shade type from the Shading Layer Library. Material is defined in the Shading materil library. Permeability factor is determined through measurements* 

# 20.1. Overview

The following special cases are covered in this section:

20.2.	Meeting Rails	page 20-2
20.3.	Dividers	page 20-10
20.4.	Storm Windows	page 20-45
20.5.	Skylights	page 20-56
20.6.	Doors	page 20-72
20.7.	Spacers	page 20-73
20.8.	Non Continuous Thermal Bridge Elements	page 20-76
20.9.	Site Built Fenestration Products Curtain Walls, Window Walls	maga <b>2</b> 0,80
	and Sloped Glazing	page 20-89
20.10.	Garage / Rolling Doors	page 20-103
20.11	Creating a Laminate in Optics for NFRC	page 20-116
20.12.	Creating an Applied Film Layer in Optics for NFRC Certification	page 20-130
20.13.	Framed Intermediate Pane	page 20-140
20.16.	Complex Glazing Database	page 20-143

## 20.2 Meeting Rails

Meeting rail cross sections are the stiles or rails that meet in the middle of a sliding window. In this manual, the term "meeting rail' is used generically to describe meeting rails, meeting stiles, interlock stiles, interlocking stiles, sliding stiles, check rails, and check stiles.

## 20.2.1. Modeling Meeting Rails

When modeling a meeting rail, both the sashes and their associated glazing systems are modeled. Figure 20-1 shows an example of the meeting rail from a horizontal aluminum slider.

Creating the cross section for a meeting rail is no different than any other model in THERM. A few things to keep in mind are:

- Two glazing systems are imported, one facing up and one facing down
  - Interior boundary conditions for each of the glazing systems are labeled with the **Edge** U-factor tag, and the program averages the values for both to derive one Edge U-factor.
  - Model the meeting rail with the glazing systems facing up and down. If the DXF file is drawn with them in a horizontal position, draw the frame cross section, and then rotate it before inserting the glazing system.

The following discussion lists the steps for making a cross section with two glazing systems and assigning the correct boundary conditions.

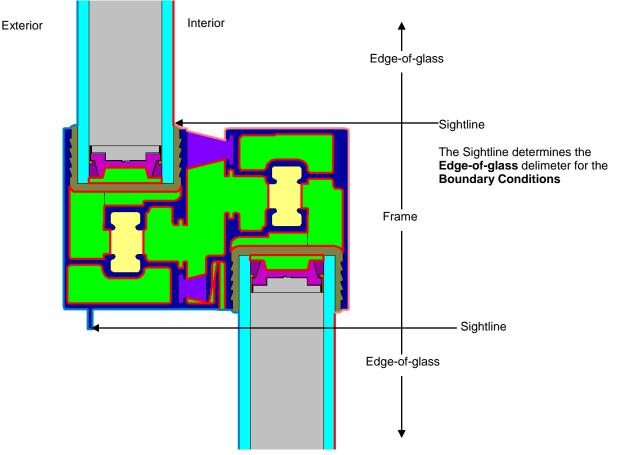


Figure 20-1. Meeting rail cross section.

#### 20.2.2. Steps for Meeting Rail U-factor Calculation

1. Using dimensioned drawings or a DXF file, create the cross section for the frame portion of the meeting rail. In Figure 20-2, the frame for the horizontal aluminum slider meeting rail has been created.

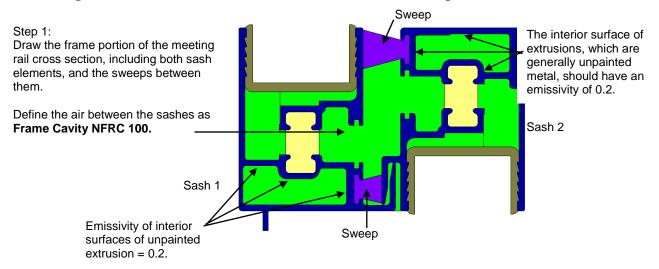


Figure 20-2. Frame portion of meeting rail cross section.

2. Position the **Locator** (using the **Draw/Locator** menu choice, or pressing **Shift F2**) in the lower left corner of the frame where the first glazing system will be inserted, as shown in Figure 20-3.

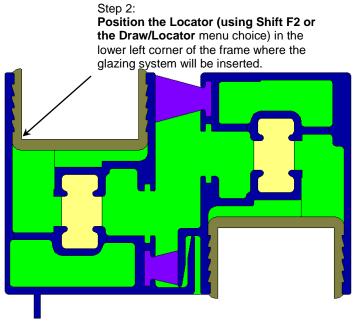
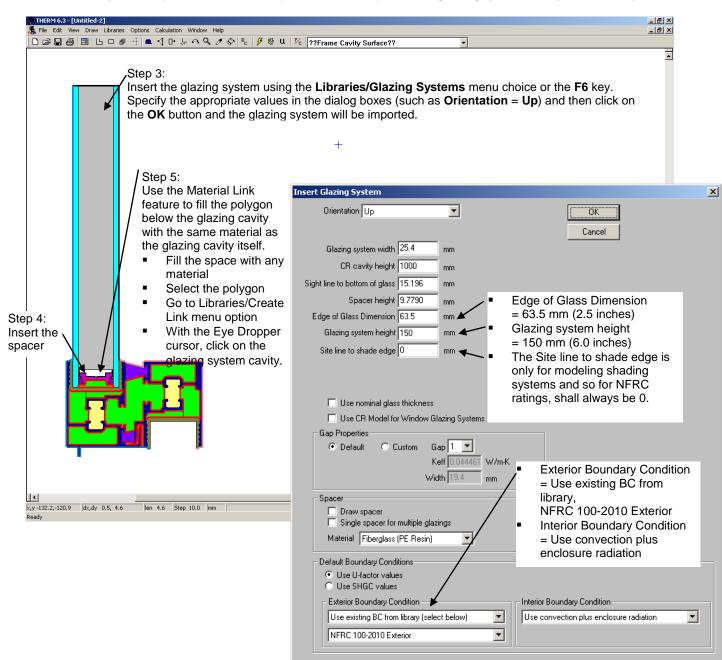


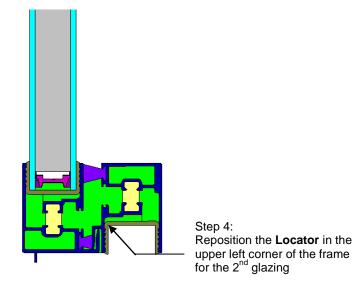
Figure 20-3. Position the Locator for the first glazing system.

3. Using the **Libraries/Glazing Systems** menu option (or the **F6** key), insert the upper glazing system, as shown in Figure 8-4. In this example, the spacer will be copied and pasted into the cross section later. Add a spacer and use the Material Link (Library/Create Link) to link the glazing system cavity conductivity with adjacent cavities in a spacer which is open to the glazing system cavity, if necessary.



*Figure 20-4. Insert the first glazing system.* 

4. Reposition the locator to the upper left corner for the 2<sup>nd</sup> glazing system.



*Figure 20-5. Reposition the Locator for the 2<sup>nd</sup> glazing system.* 

5. Insert the 2<sup>nd</sup> glazing system, setting the **Orientation** to "Down", and entering the correct values for **Sight** line to bottom of glass and Spacer height.

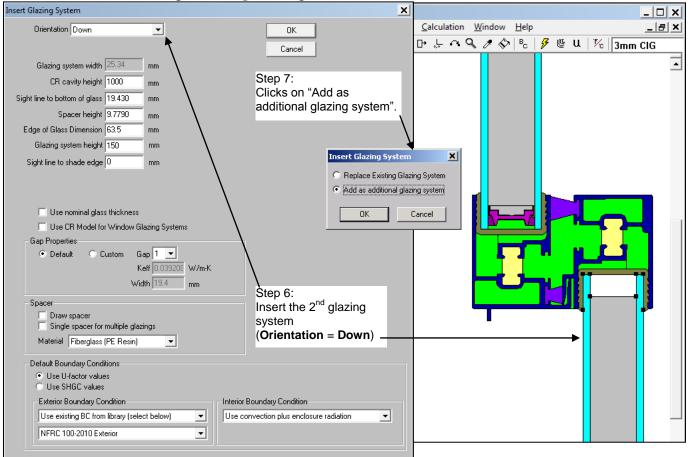


Figure 20-6. Insert the 2<sup>nd</sup> glazing system.

6. Add spacers and create materials linked to the glazing system cavity if necessary.

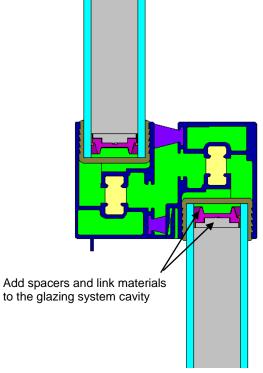


Figure 20-7. Add custom spacers.

7. Define the boundary conditions by pressing the **Boundary Conditions** toolbar button, or clicking on the **Draw/Boundary Conditions** menu choice, or pressing the **F10** key. Make sure that the interior boundary conditions are set to **Radiation Model** = "AutoEnclosure". Assign the **Edge U-factor tag** to each of the interior glazing system boundary conditions, as shown in Figure 20-8.

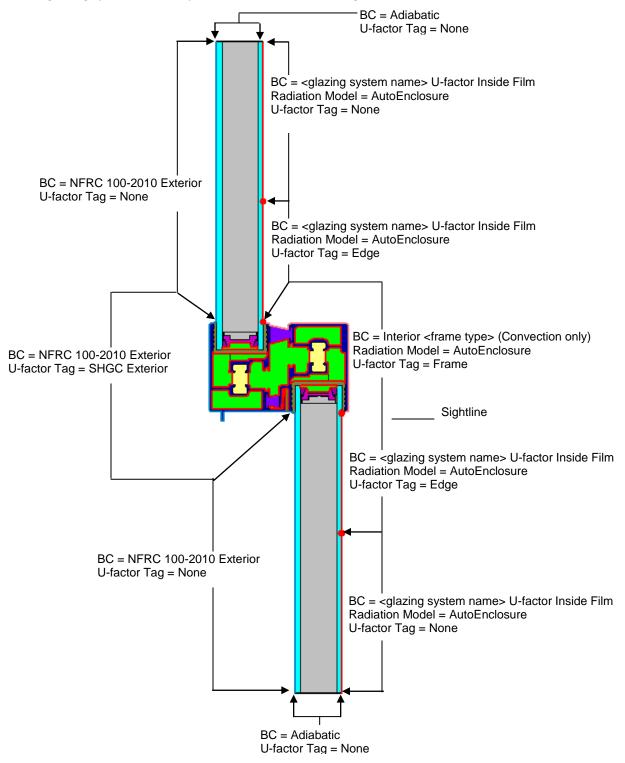


Figure 20-8. Define the Boundary Conditions for the meeting rail.

8. Run the simulation, by pressing the **Calc** toolbar button, clicking on the **Calculation/Calculation** menu choice, or pressing the **F9** key. The U-factor results are calculated for the **Frame** and **Edge U-factor tags**, as shown in the figure below.

U-Factors					×
SHGC Exteri	U-factor W/m2-K for 7.3057	delta T C 39.0	Length mm 53.5427	Rotation 90.0	Projected in Glass Plane
Fran	ne 7.0598	39.0	49.3017	90.0	Projected in Glass Plane 💌
Edge	2.0251	39.0	130.177	90.0	Projected in Glass Plane 💌
% Error Energy Nor	rm 9.04%				Export
					ОК

*Figure 20-9. Calculate the results.* 

9. Import the THERM file into the WINDOW Frame Library.

#### 20.2.3. Steps for Meeting Rail Condensation Resistance Calculation

The Condensation Resistance model is only appropriate for *horizontal meeting rails* (found in vertical sliding products) – THERM will not calculate the Condensation Resistance for a file with the **Cross Section Type** set to "Vertical Meeting Rail".

There are two methods for calculating the Condensation Resistance information in THERM, which will be used in WINDOW to calculate the total Condensation Resistance of the product:

- Check the "Use CR Model for Window Glazing System" checkbox when importing a glazing system OR
- In the Options menu, Preferences choice, THERM File Options tab, check the "Use CR Model for Glazing Systems", as shown in the figure below.

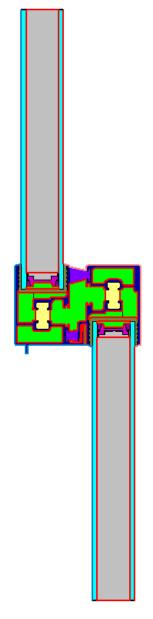
				×
Preferences	Drawing (	Options	Simulation	
Therm File Op	otions	Sr	nap Settings	
Mesh Control Quad Tree Mesh		9		
Maximum % En Maximum Iteral	or Energy Nor	m 10 5	%	
🔽 Use CR Mode	el for Glazing S	ystems		

*Figure 20-10.* In Options/Preferences/Therm File Options, check the "Use CR Model for Glazing Systems" checkbox.

When the CR model has been "turned on", red boundary conditions will appear inside the glazing system, and the following steps should be taken to simulate the file:

- 1. Check the emissivities of these boundary conditions. They should be the following:
  - Emissivity of the surrounding surface, such as 0.84 for standard glass, 0.90 for most frame materials, 0.20 for metal, and so forth.
  - 1.0 for the adiabatic (open end) of the glazing cavity.
  - Actual cavity height

- 2. Simulate the model. The program will calculate both U-factor results and the Condensation Resistance results.
- 3. Import the results into the WINDOW **Frame Library** and use the meeting rail file to create the whole product in the **Window Library** as applicable.



*Figure 20-11. Red boundary conditions will appear inside the glazing system when the Condensation Resistance feature is activated.* 

4. Check the emissivities of each of these boundaries. Note that Condensation Resistance is only modeled for horizontal meeting rails (such as in a double hung window).

## 20.3 Dividers

#### 20.3.1. Internal Dividers (Suspended Grilles)

The criteria for when dividers are modeled can be found in *NFRC 100*. The discussion below describes the methodologies in WINDOW and THERM for modeling dividers when that criteria is met.

#### 20.3.1.1. Modeling Steps

The modeling steps in THERM and WINDOW are the same for all divider shapes and all possible gas fills, in contrast to modeling steps in previous versions of THERM.

### Linking Frame Cavities and Glazing Cavities

Internal dividers are an exception to the rules for linking frame cavities to glazing cavities. Internal dividers are only modeled if the distance between the exterior sides of the divider and the inside surface of the glazing system are less than or equal to 3 mm. Therefore, even for contoured internal dividers, a simplifying assumption is made that the 5 mm rule is not applied. The space between the divider edge and the glass are modeled as frame cavities, and the boundary of that cavity extends to the top and bottom of the divider component. See the following examples for detailed descriptions.

### Modeling Steps

The modeling steps are the following:

In WINDOW:

• No new work is required, because the same glazing system that is used to model the rest of the product is used in the divider model.

In THERM:

- The new ISO 15099 modeling assumptions would theoretically warrant modeling horizontal and vertical dividers separately. However, a conservative simplification is to model all dividers, including horizontal ones, as vertical dividers. Therefore, only one divider model is created in THERM and referenced in WINDOW.
- Set the **Cross Section Type** to "Vertical Divider" for all dividers.
- Insert the glazing system twice, once facing up, with a spacer height defined as the same height as the divider height, and once facing down with the spacer height set to zero.
- NOTE: Because all dividers are modeled as "Vertical Dividers" the CR model is not run in THERM for these files. However, WINDOW will still calculate a whole product CR value when these dividers are used in a product, by using the U-factor temperatures for the dividers.
- Draw the true geometry of the divider in the upper glazing system, in the "spacer" area.
- Depending on the fill of the glazing system, assign the appropriate frame cavity material to the cavities between the glazing system and the divider, as well the cavity inside the divider, as follows:
  - For air-filled dividers: Assign "Frame Cavity NFRC 100-2010" material
  - For gas-filled dividers: Create a new material in the **Material Library** that is identical to the "Frame Cavity NFRC 100-2010" material, except that the gas used in the glazing system, found in the **Gas Library**, is referenced in the **Gas Fill** field. Assign this new material to the cavities in the divider. (See the example below)
- Assign Boundary Conditions.
- Simulate the results.

Import the file into the WINDOW Divider Library. Reference the Divider as appropriate from the Window Library when constructing the whole product.

### 20.3.1.2. Air Filled Glazing Systems

The modeling steps for a divider with an air-filled glazing system are explained in detail in the following pages.

In THERM:

- 1. Set the **Cross Section Type** to "Vertical Divider".
- 2. Import the glazing system for the divider, which is the same glazing system as the rest of the product, with the following settings:
  - Orientation = Up
  - CR Cavity height = 1000 mm (39 inches)
  - Sight line to bottom of glass = height of the divider (in this example it is 19.05 mm [0.75 inches])
  - Spacer height = height of the divider (in this example it is 19.05 mm [0.75 inches)
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Sight line to shade edge: 0 (not modeling shading system)
  - Draw spacer = Not checked

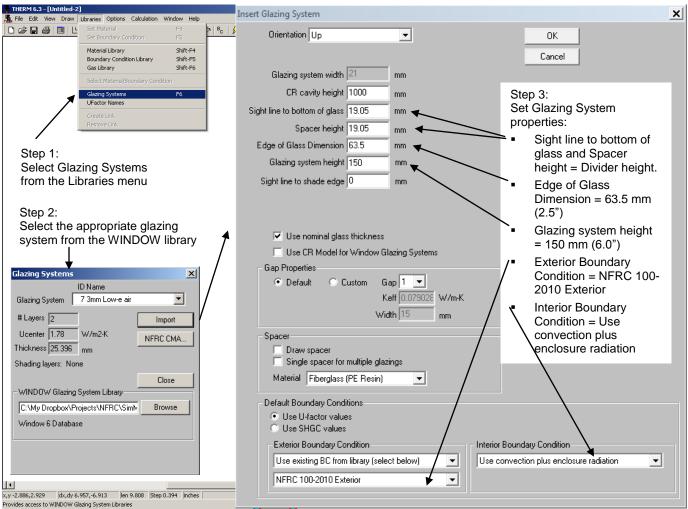
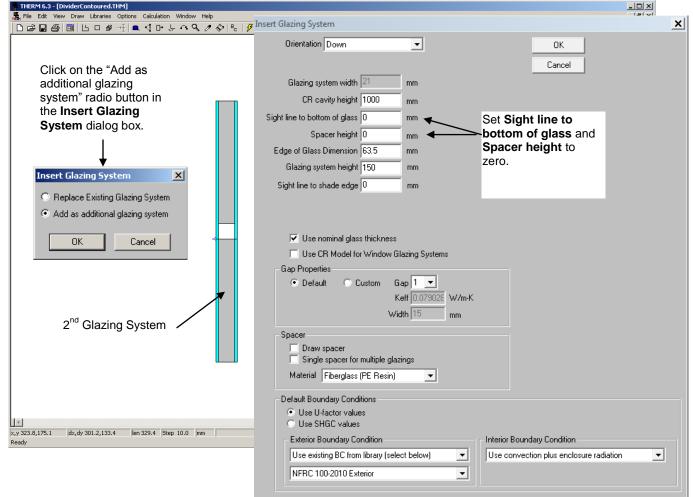


Figure 20-12. Import the first glazing system.

- 3. Import the glazing system again as an additional glazing system, below the first one (the locator does not have to be moved), but facing down this time. Use the following settings for this glazing system:
  - Orientation = Down
  - **CR Cavity height** = 1000 mm (39 inches)
  - Sight line to bottom of glass = 0
  - Spacer height = 0
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Sight line to shade edge: 0 (not modeling shading system)
  - Draw spacer = Not checked

Insert the glazing system as an Additional Glazing.



*Figure 20-13. Import the second glazing system as an additional glazing system, facing down.* 

4. Draw (or copy and paste from another THERM file) the polygons in the cavity that represent the divider. The figure below shows the divider for this example drawn with the material set to Aluminum Alloy

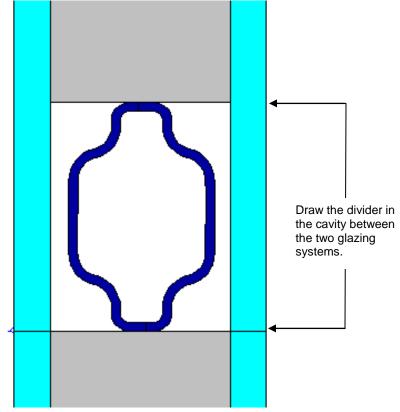


Figure 20-14. Draw the polygons to represent the divider.

5. Fill the cavities between the divider and the glass layers and inside the divider with the material "Frame Cavity NFRC 100". Because internal dividers are only modeled if the gap between the edge of the divider and the glass surface is less than 3 mm, the 5 mm rule for linking glazing cavities and frame cavities is not applied to internal dividers – the cavity surrounding the divider is modeled as a frame cavity, with boundaries at the upper and lower edges of the divider.

Check the emissivity values for the inside surface (by double-clicking on the surface) of the extruded metal divider – If there is a different surface finish on each side of the material, change the default material emissivity as appropriate based on the NFRC 101 values.

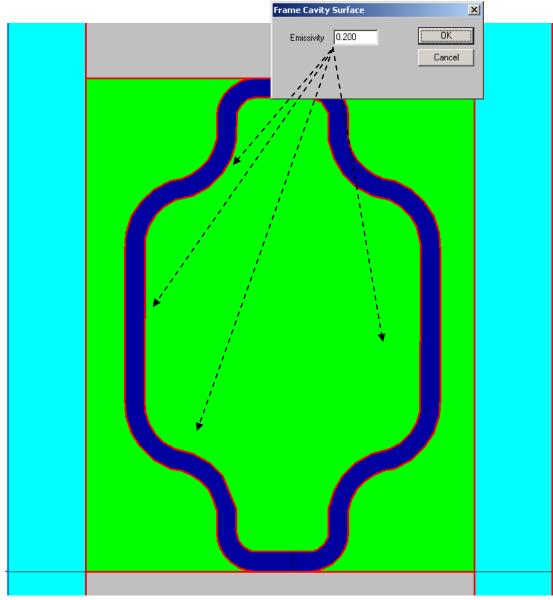


Figure 8-15. Fill the divider frame cavities with Frame Cavity NFRC 100.

6. Define the boundary conditions, using the "AutoEnclosure" choice for the Radiation Model.

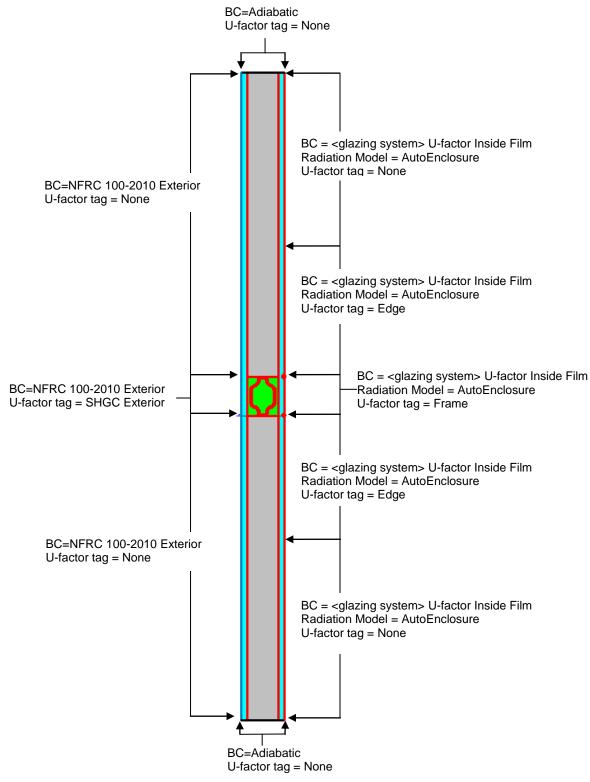


Figure 20-16. Assign the boundary conditions.

#### 7. Calculate the results.

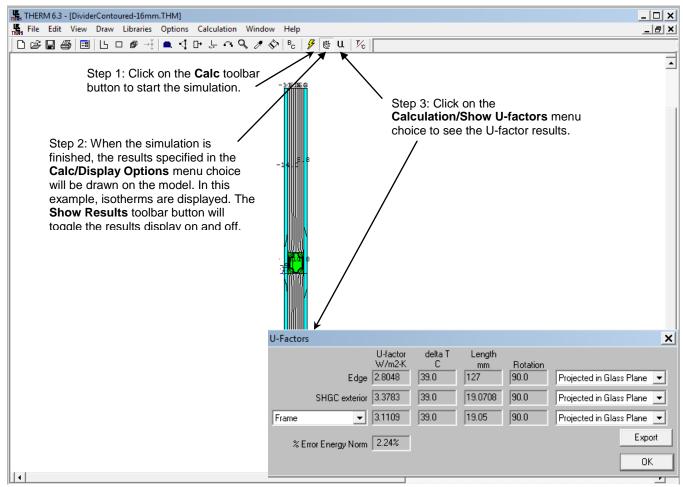


Figure 20-17. Calculate the results.

8. Save the file using the **File/Save As** menu choice.

9. Import the results to the WINDOW Divider Library, as shown below.

🗄 W6.3 - Divider Librar	ry (C:\Us	ers\Pul	blic\LBNL\WINDOW6\we	i.mdb)								
File Edit Libraries						the later of l						
] 🗅 🚅 🖬   🐰 🖻	6 6	8   🔳		🗄 🔼 🍨 🛛	17 D #	🦉   🍢	? №					
Detailed View	)ivider Lib	orary (C: '	\Users\Public\LBNL\WIND	10W6\w6.mdb)	Import						×	
Update		D	Name	Source ype	Format		erm file ndow 5 or 6 D.	atahase	•			
New	•	t Alu	m/Divided	ASHRAE N/A			erm file					
<u>С</u> ору	·		yl/Divided	ASHRAE N/A	Avoid	eating dup	olicate records	in export datab	ase by search	ing		
Delete	3	3 Wo	od/Divided	ASHRAE Suspe	for per	ntical record	s 	_				
Find			om the WINDOW	: Suspe			OK	Ca	ncel			
			<b>prary</b> , click on the tton. This will open	: Suspe		1						
			alog box	Vertica	🗄 Open				ف مع ب	_		×
Advanced	•				1.4	WINDOW	6	-	* 🗈 💣			
7 records found.			t the Format to 🖌		Name Divider	тым		Date m	odified )13 1:33 PM	Type THERM F	ile	Siz
Import	"The	rm Fil	e".		Debug	. 1 1 1 1 1			)13 2:45 PM	File folde		
Export					BSDFs				)13 1:53 PM	File folde		
Rep <u>o</u> rt			lect the THERM fil	es 🖊	Sample	is i			013 5:17 PM 2012 6:34 PM	File folde File folde		
<u>P</u> rint	to im	port							012 0.54 PW	The folde		•
					File name:						Oper	
Step 4: Specify	the re	cord	number, or use		Files of type:	, Them file	es (* thm)			•	Canc	el I
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		6	Vinyl/Suspended		E N/A	N/A	N/A	Class1	N/A	16.0	0.30	
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*Figure 20-18. Import the THERM file into the WINDOW Divider Library.* 

10. Use the new divider in the calculation of the complete product values in the main screen of WINDOW.

### 20.3.1.3. Gas Filled Glazing Systems

If the glazing system being modeled with a divider is gas-filled, it is necessary to model the divider with the same gas fill as the glazing system. This means a new material must be defined for the gas-filled frame cavities around and inside the divider.

The THERM **Gas Library** contains entries for standard gases, as well as examples of gas mixtures. These gases are not made in THERM; they are made in the WINDOW **Gap Library** and then imported into the THERM **Gas Library**. When the gas mixtures have been imported into THERM, they can be referenced from a new frame cavity material for the divider model, as shown below.

1. Create the gas mixture in the WINDOW **Gap Library**. Presumably it already exists for the product glazing system model. See Section 10 for details about creating new entries in the WINDOW **Gap Library**.

ID	Name	Туре	Conductivity	Viscosity	Ср	Density	Prand
			W/m-K	kg/m-s	J/kg-K	kg/m3	
1	Air	Pure	0.024069	0.000017	1006.103271	1.292498	0.719
2	Argon	Pure	0.016349	0.000021	521.928528	1.782282	0.670
3	Krypton	Pure	0.008664	0.000023	248.090698	3.738740	0.671
4	Xenon	Pure	0.005160	0.000021	158.339706	5.857955	0.654
6	Air (5%) / Argon (95%) Mix	Mix	0.016704	0.000021	539.729126	1.757792	0.673
7	Air (12%) / Argon (22%) / Krypton (66%)	Mix	0.011490	0.000023	322.703308	3.014770	0.640
8	Air (5%) / Krypton (95%) Mix	Mix	0.009191	0.000023	261.636230	3.616428	0.664
9	Air (10%) / Argon (90%) Mix	Mix	0.017063	0.000021	558.032715	1.733303	0.675
100	Air - EN673	Pure	0.024169	0.000017	1008.000000	1.292498	0.713
101	Argon - EN673	Pure	0.016345	0.000021	519.000000	1.782282	0.667
102	Krypton - EN673	Pure	0.008707	0.000023	245.000000	3.738740	0.655
103	Xenon - EN673	Pure	0.005119	0.000022	161.000000	5.857955	0.67
104	Air (5%) / Argon (95%) Mix - EN673	Mix	0.016705	0.000021	536.977966	1.757792	0.670
105	Air (12%) / Argon (22%) / Krypton (66%) - EN673	Mix	0.011531	0.000023	319.890289	3.014770	0.62
106	Air (5%) / Krypton (95%) Mix - EN673	Mix	0.009237	0.000023	258.634674	3.616428	0.648
107	Air (10%) / Argon (90%) Mix - EN673	Mix	0.017068	0.000021	555.463989	1.733303	0.673
200	C02	Pure	0.014567	0.000014	827.734131	1.963508	0.780
201	N2	Pure	0.023969	0.000017	1040.794678	1.250113	0.720
202	SF6	Pure	0.013000	0.000014	418.600006	6.518257	0.456
203	Helium	Pure	0.146171	0.000019	5197.000000	0.178460	0.664
204	Neon	Pure	0.045416	0.000029	1030.000000	0.900331	0.666
205	Octofluorpropane	Pure	0.010686	0.000011	762.015320	8.388474	0.814
300	Vacuum-air P=0.001 (pr-1.5 ps-30)	Pure					

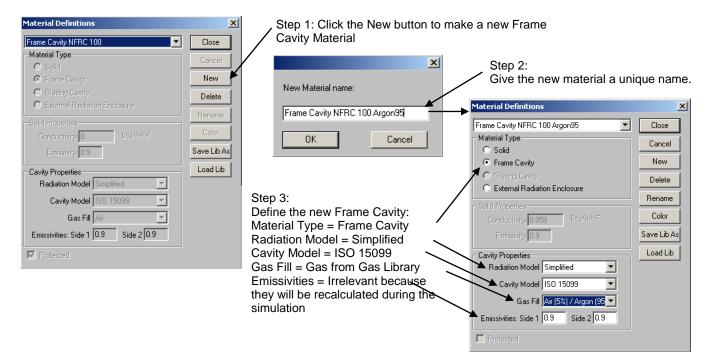
Figure 20-19. Make the necessary gas mixture in the WINDOW Gap Library.

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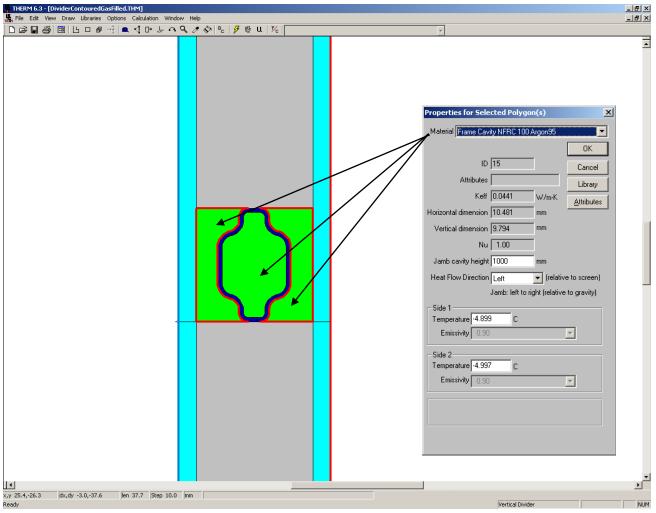
2. Import the WINDOW gas mixture into the THERM Gas Library, if it is not already there.

Figure 20-20. Import the gas mixture entries into the THERM Gas Library.

3. Make a new frame cavity material in the THERM **Material Library** based on "Frame Cavity NFRC 100" but with the **Gas Fill** field set to the correct gas mixture from the **Gas Library**.



*Figure 20-21. Import the gas mixture entries into the THERM Gas Library.* 



4. Use this new frame cavity material in the divider model cavities.

Figure 20-22. Use the new Frame Cavity material to fill the divider cavities.

### 20.3.2. Simulated Divided Lites

A simulated divided lite is a glazing system that has elements attached to the inside and outside of a glazing system to give the appearance of true divided lites. The glazing system has a metal internal reinforcement, but is all one system. The materials applied/adhered to the outside of the insulating glazing unit are not required to be modeled per NFRC 100. This is an option of the manufacturer and the following provides the details to model and simulate it correctly.

Internal dividers, such as the dividers in the glazing system gap for simulated divided lites, are an exception to the rules for linking frame cavities to glazing cavities as discussed in Chapter 6. Internal dividers are only modeled if the distance between the exterior sides of the divider and the inside surface of the glazing system are less than or equal to 3 mm. Therefore, even for contoured internal dividers, a simplifying assumption is made that the 5 mm rule is not applied. The space between the divider edge and the glass are modeled as frame cavities (with either air-filled or gas-filled as needed), and the boundary of that cavity extends to the top and bottom of the divider component. See the following examples for detailed descriptions.

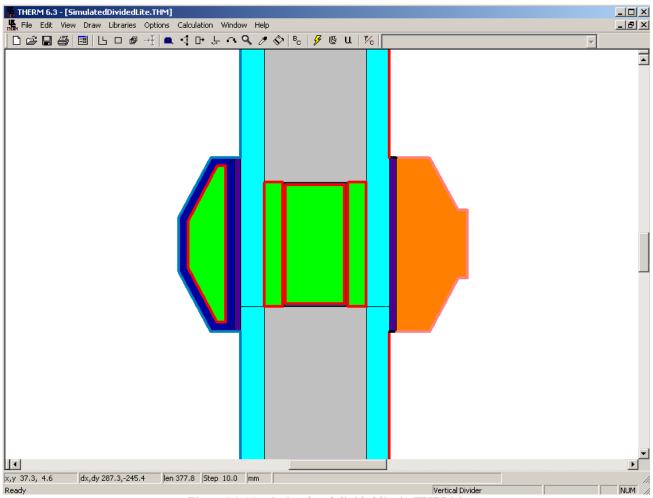


Figure 20-23. A simulated divided lite in THERM.

#### In THERM:

- 1. Set the Cross Section Type to "Vertical Divider".
- 2. Import the glazing system for the divider, which is the same glazing system as the rest of the product, with the following settings:
  - Orientation = Up
  - Actual Cavity height = 1000 mm (39 inches)
  - Sight line to bottom of glass = height of the divider (in this example it is 19.05 mm [0.75 inches])
  - **Spacer height** = height of the divider (in this example it is 19.05 mm [0.75 inches)
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Draw spacer = Not checked

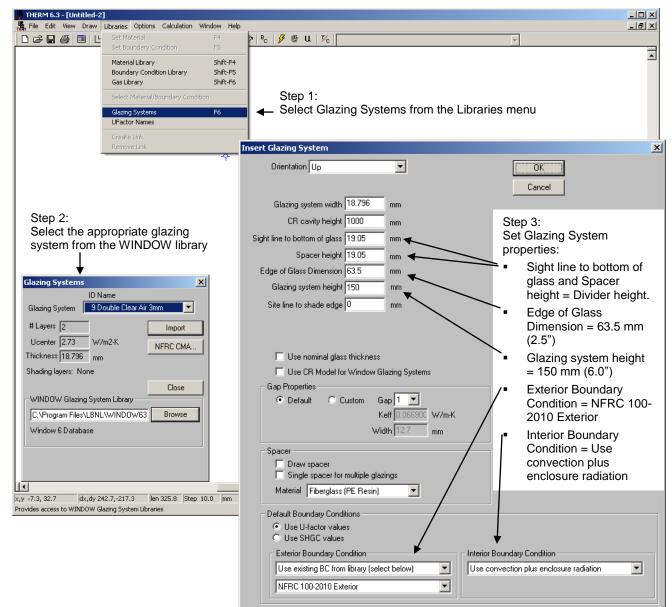


Figure 20-24. Import the first glazing system.

- 3. Import the glazing system again as an additional glazing system, below the first one (the locator does not have to be moved), but facing down this time. Use the following settings for this glazing system:
  - **Orientation** = Down
  - Actual Cavity height = 1000 mm (39 inches)
  - Sight line to bottom of glass = 3.175 mm
  - Spacer height = 0
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Draw spacer = Not checked

Insert the glazing system as an Additional Glazing.

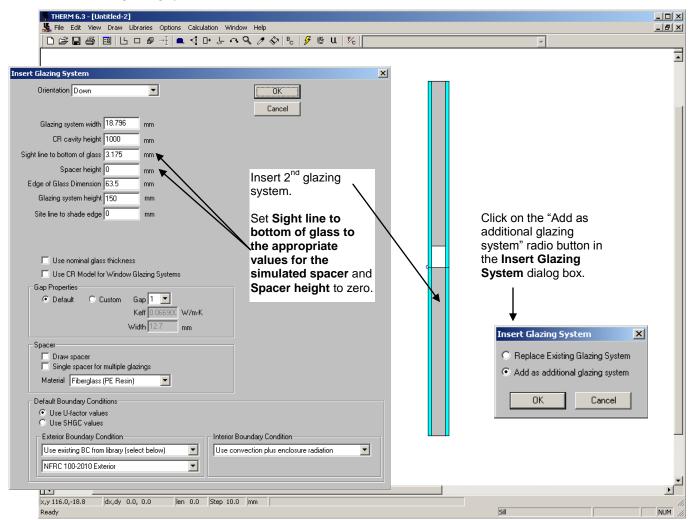
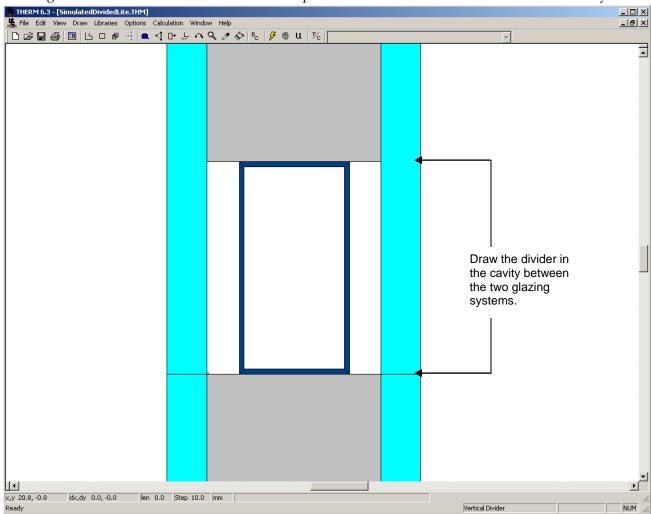


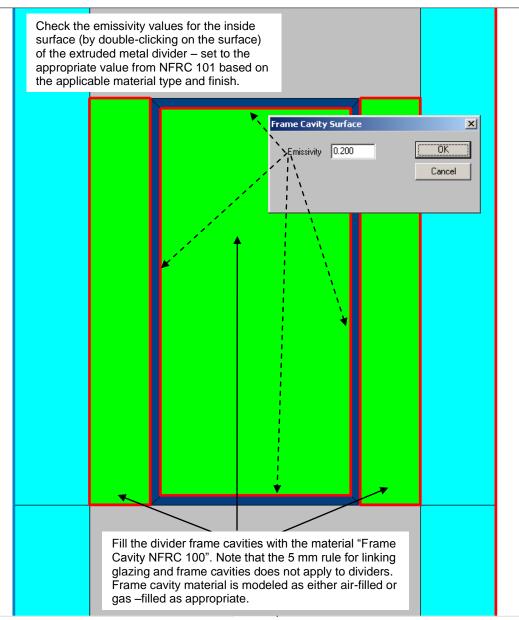
Figure 20-25. Import the second glazing system as an additional glazing system, facing down.

4. Draw (or copy and paste from another THERM file) the polygons in the cavity that represent the divider. The figure below shows the divider for this example drawn with the material set to Aluminum Alloy



*Figure 20-26. Draw the polygons to represent the divider.* 

5. Fill the cavities between the divider and the glass layers and inside the divider with the material "Frame Cavity NFRC 100". Divide the cavities up according to the 5 mm rule as necessary.



*Figure 8-27. Fill the divider frame cavities with Frame Cavity NFRC 100.* 

6. Add the polygons for the simulated divided light elements on either side of the glazing system and assign the appropriate materials to them.

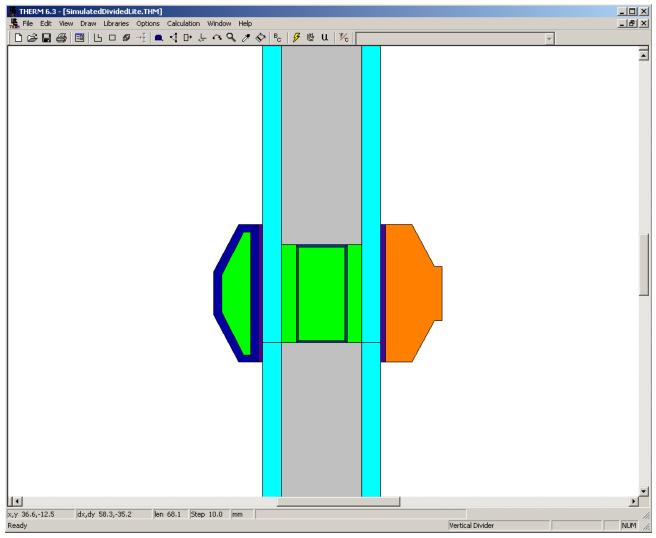
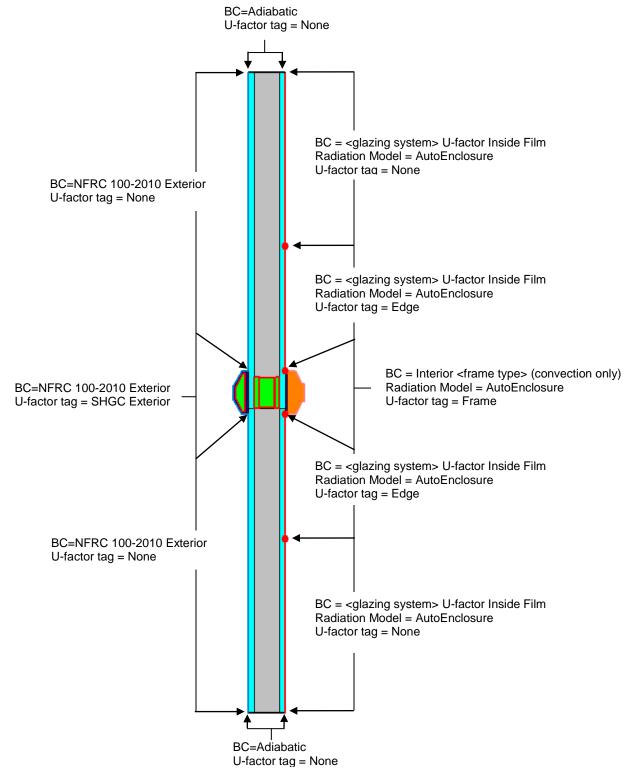


Figure 8-28. Add the polygons for the simulated divided lite elements on either side of the glazing system.



7. Define the boundary conditions, using the "AutoEnclosure" choice for the Radiation Model.

Figure 20-29. Assign the boundary conditions.

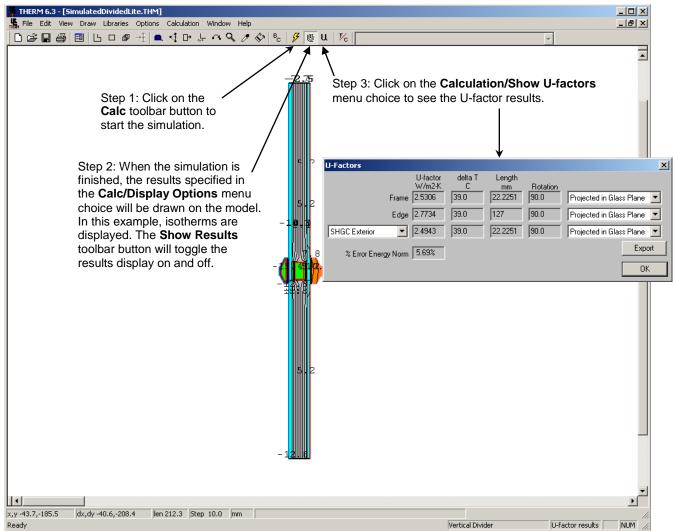


Figure 20-30. Calculate the results.

9. Save the file using the **File/Save As** menu choice.

10. Import the results to the WINDOW Divider Library, as shown below.

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*Figure 20-31. Import the THERM file into the WINDOW Divider Library.* 

11. Use the new divider in the calculation of the complete product values in the main screen of WINDOW.

#### 20.3.3. True Divided Lites

The criteria for when dividers are modeled can be found in *NFRC 100*, Section 1.4.4. The discussion below describes the methodologies in WINDOW and THERM for modeling dividers when that criteria is met.

A true divided lite means that the dividers have separate glazing systems between the divider elements, as shown in the figure below.

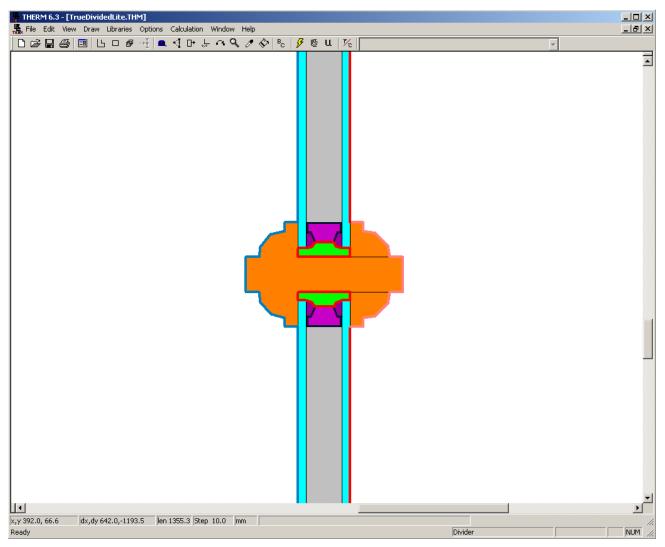


Figure 20-32. A true divided lite in THERM.

#### In THERM:

In this example, it is easier to start by drawing the polygons that represent the divider, and then placing the glazing systems relative to those polygons.

- 1. Set the Cross Section Type to "Vertical Divider".
- 2. Draw the divider polygons as shown in the figure below.

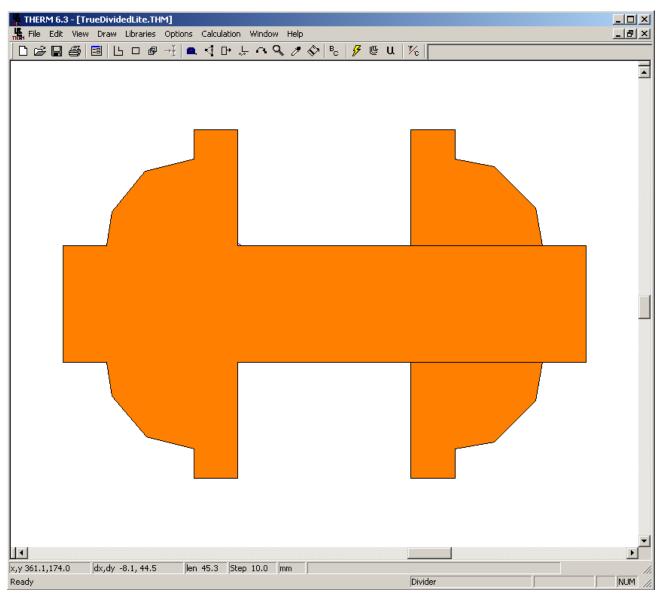


Figure 20-33. In THERM, draw the polygons for the divider elements that the glazing systems will fit into.

- 3. Import the first glazing system (in this case the top glazing system) for the divider, with the following settings:
  - Set the **Locator** in the appropriate location for where the glazing system will start, in this example 3.175 mm (0.125 inches) above the bottom of the divider
  - **Orientation** = Up
  - Actual Cavity height = 1000 mm (39 inches)
  - Sight line to bottom of glass = height of the divider (in this example it is 9.525 mm (0.375 inches)
  - **Spacer height** = height of the divider (in this example it is 9.525 mm (0.375 inches)
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Draw spacer = Not checked

#### 20. SPECIAL CASES

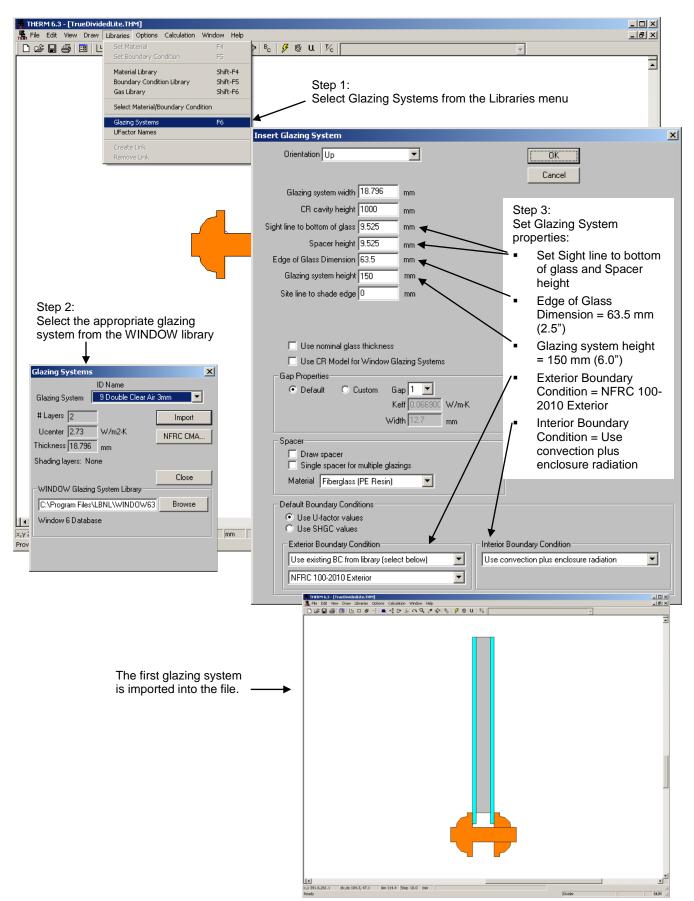


Figure 20-34. Import the first glazing system.

- 4. Import the glazing system again as an additional glazing system, facing down this time. Use the following settings for this glazing system:
  - Set the **Locator** in the appropriate location for where the glazing system will start, in this example 3.175 mm (0.125 inches) above the bottom of the divider
  - **Orientation** = Down
  - Actual Cavity height = 1000 mm (39 inches)
  - Sight line to bottom of glass = height of the divider (in this example it is 9.525 mm (0.375 inches)
  - Spacer height = height of the divider (in this example it is 9.525 mm (0.375 inches)
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Draw spacer = Not checked

Insert the glazing system as an Additional Glazing.

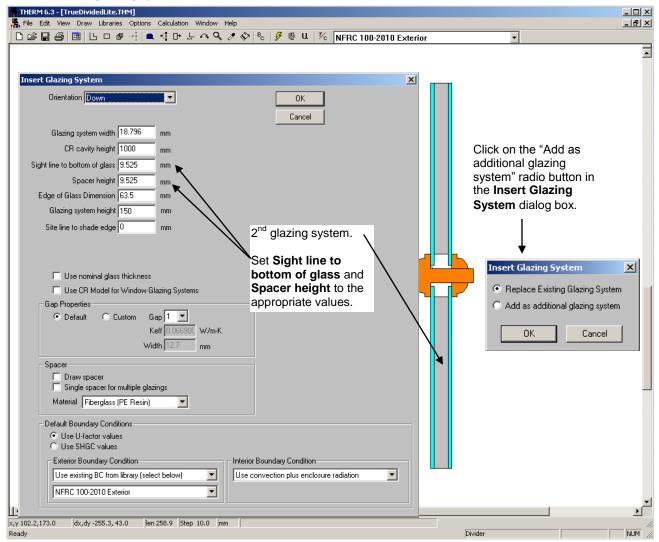
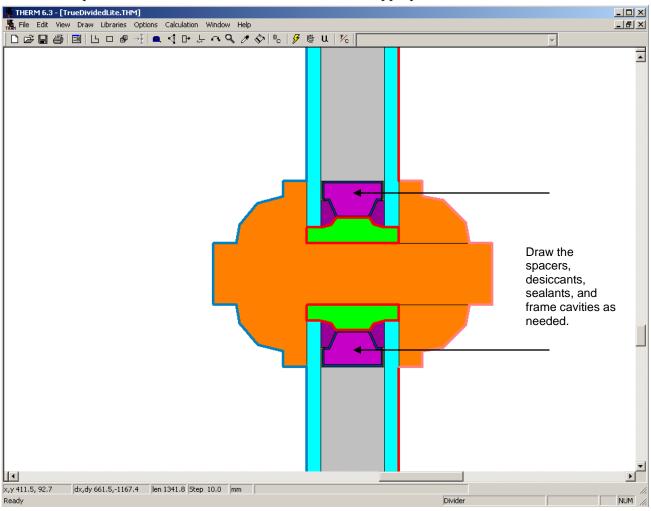
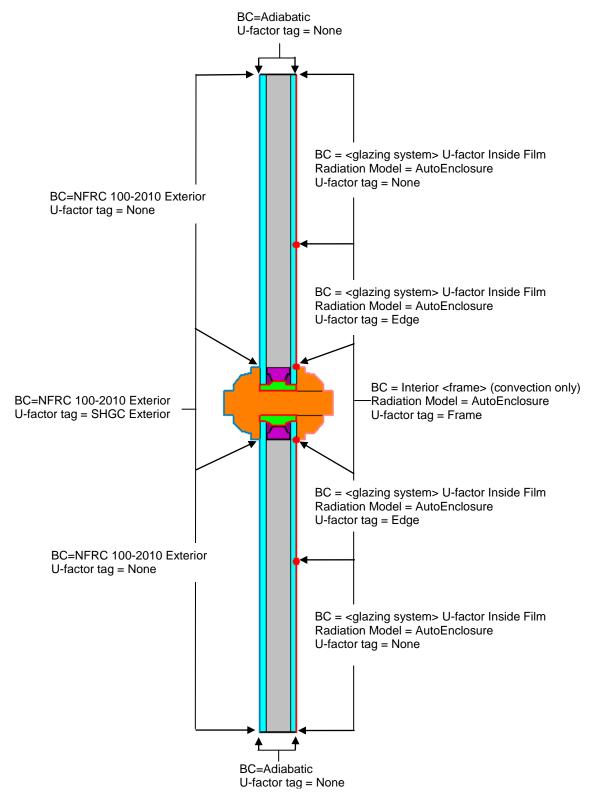


Figure 20-35. Import the second glazing system as an additional glazing system, facing down.



5. Add the spacers, sealants, desiccants, and frame cavities as appropriate.

Figure 20-36. Draw the polygons to represent the divider.



6. Define the boundary conditions, using the "AutoEnclosure" choice for the Radiation Model.

Figure 20-37. Assign the boundary conditions.

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Figure 20-38. Calculate the results.

- 8. Save the file using the **File/Save As** menu choice.
- 9. Import the results to the WINDOW Divider Library, as shown below.

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*Figure 20-39. Import the THERM file into the WINDOW Divider Library.* 

10. Use the new divider in the calculation of the complete product values in the main screen of WINDOW.

### 20.3.4. Door Caming

When modeling glazing options with caming, which are treated in a similar fashion to dividers, the NFRC default caming can be used. The flat caming (H-Bar) shall be used as the default shape. Brass conductivity and emissivity can be used as the default material.

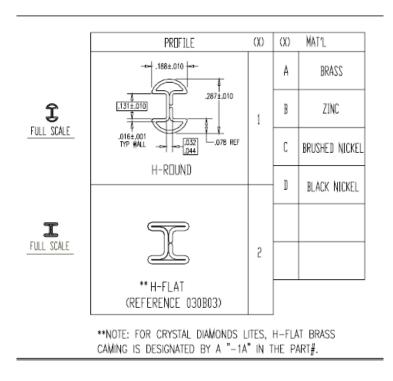


Figure **20-40**. Standardized Caming Drawing

Decorative caming between two pieces of glass is an exception to the rules for linking frame cavities to glazing cavities. This type of caming is only modeled if the distance between the exterior sides of the caming and the inside surface of the glazing system are less than 3 mm. Therefore, even for contoured caming shapes, a simplifying assumption is made that the 5 mm rule is not applied. The space between the caming edge and the glass are modeled as frame cavities, and the boundary of that cavity extends to the top and bottom of the caming component. See the following examples for detailed descriptions.

#### In THERM:

In this example, which represents an intermediate pane in an IG unit with caming, it is easier to start by drawing the polgyons that represent the divider, and then placing the glazing systems relative to those polygons.

- 1. Set the **Cross Section Type** to "Vertical Divider".
- 2. Draw the caming polygons.

- 3. Insert the first glazing system (in this case the top glazing system which is a triple glazed unit made in WINDOW) for the divider, with the following settings:
  - Set the Locator in the appropriate location for where the glazing system will start
  - Orientation = Up
  - Actual Cavity height = 1000 mm (39 inches)
  - Sight line to bottom of glass =0
  - Spacer height = 0
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Draw spacer = Not checked

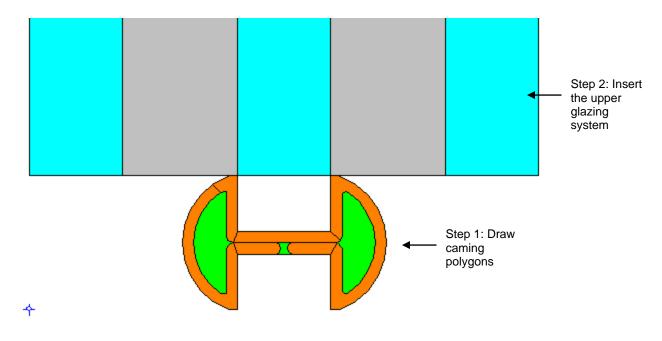


Figure 20-41. Draw the caming polygons and insert the upper glazing system

- 4. Insert the second glazing system, with the following settings, and click the "Add as additional glazing system" radio button upon insert.
  - Set the Locator in the appropriate location for where the glazing system will start
  - **Orientation** = Down
  - Actual Cavity height = 1000 mm (39 inches)
  - Sight line to bottom of glass =0
  - Spacer height = 0
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Glazing System Height: 150 mm (6.0 inches)
  - Draw spacer = Not checked

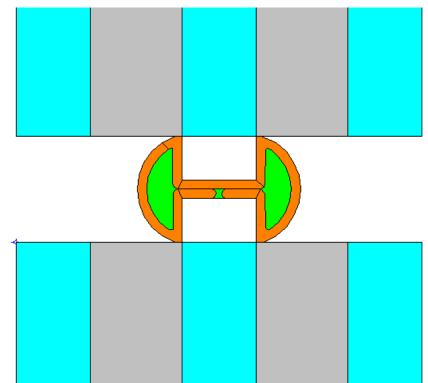


Figure 20-42. Insert the lower glazing system

- 5. From the Options menu, select Preferences, then click on the Drawing Options tab and check "Allow editing of IG polygons" so that the glazing system geometry can be modified.
- 6. For both the upper and lower glazing systems, move the points of the center glass layer into the caming, as showin in the figure below.

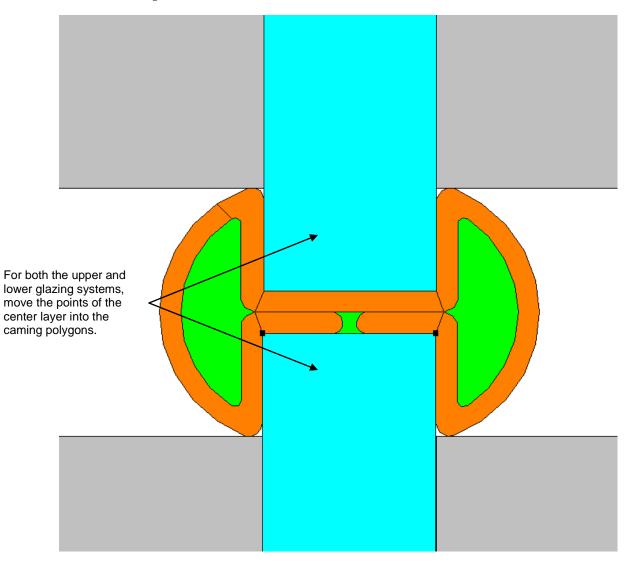


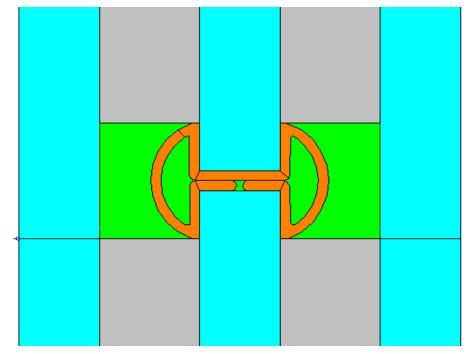
Figure 20-43. Move the points of the middle layer of the upper and lower glazing systems into the caming.

7. For either the upper or lower glazing system, move the points of the outer layers to meet the other glazing system, to enclose the IG.

*Figure* **20-44***. Move the points of either the outside layers of either the upper or lower glazing system to meet the other glazing system, to enclose the IG* 

8. If the IG Unit is air-filled, then fill the cavities with NFRC Frame Cavity 100, assign the normal boundary conditions, and simulate as usual. If the IG unit if gas-filled, follow the procedures for gas filling a divider.

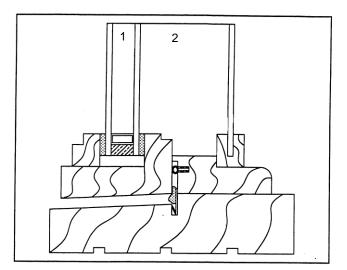
Because internal dividers are only modeled if the gap between the edge of the divider and the glass surface is less than 3 mm, the 5 mm rule for linking glazing cavities and frame cavities does not need to be applied to internal dividers. The frame cavity starts at the top and the bottom of the divider component.



*Figure* **20-45***. Fill the cavities with Frame Cavity NFRC* 100

# 20.4 Storm Windows

Storm windows present a modeling problem different from most insulated glass (IG) units, because the spacing between the IG unit and the storm window is usually quite large, as shown in the figure below. As with all other product modeling, all relevant cross sections (head, sill, jambs, meeting rails and dividers) must be modeled in THERM.



*Figure 20-46. Product with an interior storm window.* 

#### 20.4.1. Modeling Steps

The following steps can be used to model storm windows. These steps are discussed in more detail in the following sections.

If the product is *NOT* a single or double hung (i.e., it is a casement, fixed, picture, transom, awning, etc), do the following:

In WINDOW:

Create a three-layer glazing system with the correct spacing between each of the glass layers in WINDOW.

In THERM

- Draw the frame components for the product in THERM.
- Import the glazing system into THERM
   Edge of Glass Dimension = 63.5 mm (2.5 inch)
   Glazing System Height = 150 mm (6.0 inch).
- Fill the air cavity below the glazing system and use the Library/Create Link feature to link that air cavity to the glazing cavity.
- Assign the boundary conditions
   Exterior Boundary Condition = Use existing BC from library, select "NFRC 100-2010 Exterior", and assign the SHGC Exterior U-factor tag to the exterior frame components
   Interior Boundary Condition = Use "convection plus enclosure radiation" for Glazing System, use appropriate "convection only" frame boundary condition for the frame components.
- Simulate the problem

If the product *IS* a hung or sliding window (i.e., a vertical or horizontal slider), where there will be a different gap width between the glazing system and the storm window for different frame profiles, do the following:

#### In WINDOW:

- Before starting the program, open the W6.INI file and add the following line (if it does not already exist):
  - FrameToleranceGlazingSystemThickness=5

**Note:** it is all one word, no spaces, and it can go anywhere in the INI file. If this line already exists, but has some other value other than "5", change the value to "5". This represents the percentage tolerance between the frame and glazing system thickness. Setting it to "5" makes the thickness tolerance checking 500%, which should disable the WINDOW thickness tolerance checking, and therefore allowing the program to perform a calculation with glazing systems of different thicknesses.

Location of W6.ini file: The location of the W7.ini file will depend on your operating system.

C:\Users\Public\LBNL\Settings

 Create the two glazing systems with the actual thicknesses between the glazing system and the storm window, which will fit into the frame profiles that will be modeled in THERM.

#### In THERM

- Draw the frame components for the product in THERM.
- Import the glazing systems with the actual gap widths into the appropriate frame profiles with the following settings:
   Edge of Glass Dimension = 63.5 mm (2.5 inch)
   Glazing System Height = 150 mm (6.0 inch).
- Fill any air cavity between the bottom of the glazing system and the top of the frame profile as necessary, and use the Library/Create Link feature to link that air cavity to the glazing cavity.
- Assign the boundary conditions
   Exterior Boundary Condition = Use existing BC from library, select "NFRC 100-2010 Exterior", and assign the SHGC Exterior U-factor tag to the exterior frame components
   Interior Boundary Condition = Use "convection plus enclosure radiation" for Glazing System, use appropriate "convection only" frame boundary condition for the frame components.
- Simulate each model.

#### In WINDOW:

- Import the THERM frame profiles that have the correct geometry for the glazing systems into the Frame Library.
- In the Window Library, create the window, referencing the matching frames and glazing systems, including the meeting rail (you cannot "match" the glazing system thicknesses in the meeting rail, so just reference it).
- Calculate the overall product values from this combination of components.
- Close the program, open the W7.ini file, and do the following:
  - Delete the line FrameToleranceGlazingSystemThickness=5

Or

Put a semicolon ";" in front of it which keeps it in the file, but makes it a comment instead of a command. This way it will be there the next time you need to use it.
 ; FrameToleranceGlazingSystemThickness=5

### 20.4.2. Storm Window Example

The following example problem, based on the product in Figure 20-46, is explained in detail in the following discussion.

### 20.4.2.1. Create Glazing System in WINDOW:

1. Make a glazing system consisting of three layers of glass, with the dimensions of the glazing cavity for the first gap, and the correct dimension from the glass to the storm window for the second gap.

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		-	Glass 2	► 102	2 CLEAR	_3.DAT		3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	0.900
			Gap 2		l Air			50.8											
			Glass 3	10:	2 CLEAR	_3.DAT		3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	0.900
																			•
		Cer	nter of Glass Ri	esults   T	emperatur	e Data   Optica	al Data	Angula	ır Dat	a   Color	Propert	ies							
			Ufactor		SC	SHGC		Rel. H	t. Gai	n	Tvis		Kef	if	Gap	1 Keff	Gap	o 2 Keff	
			W/m2-K					- W/	'm2				W/m	ъК	W	/m-K	W	//m-K	
			1.7648	(	).7864	0.6842	!	51	11		0.7415	5	0.17:	23	0.0	)633	0.1	2789	

Figure 20-47. Make a triple glazed glazing system with a large gap width between the IG and the storm window.

### 20.4.2.2. Calculate U-factor in THERM

The steps for importing the glazing system into THERM are explained in more detail below.

- 1. Draw the required frame cross sections (such as head, sill, jambs, meeting rails, and dividers)
- 2. From the **File/Properties** menu, select the appropriate **Cross Section Type**, such as "Sill", "Head", "Jamb", and so forth.
- 3. Import the glazing system with the correct storm window cavity dimensions (created in WINDOW), in this case the glazing system with the 2" gap.

Edge of Glass Dimension = 63.5 mm (2.5 inch)

**Glazing System Height =** 150 mm (6.0 inch).

**Exterior Boundary Condition = Use existing BC from library**, select "NFRC 100-2010 Exterior" **Interior Boundary Condition = Use convection plus enclosure radiation** for glazing system, and appropriate "convection only" boundary condition for the interior frame components.

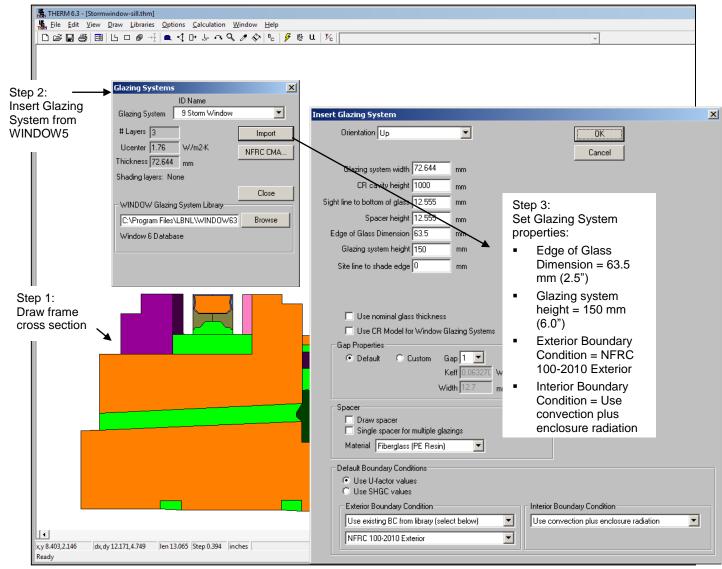
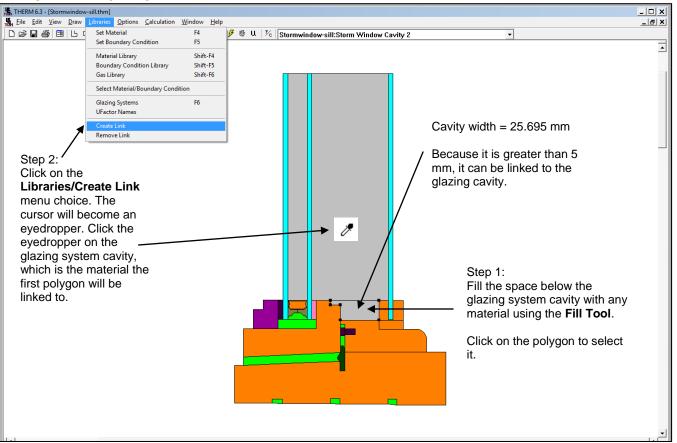


Figure 20-48. Insert the glazing system.

4. If necessary (as in this example because there is a gap between the bottom of the glazing cavity and the frame), create a separate polygon and use the Library > Create Link feature to link the properties to the 2" glazing cavity. In the example below, the width of the inner gap is 50.800 mm, and therefore is greater than 5 mm, so the smaller cavity can be linked to the larger cavity. See Section 6.4.4 for details about linking cavities to glazing cavities.



*Figure 20-49. If needed, create a material link between the glazing system cavity.* 

5. Generate the **Boundary Conditions** by pressing the **BC** toolbar button. The figure below shows the boundary conditions for one storm window cross section. Make sure that the interior boundary conditions have the Radiation Model set to "AutoEnclosure".

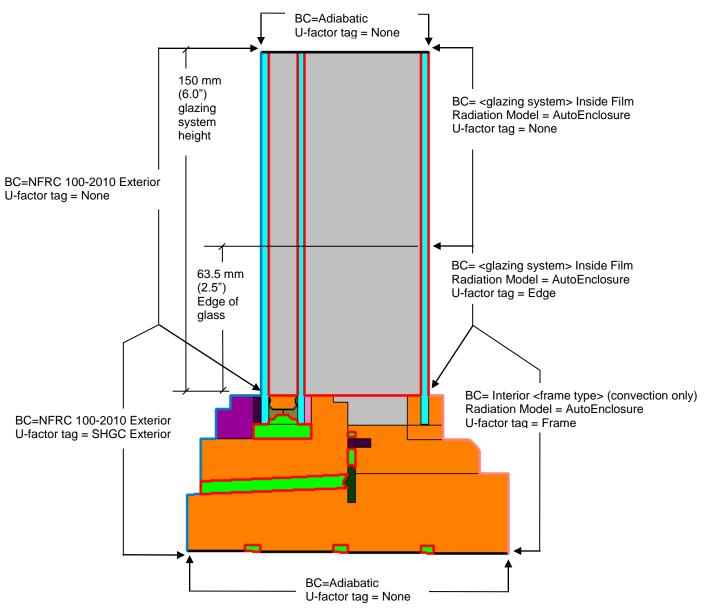


Figure 20-50. Define the boundary conditions.

6. Simulate the problem and save the file.

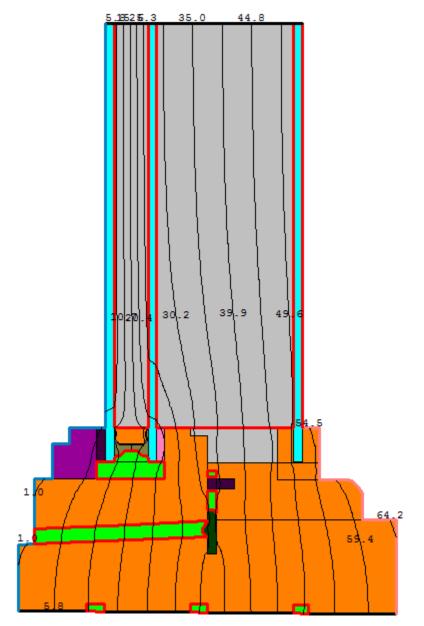
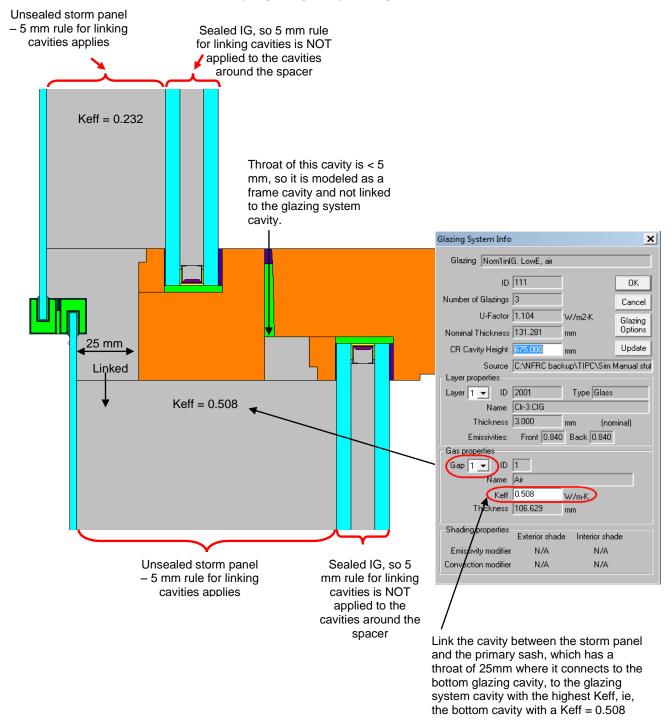


Figure 20-51. Simulate the file.

### 20.4.3. Storm Window Meeting Rails

In the case of a meeting rail with a storm window, if the the space between the storm panel and the primary sash is > 5 mm, that space is linked to the glazing system cavity with the highest Keff (effective conductivity) value. See Chapter 6 for the frame cavity / glazing cavity linking rules for sealed and unsealed units.



*Figure 20-52. Link the cavity between the storm panel and the primary sash, which is > 5 mm, to the glazing system with the highest Keff value.* 

### 20.4.4. Steps for Storm Window Condensation Resistance Calculation

The Condensation Resistance model is only appropriate for *horizontal* frame components such as Head and Sill elements – THERM will not calculate the Condensation Resistance for a file with the **Cross Section Type** set to "Jamb" or "Vertical Meeting Rail".

There are two methods for calculating the Condensation Resistance information in THERM, which will be used in WINDOW to calculate the total Condensation Resistance of the product:

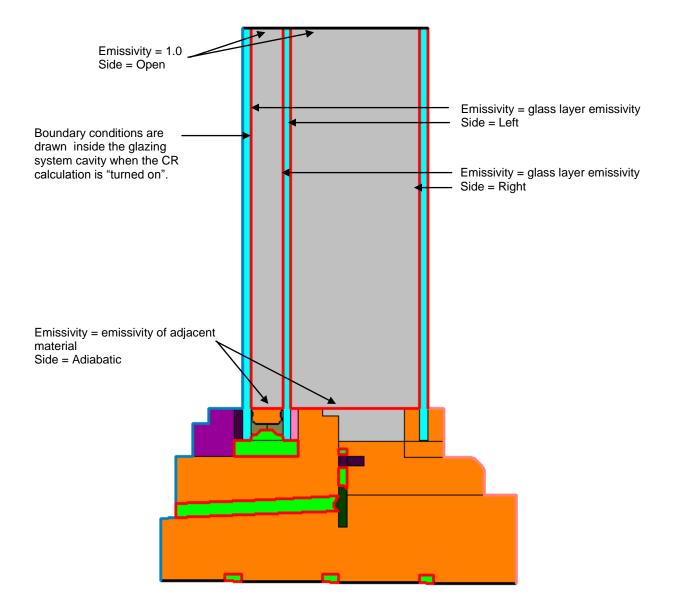
- Check the "Use CR Model for Window Glazing System" checkbox when importing a glazing system OR
- In the Options menu, Preferences choice, THERM File Options tab, check the "Use CR Model for Glazing Systems", as shown in the figure below.

Preferen	ces Dray	ving Options
Simulation	Therm File Options	Snap Setting:
Run Er	fesh Parameter	*

*Figure 20-53.* In Options/Preferences/Therm File Options, check the "Use CR Model for Glazing Systems" checkbox.

When the CR model has been "turned on", red boundary conditions will appear inside the glazing system, and the following steps should be taken to simulate the file:

- 1. Check the emissivities of these boundary conditions. They should be the following:
  - Emissivity of the surrounding surface, such as 0.84 for standard glass, 0.90 for painted metal and most other frame materials, 0.20 for mill finish metal, and so forth.
  - 1.0 for the adiabatic (open end) of the glazing cavity.
- 2. Simulate the model. The program will calculate both U-factor results and the Condensation Resistance results if the CR model is checked.
- 3. Import the results into the WINDOW **Frame Library** and use the file to create the whole product in the **Window Library** as applicable.



*Figure 20-54. Red boundary conditions will appear inside the glazing system when the Condensation Resistance option is turned on. Check the emissivities of each boundary condition.* 

### 20.4.4.3. Calculate the Total Product Values in WINDOW

The following discussion explains how to model the whole product values for the storm window in WINDOW.

• Import the THERM files into the WINDOW Frame Library.

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		<u>С</u> ору				18	Stormy	vindov	v-sill.tł	hm				Th	erm	Sil	I		0.439	1.91	5	N/A	72.6	69.0	0.30	
	_	Gobà				19	Stormy		· ·					Th	erm	Ja	mb		0.452	1.93	0	N/A	72.6	69.0	0.30	
		Delete			•	20	Stormy	vindov	v-head	d.thm				Th	erm	He	ead		0.440	1.91	7	N/A	72.6	69.0	0.30	
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For H	łelp,	press F	1																				Mode: N	IFRC SI	NU	M SCRL

Figure 20-55. Import the storm window THERM files.

• In the WINDOW **Window Library**, construct the storm window from the THERM files and the glazing system previously defined, and calculate the total product values.

🚦 Window Library (C	:\Program Files\LBNL\WINDOW63	3\StormWindow.mdb)	_ 🗆 🗙
File Edit Libraries R	ecord Tools View Help		
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List Calc (F9) New Copy Delete Save Report Dividers Dividers	ID # 5 V Name Storm Window Mode NFRC V Type Fixed (picture) V Width 1200 mm Height 1500 mm Area 1.800 m2 Tilt 90 Environmental Conditions NFRC 100-2010 V		1
Display mode: Normal	Total Window Results U-factor ? W/m2-K SHGC ? Detail VT ? Detail CR ? Detail	Click on a component to display characteristics below Frame Name Stormwindow-sill.thm	
		Mada NEDC CT	
For Help, press F1		Mode: NFRC SI NUM	4 SCRL //

Figure 20-56. Storm window created in the Window Library to obtain total product results.

# 20.5 Skylights

This section discusses the modeling procedures for skylights, which are modeled in sections in a similar manner to other products. In addition, in accordance with *NFRC 100*, skylights are modeled at a 20° slope from horizontal.

### 20.5.1. Skylight Modeling Steps

The steps for modeling a skylight are as follows:

### In WINDOW:

- Create the skylight glazing system in WINDOW:
  - Set **Tilt** to "20" degrees

### In THERM:

- Draw the required frame cross sections in THERM, for example a head, sill, and jambs if they are all different, untilted. Because the tilt of the jambs will be in the z-direction, which is not possible to display in the two dimensional viewing of THERM, they will be drawn vertically and the gravity vector oriented properly to reflect the tilt in the z-direction.
- Do not use the Condensation Resistance Model on any of the THERM skylight cross sections. WINDOW
  will calculate the CR value based on the temperatures from the U-factor results. (Even if the THERM
  cross sections are modeled with CR enabled, WINDOW will use the U-factor temperature results rather
  than the CR temperature results when calculating the whole product CR value).
- Set the **Cross Section** value in **File/Properties** as follows:
  - For Sill: set Cross Section to "Sill", Gravity Vector should face "Down"
  - For Head: set Cross Section to "Head", Gravity Vector should face "Down"
  - For Jambs: set Cross Section to "Sill", set Gravity Vector to "Right"
- The Frame Cavity height is not used by the program for the skylight cross sections, as long as the Types are defined properly as shown above, so the default value of 1000 mm can be left unchanged.
- Insert the glazing system from WINDOW into the frame cross sections with the Glazing system height field set to 150 mm (6.0 inches) and the Edge of Glass Dimension field set to 63.5 mm (2.5 inches). The CR cavity height field can be set to any value (you can leave it set to the default of 1000 mm) because the U-factor temperatures not the CR temperatures will be used in WINDOW to calculate the overall CR value).
  - Insert the **Sill** glazing system with orientation up
  - Insert the Head glazing system with orientation down
  - Insert the **Jamb** glazing system with orientation up
- Assign the boundary conditions. Interior Boundary conditions have the following settings:
  - Radiation Model set to "AutoEnclosure"
  - Frame Boundary Conditions: set to the appropriate "Interior (20 tilt) ..." choices
- Tilt the cross section 20 degrees from horizontal:
  - For a **Sill** or **Head**, rotate the entire model 70 degrees clockwise

- For **Jambs**, do not rotate the model at all
- Simulate the skylight cross sections and save them.
- View the U-factor for the cross section, and make sure the "Projected in Glass Plane" is selected from the Projection pulldown list, as shown in the figure below. This will ensure that the projection will be correct for the tilted cross section.

U-Factors					×
SHGC Exterior	U-factor W/m2-C 3.5302	delta T C 39.0	Length mm 198.411	Rotation 70.0	Projected in Glass Plane
Frame	4.9540	39.0	44.0342	70.0	Projected in Glass Plane 💌
Edge 💌	3.2525	39.0	63.5	70.0	Projected in Glass Plane
% Error Energy Norm	4.45%				Export OK

Figure 20-57. Make sure the "Projected in Glass Plane" projection option is selected for the tilted cross section.

There is a circumstance where THERM will not calculate the total frame length correctly, and it is necessary to enter a "Custom Frame Length" into the U-factor dialog box above. It occurs when a section of an adiabatic boundary "overlaps" a boundary with a U-factor tag in the projected dimension over which the length is being calculated.

- Import the components into the WINDOW Frame Library (and Divider Library if appropriate)
- Construct the whole product in the WINDOW Window Library to get the overall product results.

### 20.5.2. Skylight Mounting Details

There are two ways that skylights can be mounted into a roof system, either flush-mounted (also called insetmounted) or curb-mounted. The figures below show these two different mounting styles. Each mounting style has a slightly different definition of the adiabatic boundary condition, and each will have a different projected frame length. The rules for modeling can be found in *NFRC 100* and the NFRC Technical Interpretations. To model curb mounted skylights, if the projected frame height is zero, define a Frame Ufactor Surface Tag 0.25 mm (0.01 inches) up the interior of the glass, which will result in a non-zero frame height.

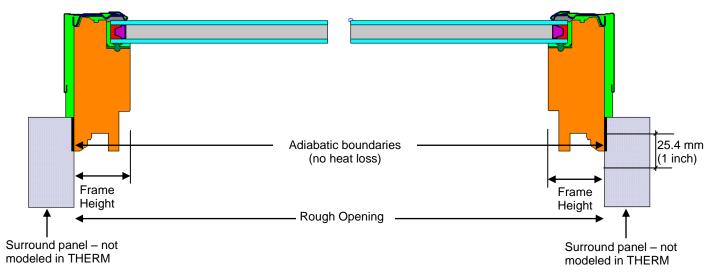


Figure 20-58. A flush-mounted (or inset-mounted) skylight.

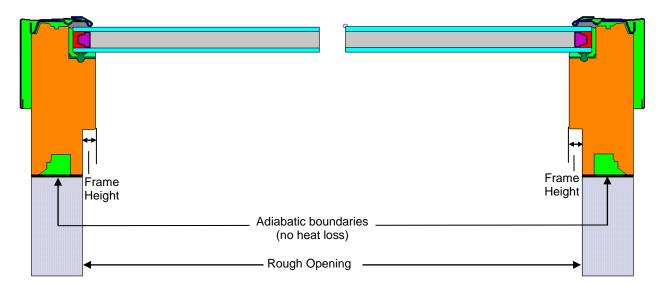


Figure 20-59. A curb-mounted skylight.

### 20.5.3. Example Flush Mounted Skylight Problem

This example assumes a flush-mounted skylight.

#### In WINDOW:

1. **Glazing System Library:** Make a glazing system with a tilt of 20° off horizontal. In this example, the glazing system is called **Skylight Double Glz** and is made up of generic glass layers.

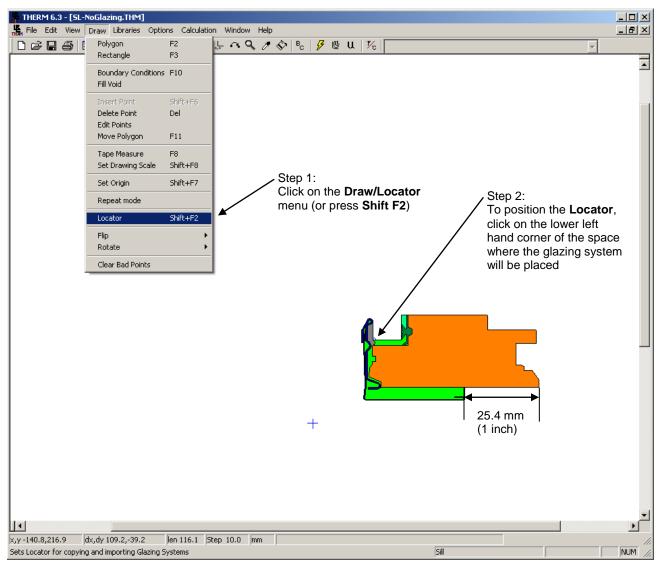
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	<u>N</u> ew			# Laye	ers: 2		Tilt:	20	ī °	IG F	leight:	100	)0 mm				8						
	<u>С</u> ору	1	Er	nvironmer Conditio	ntal Ins: Ni	RC 10	D-2010		•	IG Y	width:	100	)0 mm				8						
	<u>D</u> elete	ī		Comme	_									1		1	×>> 2						
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	<u>R</u> eport	i I				ID		Name		Mode	Thick	Flip	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	E1	E2	Cond	
		-	•	Glass	:1 🕨	102	CLEAR	_3.DAT		#	3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	1.000	
				Gap	1 🕨	1	Air				10.9												
			-	Glass	2 🕨	102	CLEAR	_3.DAT		#	3.0		0.834	0.075	0.075	0.899	0.083	0.083	0.000	0.840	0.840	1.000	
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Figure 20-60. Make new glazing system in the Glazing System Library with Tilt = 20 degrees.

2. Save the file: Make sure to save the glazing system (Record menu, Save choice.).

## In THERM, for Sill:

1. Draw the appropriate cross sections for the Sill.



*Figure 20-61. Position the locator so that the first glazing section can be inserted.* 

- 2. Insert the glazing system for the Sill, with the following settings:
  - Orientation = Up
  - Cavity height = 1000 mm
  - Sight line to bottom of glass = measure this value with the tape measure or get from dimensioned drawings
  - **Spacer height** = measure this value with the tape measure or get from dimensioned drawings
  - Edge of Glass Dimension = 63.5 mm (2.5 inches)
  - Draw spacer = not checked

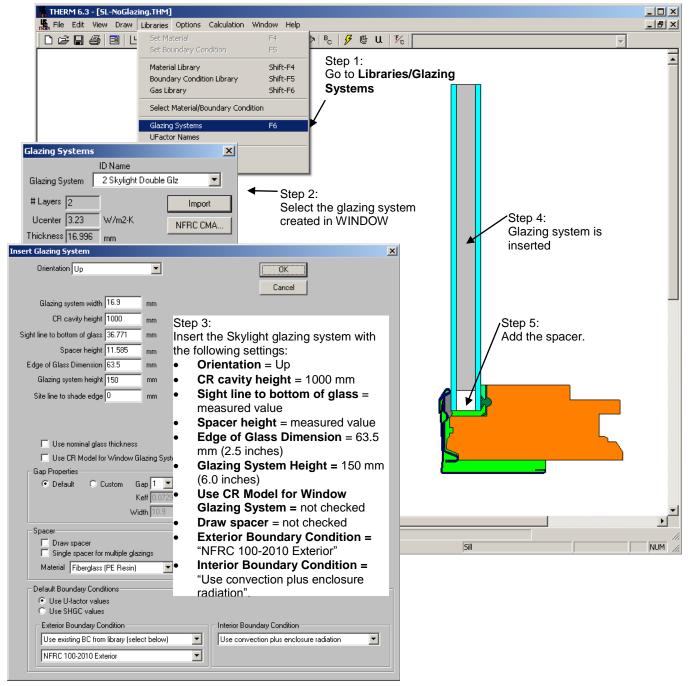


Figure 20-62. Insert the glazing system.

- Note: If using the Multiple Glazing Options feature of THERM, set up the multiple glazing options before tilting the profile, so that all the Boundary Conditions become defined automatically for the glazing options by THERM. Then tilt the cross-section.
- 3. Assign Boundary Conditions and U-factor tags: Click on the Boundary Conditions (BC) toolbar button and correct any problems encountered with the geometry (see Section 6.5.3, "Voids, Overlaps, and Bad Points" in this manual).
- 4. Tilt the cross section to be 20 degrees off the horizontal plane. For this example sill cross section, click on the **Draw** menu, **Rotate/Degree** choice, and enter **70** degrees **Clockwise**.

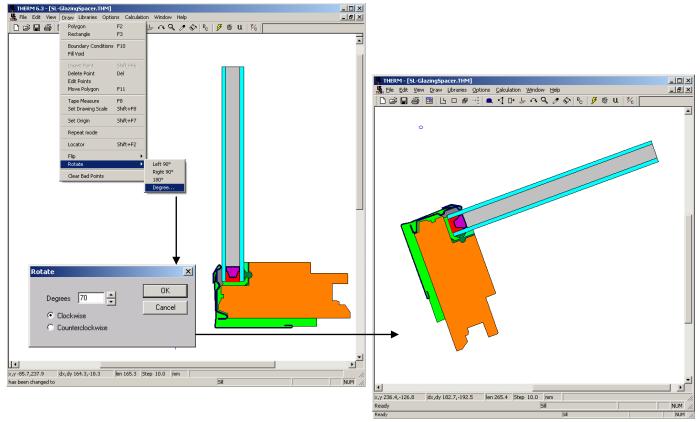
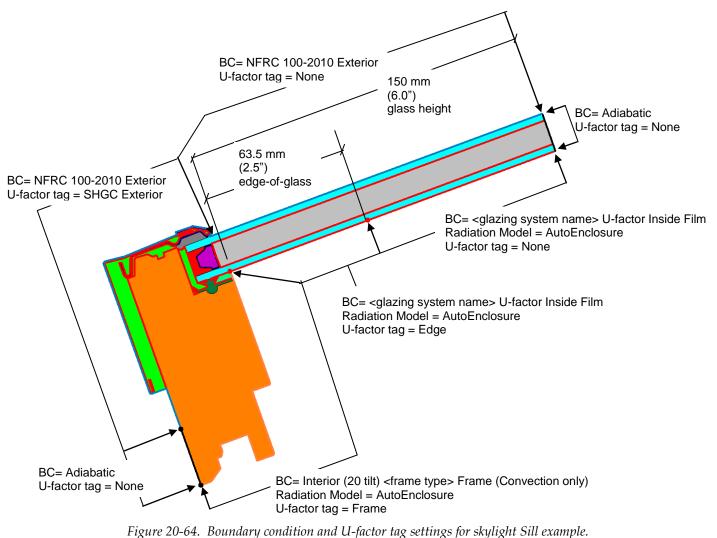


Figure 20-63. Rotate the sill cross section AFTER assigning Boundary Conditions.

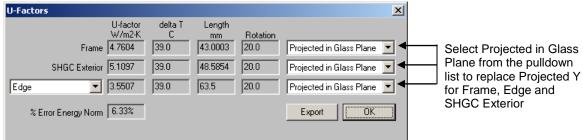


- Check the Gravity Vector for the Sill cross section (View/Gravity Arrow), which should point
- 7. Simulate the file.

down.



8. Click on the Show U-factors button to view the U-factors dialog box. Make sure that the projection is set to "Projected in Glass Plane" which will allow the program to calculate the correct projected frame dimensions with a tilted cross section.



*Figure 20-65. Select the Projected in Glass Plane for the projected frame dimension calculation.* 

### In THERM, for Head:

- 1. Create the cross section for the Head, set the **Cross Section Type** to "Head", and import the glazing system facing **Down** (in order to get the Gravity Vector pointing in the proper direction).
- 2. Assign the Boundary Conditions as shown in the figure below.
- 3. Tilt the Head cross section so that it is 20 degrees off horizontal (click on the **Draw** menu, **Rotate/Degree** choice, and enter **70** degrees **Clockwise**).
- 4. Check the Gravity Vector (View/Gravity Arrow), which should be pointed down.

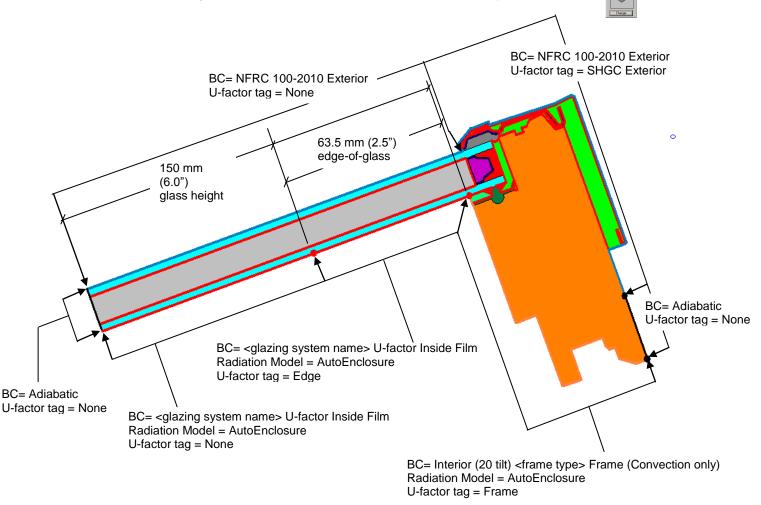


Figure 20-66. Boundary condition and U-factor tag settings for skylight Head example.

5. Simulate the file.

6. Click on the Show U-factors button to view the U-factors dialog box. Make sure that the projection is set to "Projected in Glass Plane" which will allow the program to calculate the correct projected frame dimensions with a tilted cross section.

U-Factors					×
Frame	U-factor W/m2-K 4.7955	delta T C 39.0	Length mm 43.0001	Rotation 20.0	Projected in Glass Plane
SHGC Exterior	5.1479	39.0	48.5853	20.0	Projected in Glass Plane 💌
Edge 💌	3.5527	39.0	63.5	20.0	Projected in Glass Plane 💌
% Error Energy Norm	7.37%				Export OK

Figure 20-67. Select the Projected in Glass Plane for the projected frame dimension calculation.

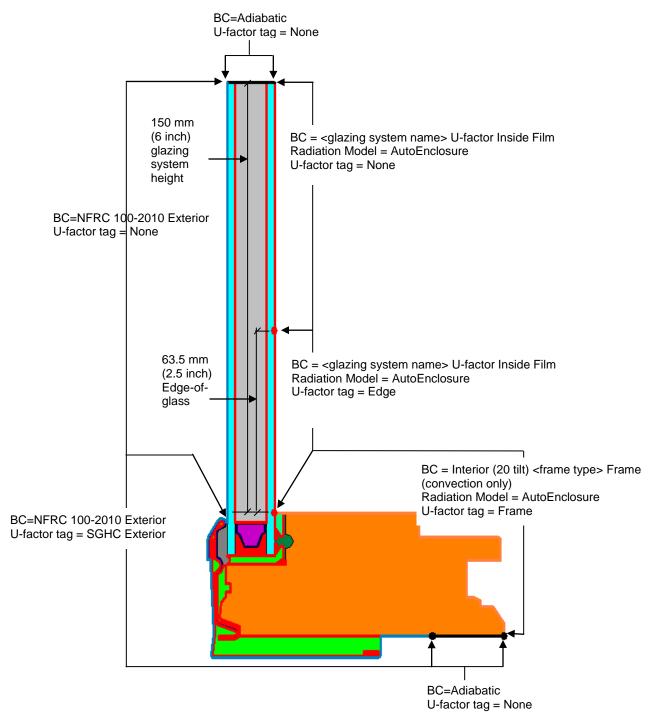
### In THERM, for Jamb:

- 1. Create the cross-section for the Jamb. The steps are similar to modeling the head and sill, except for the following:
  - Jambs are modeled in the vertical direction
  - The Cross Section Type is set to "Sill" (because the dominant direction of gravity is not vertical as it is with a normal jamb)
  - The glazing system is oriented "Up"
  - The gravity vector is set by hand to "Right"
- 2. Simulate the file.

Because the cross section is not rotated, the projection in the U-factor dialog box can be set to either "Projected Y" or "Projected in Glass Plane"; both settings will result in the same answer.

U-Factors					X
Fram	U-factor W/m2-K e 4.8282	delta T C 39.0	Length mm 43.0002	Rotation 90.0	Projected in Glass Plane
SHGC Exteri	or 5.1595	39.0	48.5853	90.0	Projected in Glass Plane 💌
Edge	3.5455	39.0	63.5	90.0	Projected in Glass Plane 💌
% Error Energy Nor	m 7.30%				Export OK

*Figure 20-68.* The projection can be set to either "Projected Y" or "Projected in Glass Plane"; both will result in the same answer.



*Figure 20-69.* Boundary condition and U-factor tag settings for skylight jamb example.

## In WINDOW, Calculate the Total Product U-factor:

1. In the WINDOW **Frame Library**, import the THERM files for the Head, Sill, Jamb and any other needed cross sections that were modeled.

Detailed View	Frame	Library	(C:\Users\Public\LBNL\WINI	DOW6\Skylight.md	Ь)						
Update		ID	Name	Source	Туре	Frame Uvalue	Edge Uvalue	Edge Correlation	Glazing Thickness	Pfd	Abs
New						W/m2-K	W/m2-K		mm	mm	
<u> </u>	•	1	HD.THM	Therm	Head	4.795	3.553	N/A	16.9	43.0	0.30
		2	JB.THM	Therm	Sill	4.784	3.551	N/A	16.9	43.0	0.30
Delete		3	SL.THM	Therm	∕ sill	4.760	3.551	N/A	16.9	43.0	0.30
Advanced			Jamb has cross s Jamb description		⊧ Sill (see	9					
3 records found.  Import Export Report Print											

*Figure 20-70. Import the skylight THERM files into the WINDOW Frame Library.* 

2. Construct the whole skylight in the WINDOW **Window Library** by using the THERM files for the frame components and the glazing system for the center of glass. Make sure that Type = Skylight and Tilt = 20

<u>File Edit Libraries</u>	<u>R</u> ecord Tools <u>V</u> iew <u>H</u> elp	
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List Calc (F9) New Copy Delete Save Report Dividers Dividers Dividers Dividers	ID # 1 Name Skylight - 3mm Generic Mode NFRC Type Skylight Type Skylight 1200 mm Height 1200 mm Area 1.440 m2 Tilt 20 Environmental Conditions NFRC 100-2010 Total Window Results U-factor 3.5062 W/m2-K SHGC 0.6623 VT 0.7017 CR 36 Detail	Click on a component to display characteristics below         Frame         Name       SLTHM       >>         ID       3       Uedge       3.553       W/m2-K         Source       2       Edge area       0.067       m2         Ufactor       4.760       W/m2-K       PFD       43.0         Area       0.050       m2       Abs       0.300

*Figure 20-71. Create the whole skylight in the Window Library.* 

# 20.5.4. Domed Skylights / Glass Block

The following describes the steps for simulating a domed skylight or glass block product to obtain the total product U-factor.

- 1) Determine the glazing components conductance, Cs, per ASTM C1363.
- 2) Calculate the effective conductivity (to 3 significant figures) in  $Btu/h/ft/{}^{\circ}F$  by the following formula: Keffglass = Cs \* t / 12,

Where:

Cs	=	Conductance of glass as determined per ASTM C1363 test
Т	=	thickness of sample in inches
12	=	conversion factor from conductance to conductivity
		(Btu-in/hr/ft2/ºF to Btu/h/ft/ºF)

- 3) Make a new a glass layer in the Glass Library, and set the conductance to the calculated Keffglass value.
  - a. Enter the thickness of the sample
  - b. If the sample is glass, enter 0.84 for the emissivity of the front and back surfaces
  - c. If the sample is not glass, then the emissivity of the material shall be determined per the applicable ASTM standard.
  - d. The solar, visible, and Tir spectral data values shall not be used and therefore the default values shown do not need to be modified.
- 4) Build the glazing system to be used in the THERM model in the Glazing System Library
- 5) Import the glazing system into the applicable THERM model.

### Glass Block Example

- 1. The Cs value from the ASTM C1363 test = 0.635 Btu/hr-ft2- $^{\circ}$ F. The glass = 1.008" thick.
- 2. Keffglass = 0.635 \* 1.008 / 12 = 0.0533 Btu/hr-ft- ${}^{\circ}F = 0.092$  W/m-K
- 3. In the Glass Library, make a new record, and set the Conducivity to 0.092 W/m-K. Set the front and back emissivity to 0.84.

	<pre>:\Program Files\LBNL\WINDOW63\Skylight.mdb) ecord Tools View Help</pre>	-OX
		? №
List Optics 5 New Copy Delete Save	Glass Library       ID #:       20000       Thickness:       25.6 mm         Name:       Glass Block       Product Name:	•
For Help, press F1	Mode: NFRC SI NUM	1

Figure 20-72. Create a new record in the Glass Library for the Glass Block tested value.

4. In the Glazing System library, create a record for, in this example, a glass block glazing system using the new glass layer created in the Glass Library, and calculate the properties.

🚦 Window Library (	C:\Program Files\LBNL	WINDOW63/5	kylight.mdb)										
File Edit Libraries Record Tools View Help													
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Glazing System Library													
List													
Calc (F9)	ID #: 3	Name:	Glass Block 25	mm				_					
New	# Layers: 1	• • • • • •	90 *	IG Height:	1000 mm								
Сору	Environmental Conditions:	FRC 100-2010	-	IG Width:	1000 mm								
<u>D</u> elete	Comment:						1						
Save	Overall thickness: 25	5.603 mm	Mode: ?			1							
<u>R</u> eport		ID	Name	Mode Thick	Flip Tsol	Rsol1 Rsol2	Tvis Rvis1	Rvis2 Tir	E1	E2	Cond		
	🔹 Glass 1 🕨	20000 Glass Bl	lock	25.6	0.834	0.075 0.075	0.899 0.083	0.083 0.00	0 0.840	0.840	0.092		
											<u> </u>		
	Center of Glass Results   Temperature Data   Optical Data   Angular Data   Color Properties												
	Ufactor	SC	SHGC	Rel. Ht	. Gain	Tvis	Keff						
	W/m2-K			W/i	m2		W/m-K						
	2.2250	1.0018	0.8715	64	9	0.8992	N/A						
For Help, press F1								Mode: NF	RC SI	NU	м 🕅 //		

*Figure 20-73. Create a new record in the Glazing System Library using the Glass Block layer.* 

- 5. Import the glazing system into the applicable THERM model and simulate the product.
- 6. Calculate the total product U-factor. WINDOW should be able to calculate this value but if not, then use a spreadsheet to obtain the area-weighted U-factor.

## 20.5.5. Sloped Glazing Systems with Large Gaps:

WINDOW can now calculate the Center-of-Glass correctly for gaps widths greater than 30 mm. Therefore, there are no special steps required for this situation – model it as you would any other sloped skylight.

## 20.6 Doors

Swinging entry doors are modeled differently than window products because there are more opaque sections to be modeled in THERM. The procedures for modeling doors are included in *NFRC 100* and that document should be reviewed in detail before modeling any entry door systems.

NFRC has defined ten regions within a door that need to be modeled. These regions include:

- Frame Area
- Lite Frame Area
- Divider area
- Edge-of-divider area
- Edge-of-Lite Area
- Center-of-lite area
- Door Core Area
- Panel Area
- Edge-of-Panel Area

NFRC 100 contains several figures which illustrate the location of the door sections to be modeled in THERM.

When modeling glazing options with caming, the NFRC default caming can be used. See the section on Dividers in this chapter for information about modeling caming inside an IG.

A spreadsheet must be used to do the door area-weighting from the THERM files, because the current version of WINDOW does not area-weight doors. In THERM, the U-factor Surface Tags can have any name and as many U-factor Surface Tags can be defined as are needed to accurately describe the model. (See Section 6.2.4, "Define U-factor Surface Tags in the *THERM User's Manual*), so define as many U-factor Surface Tags as needed and name them descriptively.

SHGC CalculationWhen calculating the SHGC for the opaque components of a door, using the ISO 15099 equation for frames (see formula for SHGC<sub>f</sub> below), using an  $h_{out}$  value of 30 W/m<sup>2</sup>-°C.

$$SHGC_{\rm f} = \alpha_{\rm f} \cdot \frac{U_{\rm f}}{\frac{A_{\rm surf}}{A_{\rm f}} h_{\rm out}}$$

### Boundary Conditions for Steel Skin Doors

The following boundary conditions (BC) shall be applied when modeling doors containing a steel skin with either a non-metal or wood edge or steel edge. The appropriate BC shall be applied to applicable individual sections.

Door section material	Boundary Condition
Non-metal / wood edge	Wood / Vinyl
Steel edge	Thermally-Improved

## 20.7 Spacers

### 20.7.1. Overview

THERM has the capability to model spacers in great detail, so that modeling of spacer effective conductivity is no longer needed. Spacer models can be easily reshaped in THERM, and the program's cut and paste feature allows spacers to be copied into each cross section as needed. A library of spacer models can be produced for each spacer type. A sample spacer, spacer.thm, is included on the THERM installation CD.

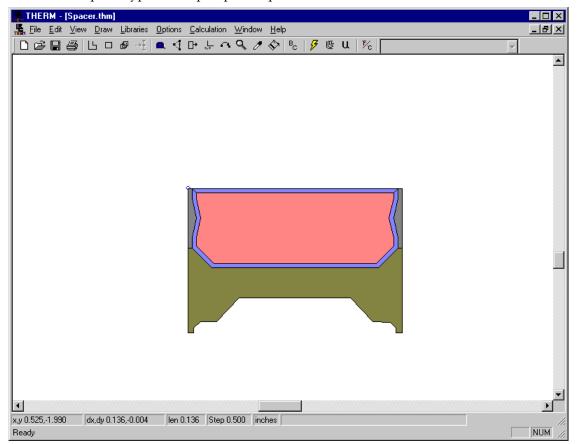


Figure 20-74. Spacer.thm sample file.

## 20.7.2. Linking Glazing Cavity properties (imported from WINDOW) for Open Spacers

The properties of a glazing cavity can be linked to another polygon in order to properly model spacers that are open to the glazing system cavity.

To Link the properties of two materials, follow these steps:

- Select the polygon that is to linked to another polygon
- Select the Libraries/Create Link menu choice.
- The cursor will become an Eye Dropper. Click the Eye Dropper cursor in the polygon to be linked to. The material properties of the first polygon are not linked to the material properties of the second polygon.

When using the multiple glazing calculation option, THERM will automatically use the glazing system cavity properties for each glazing option for the linked polygon.

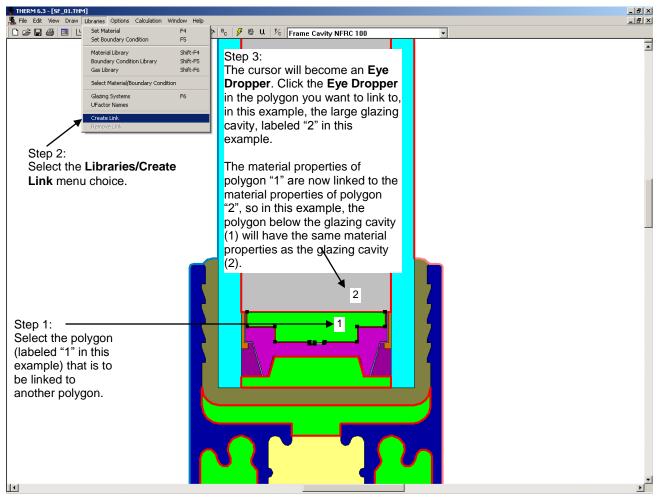
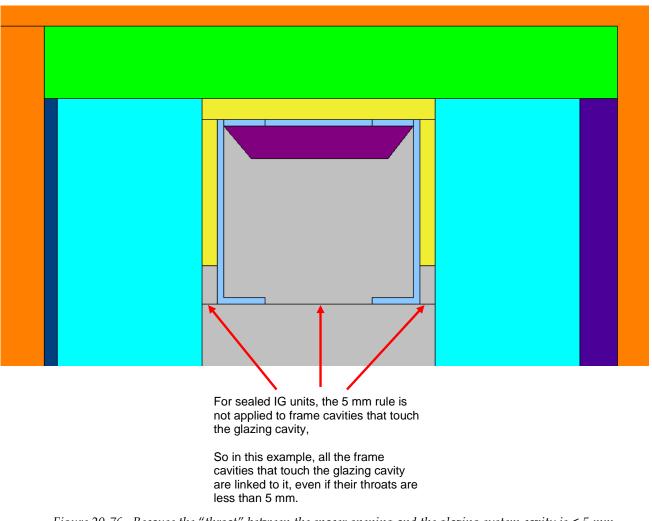


Figure 20-75. Link the open spacer cavity to the glazing system cavity using the Library/Create Link feature .

Another example of an "open" spacer is shown below. For sealed glazing systems (such as an IG) the 5 mm rule for linking frame cavities and glazing cavities does not apply. So in the example below, the frame cavity inside the spacer as well as the two small cavities on either side of it, all of which are connected to the glazing cavity, are linked to the glazing cavity even though the connection (throat) to the glazing cavity is less than 5 mm.



*Figure 20-76.* Because the "throat" between the spacer opening and the glazing system cavity is < 5 mm, the two cavities are not linked.

# 20.8 Non Continuous Thermal Bridge Elements

Bolts, skip and debridge thermal break, including partially de-bridged thermal break material, and thermally slotted cross section shall be included in the model using the concept of *isothermal planes*. The isothermal planes methodology calculates an effective conductivity of the bridging material based on area weighting the sections of the product with and without thermal bridging material based on the bridging material spacing dimensions. This method is also valid for other regularly spaced thermal bridges such as skip-and-debridged systems.

The effect on the performance of a curtain wall system due to bolts is explained in detail in an ASHRAE paper published in 1998 entitled *"The Significance of Bolts in the Thermal Performance of Curtain-Wall Frames for Glazed Facades", by Brent Griffith, Elizabeth Finlayson, Mehrangiz Yazdanian and Dariush Arasteh.* 

The THERM model to be simulated for the final result is one in which the actual materials of the thermal bridging elements are replaced with a user-defined material having an effective conductivity which represents the area-weighted value that combines the bridging and non-bridging elements.

Figure 20-77 below illustrates an example of a curtain wall system which would require that the thermal bridging elements, in this case the bolts, be modeled using the isothermal planes method.

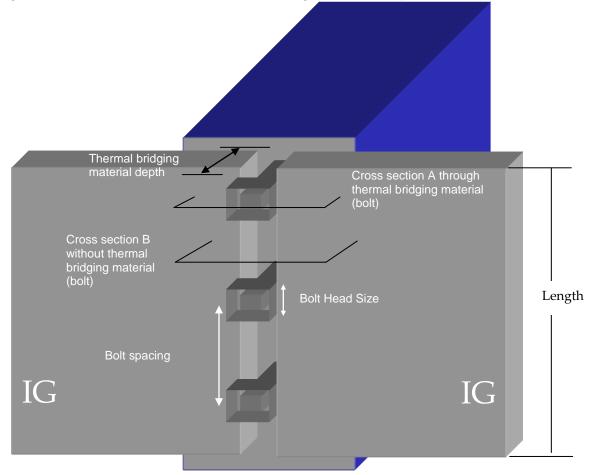


Figure 20-77. Example of a curtain wall system with regularly spaced bolts which act as thermal bridges.

### 20.8.3. Modeling Steps

The steps for constructing the final THERM model to be simulated are the following:

- 1. Draw the THERM model without the thermal bridging material.
- 2. Determine the conductivities of the materials that the thermal bridging material replaces.
  - Conductivities of *materials* can be obtained from the THERM Material Library
  - Conductivities of *air-filled* cavities (such as frame cavities) are assumed to be 0.024 W/m-K (or 0.014 Btu/hr-ft-°F).
- 3. Using a cross-section that contains the non-thermal bridging material, measure the depths of each element of the non-thermal bridging material that will have a different thermal conductivity in the non-bridging cross section.
- 4. Use the conductivities of the non-thermal bridging materials and depths of the non-thermal bridging materials in Equation 2 below to determine the Resistance (R) for each non-thermal bridging element.
- 5. Sum the resistances (Rt) and divide by the total depth of the non-thermal bridging elements to obtain Kn, as shown in Equation 3, to calculate the conductivity of the non-thermal bridging elements
- 6. Calculate the fraction of thermal and non-thermal bridging material along the length of the façade using Equations 4 and 5.
- 7. Calculate the final effective conductivity value for the thermal bridging elements using Equation 1.
- 8. In THERM, define a new material with the Keff value derived in Step 7, and assign it to the cross section polygons that represent the thermal bridging elements.
- 9. Simulate the model.

### 20.8.4. Equations

Calculate the effective conductivity of thermal bridging elements (e.g., bolts, screws, etc.)

Keff= Fb\*Kb + Fn\*Kn

Equation 1

where

- Fb = Fraction of the Length which contains the thermal bridging elements (see equation 4 below)
- Fn = the fraction of the Length which contains non-thermal bridging elements(see equation 5 below)
- Kb = conductivity of the thermal bridging elements
- Kn = conductivity of the non-thermal-bridging elements (from the sum of the resistances, Rt, of individual elements from Equation 2 below) Assume a default value of 0.024 W/m-K for air cavities.

This methodology should be applied with the following caveats:

- If less than 1% (to obtain percentage, multiply fraction by a 100) of the Length is made of thermal bridging elements (such as stainless steel), i.e., Fb < 0.01, do not model the thermal bridging elements.</li>
- If between 1% and 5% of the Length is made of thermal bridging elements (0.01 <= Fb <= 0.05) and if the conductivity of the thermal bridging elements is more than 10 times the conductivity of the thermal break, model the thermal bridging elements using the keff calculated in Equation 1.
- If more than 5% of the length is made of thermal bridging elements (Fb > 0.05), model the thermal bridging elements using the keff calculated in Equation 1.

Calculate the total resistance of the non-thermal bridging elements, Rt, by summing individual resistances (non-thermal bridging element conductivity) for each non-thermal bridging element using the formula:

 $Rt = \Sigma(D / k)$ 

*Equation* 2

Where:

Rt = Sum of the thermal resistances of the individual non-thermal bridging material. Units:  $m^2 K/W$  (SI), or hr ft<sup>2</sup>.°F/Btu (IP)

D = Depth of the individual non-thermal bridging elements that will be substituted by the calculated effective conductivity. Units: m (SI), or ft (IP), or (in) (alternate IP)k = conductivity of the individual non-thermal bridging elements that will be substituted. Units: W/m·K (SI), or Btu/hr in °F (IP), or Btu in/hr ft<sup>2</sup> °F (alternate IP)

Therefore:

Kn=Dt/Rt

Equation 3

Where:

Dt = Total depth, which is the sum of the depths of the individual non-thermal bridging elements

Calculate the fraction of thermal bridging material to non thermal bridging material as follows:

Fb=Wb / Sb(%Fb=Fb 100)Equation 4Fn=1-FbEquation 5

Where:

Wb = Bridging material width

Sb = Bridging material spacing

## 20.8.5. Example 1: Bolts in Curtain Wall

Note: This example is only presented in SI units and is not translated into IP units.

The following figures show two cross sections of the curtain wall in Figure 20-78. Figure 20-80 represents the cross section of the curtain wall where the bolt occurs (screw threads should be averaged and not drawn explicitly), and Figure 20-79 represents the cross section of the curtain wall where the bolt does not occur. The geometry of the cross-section in Figure 20-80 would be used for the final THERM run, and the conductivity of the materials used to define the bolt would be changed to the value derived from the methodology explained in this section. The geometry in Figure 20-79 is drawn only to obtain the conductivity values for calculating the conductivity of this "averaged" material.

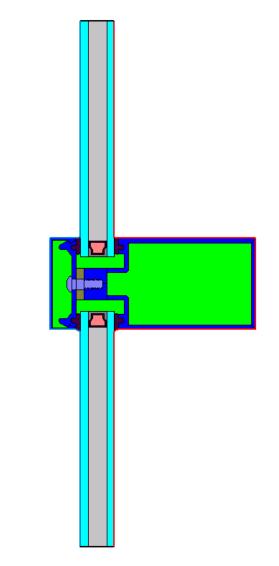


Figure 20-78. THERM cross section where the bolt occurs (curtain wall bolt.thm).

Figure 20-79 shows the conductivity values for the four materials that must be obtained for the calculation. Material 1 and 4 are air cavities, and the conductivity is assumed to be 0.024 W/m-K.

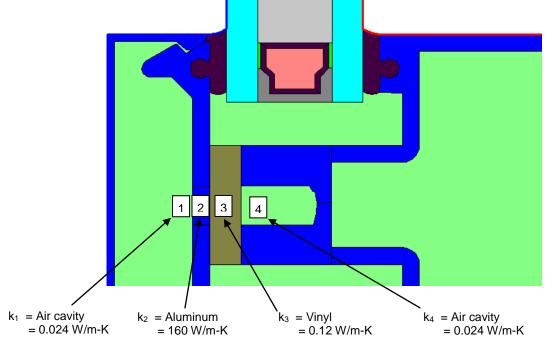


Figure 20-79. Materials in the non-bridging material cross section for which conductivities must be obtained.

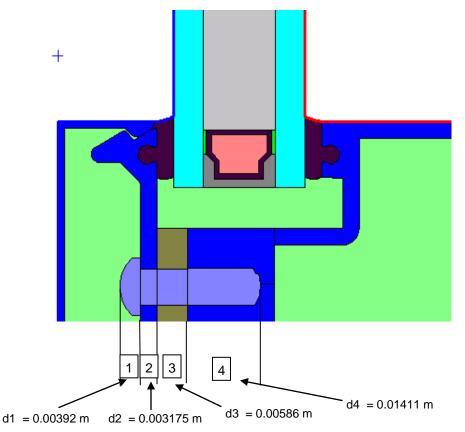


Figure 20-80 shows the depths of each of the thermal bridging elements that are used in the Keff calculation.

## *Figure 20-80. Material depths for the thermal bridging materials.*

Table 20-1 shows the conductivity and depth values used to calculate the R for each non-thermal bridging element using Equation 2.

Cross Section Element	Material	Conductivity [W/mK]	Depth (m)	R [m2K/ W]
1	Air cavity (default value)	0.024	0.00392	0.16333
2	Aluminum (conductivity from THERM Material Library)	160	0.003175	0.0000198
3	Vinyl (conductivity from THERM Material Library)	0.12	0.00586	0.049
4	Air cavity (default value)	0.024	0.01411	0.587917
	Total		0.02706	0.800103

Table 20-1

Calculate Rt as follows:

Rt =  $\Sigma(d/k)$ =  $(d_1/k_1) + (d_2/k_2) + (d_3/k_3) + (d_4/k_4)$ (0.00392 / 0.024) + (0.003175 / 160) + (0.00586 / 0.12) + (0.01411 / 0.024) = 0.800103 m<sup>2</sup>K/W = 0.00392 m + 0.003175 m + 0.00586 m + 0.01411 m Dt = 0.02706 m = Calculate the conductivities as follows: Kn =  $D_t/R_t$ 0.02706 / 0.800103 = = 0.033821 W/m·K Kb 14.3 W/m·K (stainless steel) = Calculate the fraction of bolt to no bolt as follows: Wb Bolt head width = = 11.1 mm Sb = Bolt spacing 12" 304.8 mm = Fb Wb / Sb = 11.1 mm / 304.8 mm = 0.036 (%Fb=0.036 ·100 = 3.6%) =

- Fn = 1-Fb
  - = 1-0.036
  - = 0.964

Calculate the new Keff, which will be used in THERM as follows:

Keff	=	Fb*Kb + Fn*Kn
Keff	=	(0.036 * 14.3)+(0.964 * 0.033827)
	=	0.55 W/m·K

In THERM, create a new material in the Material Library with this Keff. In the THERM cross section, the bolt material should be changed from Stainless Steel to this new material. The resulting cross section is a 2-D thermal equivalent of the cross section with and without the thermal bridging material.

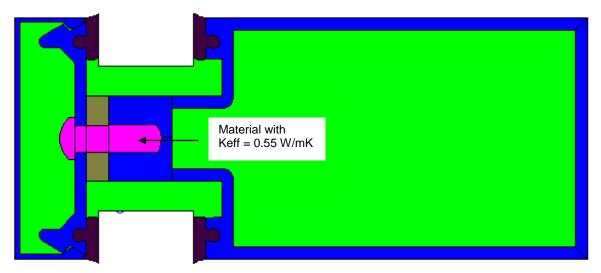
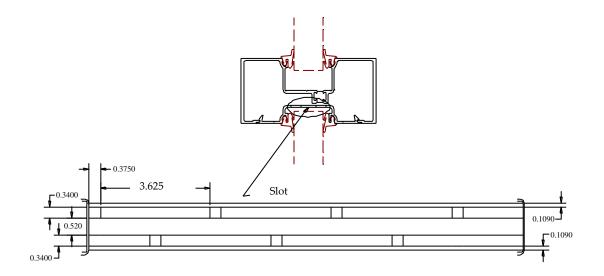


Figure 20-81. Final THERM model with boundary conditions defined.

### 20.8.6. Example 2: Thermally slotted cross-section



*Figure 20-82. DXF for thermally slotted cross section.* 

#### Step I

•			
Skip	= 0.009525 m (	0.375 in)	
Slot (Air)	= 0.092075 m (	3.625 in)	
Interval	= 0.092075 m (3.625 in) + 0.009525 m (0.375 in)		
	= 0.1016 m (4	in)	
Fb	= 0.009525 m/ 0.1016 m		
	= 0.094		
Fn	= 1-Fb		
	= 1- 0.094		
	= 0.906		
Percent of thermal bridge		= (Fb)*100	
		= 0.094 * 100	
		= 9.4%	

Because the thermal bridge is 9.4% of the length of the façade, the skip-and-debridge needs to be calculated using the isothermal plane procedure. Note: The rest of the example will be in SI units only, with no IP unit translation

Kb = 160 W/m-K (conductivity of skipped debridge, in this case Aluminum)

Rt =  $\sum$  (Depth/ conductivity)

 $= D_d/k_d$ 

- = (0.0086 m/0.024 W/m-K)
- $= 0.35833 \text{ m}^2\text{-K/W}$

where Depth is length of thermal bridge in a direction of heat flow, and the air is assumed to have the conductivity of 0.024 W/m-K

Kn = total depth/Rt

= 0.0086m/ 0.35833 W/m-K

= 0.024 W/m-K

- Keff = Fb\*Kb + Fn\*Kn
  - = 0.094\*160 W/m-K + 0.906\* 0.024 W/m-K

= 15.062 W/m-K

To convert to IP:

Keff = 15.062 W/m-K \* 0.57782

= 8.703 Btu/hr-ft-ºF

or in alternative IP units,

Keff = 15.062\* 0.57782 \* 12 in/ft

= 104.436 Btu-in/hr-ft<sup>2</sup>-°F

## Step-2

Replace the strip of air-aluminum-air with new keff material of 15.078 W/m-K

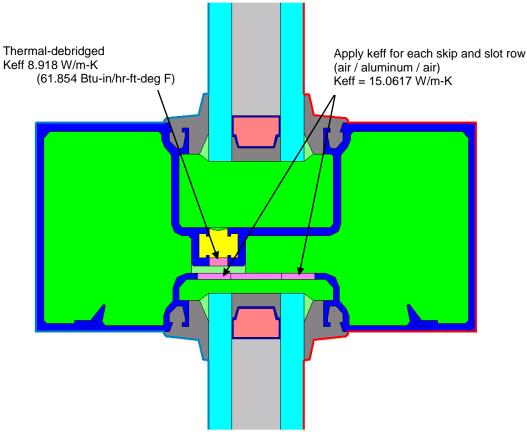
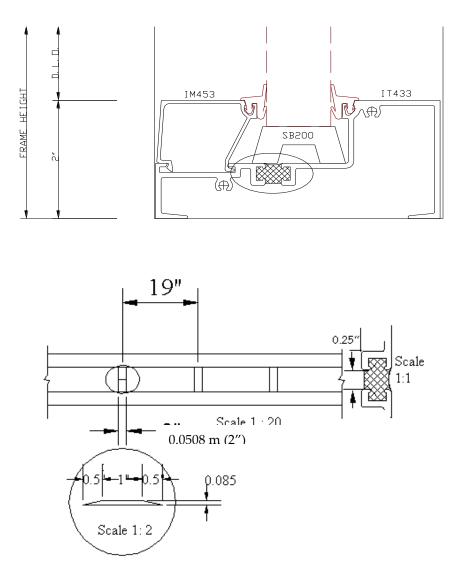


Figure 20-83. New Keff assigned to each skip and debridged row.

## Step 3

Define the Boundary condition and run the model to calculate the U-factor for frame and edge-of-glass.

## 20.8.7. Example 3: Skip-and-debridge:



Note: the skip trapezoid shall be treated as a rectangle equal to the total length of the base of the trapezoid.

Figure 20-84. Drawings for Example 3 Skip and Debridge.

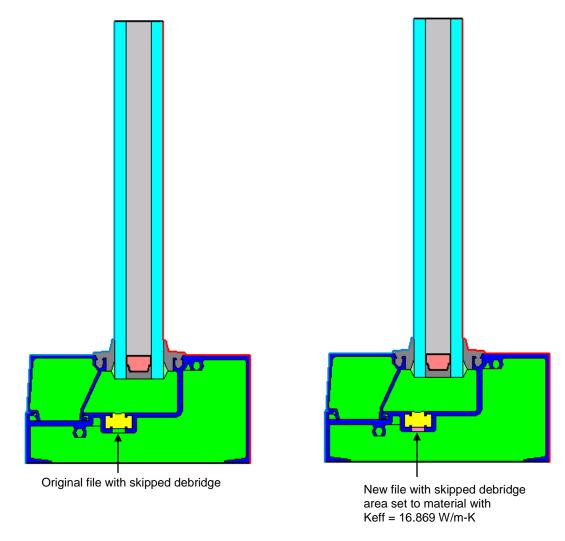
## STEP 1

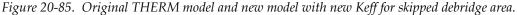
Skip = 0.0508 m (2 in)

Debridge (Air) = 0.4318 m (17 in)

Interval = 0.508 m (2 in) + 0.4318m (17 in) = 0.4826 m (19 in)

Note: The rest of the example will be in SI units only, with no IP unit translation





Fb = 0.0508 m / 0.4826 m = 0.1053

Fn = 1-Fb

= 1 - 0.1053 = 0.8947

%Fb = (Fb) ·100 = (0 1053) ·10

= (0.1053) · 100

= 10.53% (Skip-and-debridge needs to be calculated using Isothermal plane procedure).

Kb = 160 W/m-K (conductivity of skipped debridge, in this case aluminum)

Rt =  $\sum$  Length/ conductivity = (0.00635 m/0.024 W/m-K) = 0.2646 m<sup>2</sup>-K/W

The length is the length of material in a direction of heat flow i.e. 0.25" as shown in the figure above. (The air effective conductivity calculated using THERM)

- Kn = length/Rt =  $0.00635m/0.2646 \text{ m}^2\text{-K/W}$ = 0.024 W/m-K
- Keff = Fb\*Kb +Fn\*Kn = 0.1053\*160 W/m-K + 0.8947\*0.024 W/m-K = 16.869 W/m-K

To convert to IP:

Keff = 16.869 \* 0.57782 = 9.747 Btu/hr-ft-F (or in alternative IP Units: 116.97 Btu-in/hr-ft<sup>2</sup>-F)

# 20.9 Site Built fenestration products (Curtain Walls, Window Walls and Sloped Glazing)

A few things to be aware of:

- Review the drawings carefully for non-continuous elements. These systems tend to have many such elements including shear blocks, installation clips and spacers at the bolts.
- Site built modeling is partially depend<sup>1</sup>/<sub>2</sub> widthent on the installation of the product. Make sure that the drawings show the installation.
- Site built products are typically multiple lite systems where the intermediate vertical and horizontal frame members repeat in some pattern.

### 20.9.1. Curtain Walls, Window Walls, and Sloped Glazing

A curtain wall and window wall is a building wall carrying no super-imposed vertical load. A *curtain/window wall system* will typically be exterior to the building framework and will typically bypass the building floors.

Curtain walls, window walls, and sloped glazed wall systems can be simulated as two lites with one vertical mullion. See the introduction to this section for the specific members of curtain walls, window walls, and sloped glazed wall systems that are to be modeled. If the intermediate vertical and horizontal members were simulated full width or height for the jambs, head and sill, then the total area of the frame as simulated would be significantly larger than actual frames, so some members (depending on whether it is a curtain wall, window wall or sloped glazing) can be simulated as ½ the full height ( for head and sill) or width (for jambs). The vertical mullion is generally simulated full width.

#### Modeling Procedures:

• **Curtain Walls:** See the modeling steps in the following section.

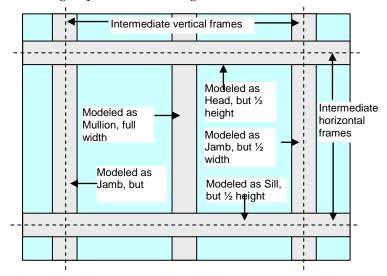


Figure 20-86. Curtain Wall Modeling Method

• Window Walls: For window walls, the standard head and sill members are modeled, and therefore the steps for simulation are identical to that of a normal window cross-section.

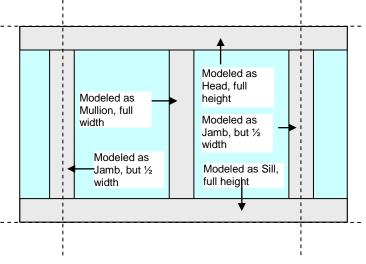
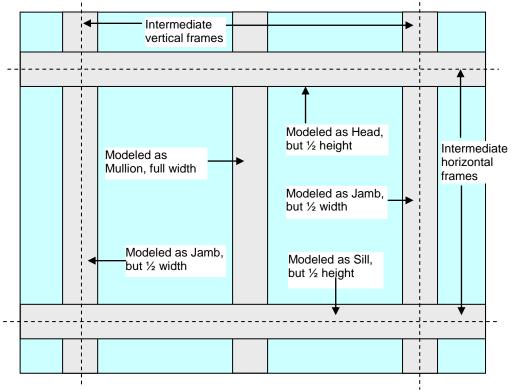


Figure 20-87. Window Wall Modeling Method

Sloped Glazed Wall System: If the product to be simulated is a sloped glazed wall system, then the
modeling steps are identical to a curtain wall or window wall, except that the cross-section is to be sloped
20 degrees (see skylight section for instruction on sloping products).





*Figure 20-88. Curtain wall simulation model (represented by dotted lines) for rating, where the framing members are modeled at half their width.* 

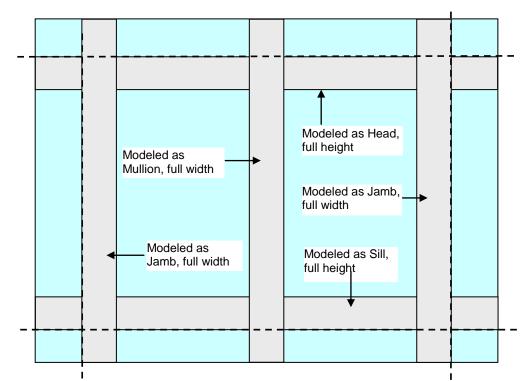


Figure 20-89. Curtain wall simulation model (represented by dotted lines) to match testing.

# Steps in Modeling Curtain Walls for Rating Simulation In WINDOW:

Create glazing systems in WINDOW as usual, with Tilt set to "90".

### In THERM:

• Draw the cross sections for curtain walls in the same manner as any other model in THERM – it will be a model similar to a meeting rail.

The following discussion lists the steps for making cross sections for intermediate horizontal and vertical frames. In the example, the horizontal frame and vertical frame are the same so only one drawing will be needed.

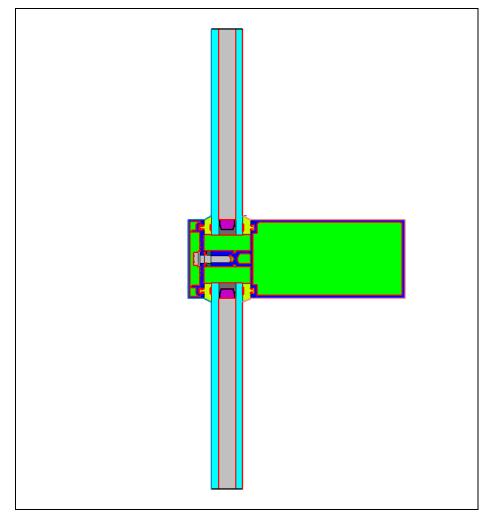


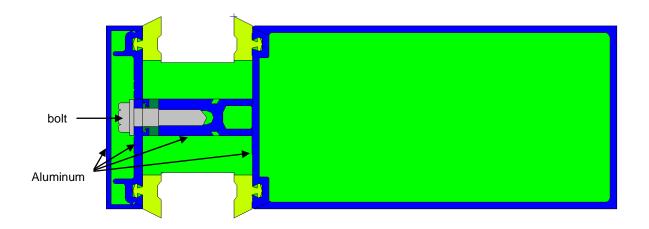
Figure 20-90. Curtain Wall Mullion Cross Section (mull.thm)

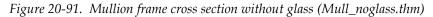
## Modeling the Intermediate Vertical Mullion:

Using the dimensioned drawings or a DXF file, create the cross section for the frame portion of the vertical mullion. The figure below shows a THERM cross section of the frame portion of the vertical mullion.

Make sure that the section is oriented correctly with the glazing oriented up and down.

- If bolts are present make sure to model them as non-continuous thermal bridging elements if needed. (see Section 20.8).
- Pay particular attention to the aluminum finish in order to assign the correct materials to the drawing. (In the figure below, where the arrows point to Aluminum)



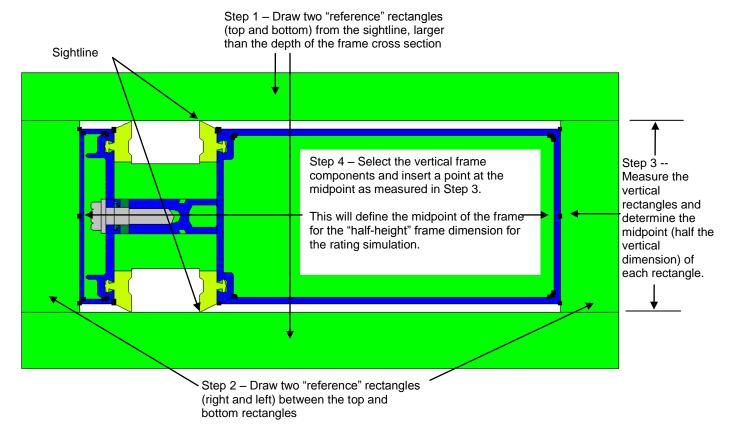


This vertical cross section will be used for the vertical intermediate (mullion) and for the jambs. The jamb model it is necessary to determine and mark the  $\frac{1}{2}$  width point between the sightlines. The easiest way to do this is to make temporary reference rectangles as follows:

### **Determine Frame Midpoints**

In order to model the "half-width" frame dimensions for the rating simulation, it is necessary to determine the mid-point of the frame, which is most easily done before the glazing systems are inserted.

- Draw a rectangle from the sightline (highest interior point) for both glazing systems, going horizontally in both directions, so that each rectangle is larger than the horizontal dimension of the frame.
- On both the right and left side of the frame draw a rectangle between the other two reference rectangles and make sure it contacts the frame.
- Measure the exterior rectangle just created in the vertical dimension. The midpoint of the frame is half of this dimension.
- For both the right and left sides of the frame cross section, select the vertical frame component and insert a point on the frame at the midpoint dimension.

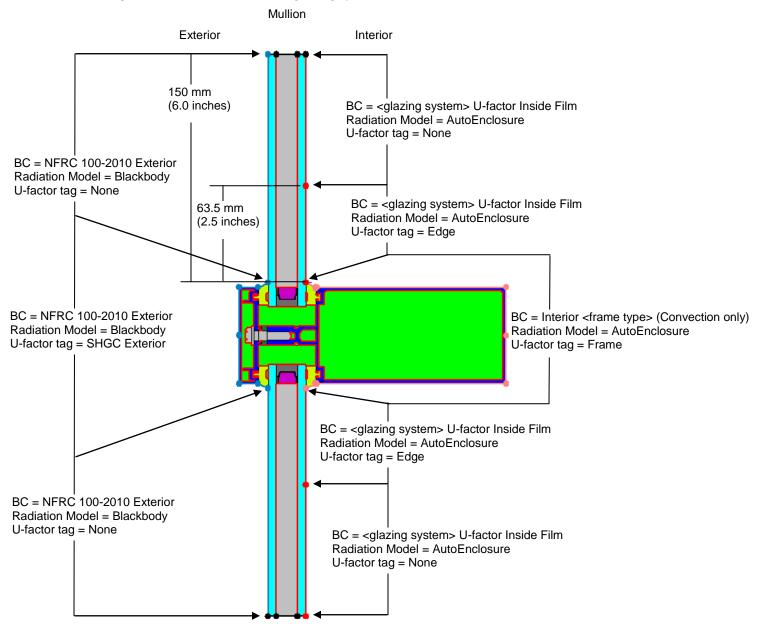


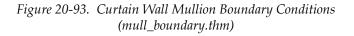
*Figure 20-92. Determine the frame mid-points (mull\_midpoint.thm)* 

### Finish the cross section

- Delete the four "reference" rectangles.
- Insert the glazing and spacers as usual.
- In Therm File Properties (File/Properties), set the Cross Section Type to "Vertical Meeting Rail".
- Assign the Boundary Conditions as follows:
  - Interior Frame: For the mullion cross section, the entire frame width (not just half) is modeled, so all the interior frame boundary condition elements are assigned a Boundary Condition of "<frame type> Interior (Convection Only), and a U-factor Surface tag of "Frame".

- Interior Glazing: Set the Boundary Conditions for each glazing system to "<glazing system> U-factor Inside Film" and the U-factor Surface tag to "Edge" for the first 63.5 mm (2.5 inches) from the sightline, and "None" for the remainder of the glazing system.
- Exterior Frame: Set the BoundaryCondition to "NFRC 100-2010 Exterior" and the U-factor Surface tag to "SHGC Exterior" for the exterior frame
- Exterior Glazing: Set the BoundaryCondition to "NFRC 100-2010 Exterior" and the U-factor Surface tag to "None" for both exterior glazing systems.



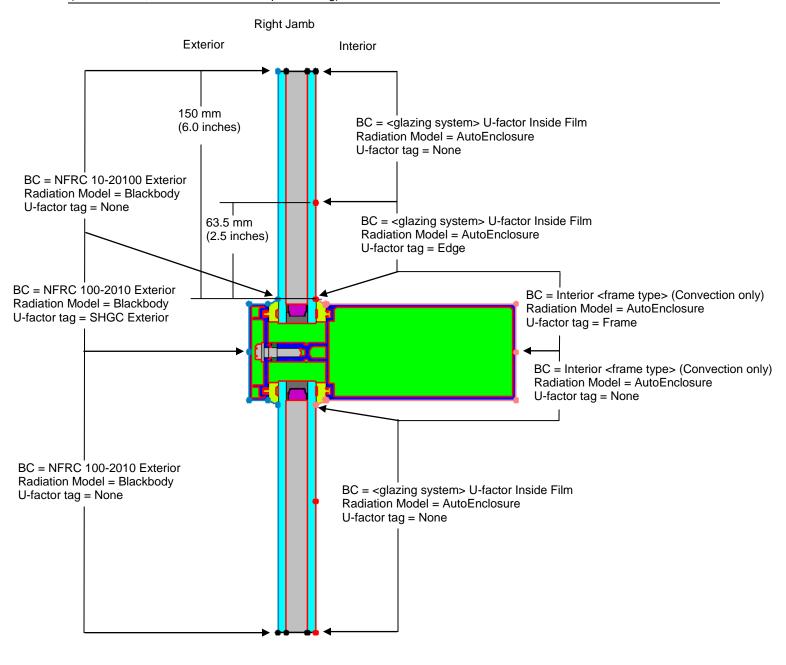


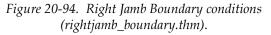
## Modeling Curtain Wall Jambs:

In this example, the curtain wall jambs are modeled using the same drawing as the mullion. The boundary conditions are adjusted to capture the heat flow of only half the width. Since the sections may be asymmetrical, both the left and right portions of the mullion are required to be simulated as left and right jambs.

### For the Right Jamb:

- Copy the vertical mullion drawing with boundary conditions assigned .
- In Therm File Properties (File/Properties), set the Cross Section Type to "Vertical Meeting Rail".
- Do not change the **Boundary Conditions** but assign new **U-factor Surface** tags as follows:
  - Interior Frame:
    - from the midpoint to the top sightline set the **U-factor Surface** tag to "Frame"
    - from midpoint to the bottom sightline and the entire bottom glass assign the **U-factor Surface** tag to "None".
    - Interior Glazing System: for the first 63.5 mm of the top glazing system set the U-factor Surface tag to "Edge", and the remainder of the glazing system to "None". For the entire bottom glass assign the U-factor Surface tag to "None".
  - Exterior Frame:
    - from the midpoint to the top sightline assign the **U-factor Surface** tag to "SHGC Exterior"
    - from midpoint to the bottom sightline assign the **U-factor Surface** tag to "None".
  - Exterior Glazing System: set the U-factor Surface to "None".





### For the Left Jamb:

• The process is the same as the right jamb except that the Frame, edge and SHGC Exterior tags are assigned to the bottom half of the drawing and the top half is assigned the tag of "none"

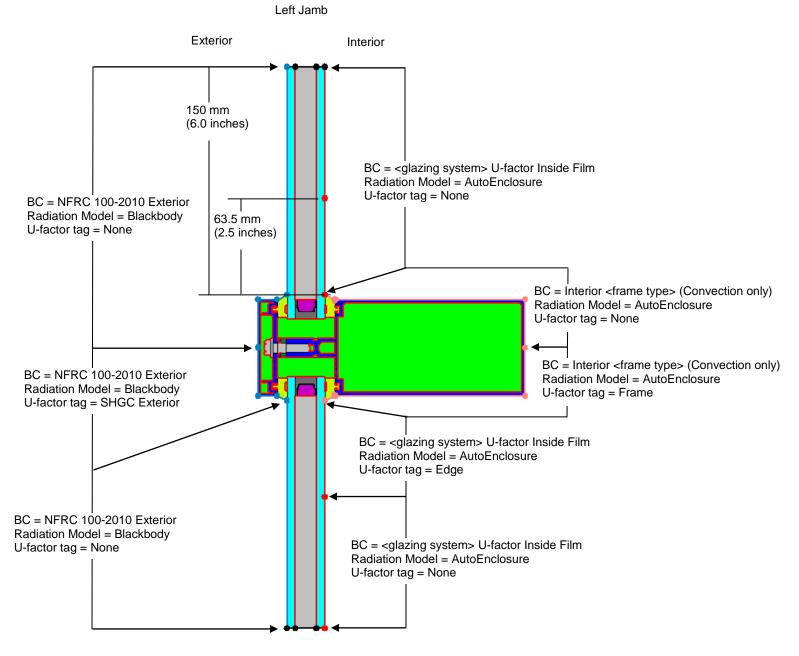


Figure 20-95. Left Jamb Boundary Conditions (leftjamb\_boundary.thm)

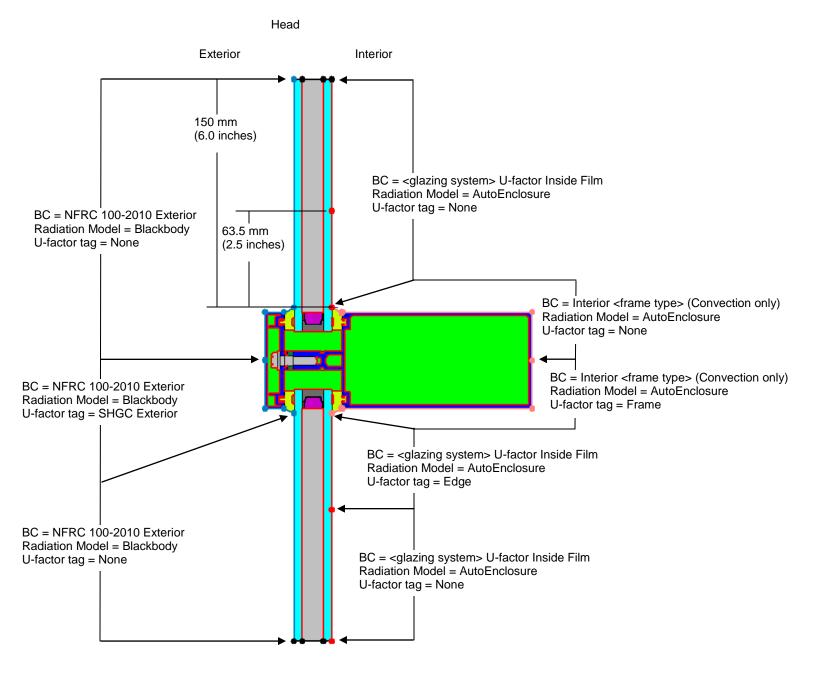
NOTE: the THERM File option " Use CR Model for Window Glazing System" may be left checked since THERM will not calculate Condensation resistance for a cross section Type tagged Vertical Meeting Rail or Jamb.

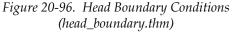
### Modeling the Intermediate Horizontal (as Head and Sill):

The horizontal frame cross section is drawn in exactly the same way as the intermediate vertical frame cross section, including inserting the midpoint. For this example the horizontal and vertical frames are identical so the same drawing is used. Assign boundary conditions in the usual way and then assign new boundary condition U-Factor Surface tags as follows for the head and sill.

### For the Head:

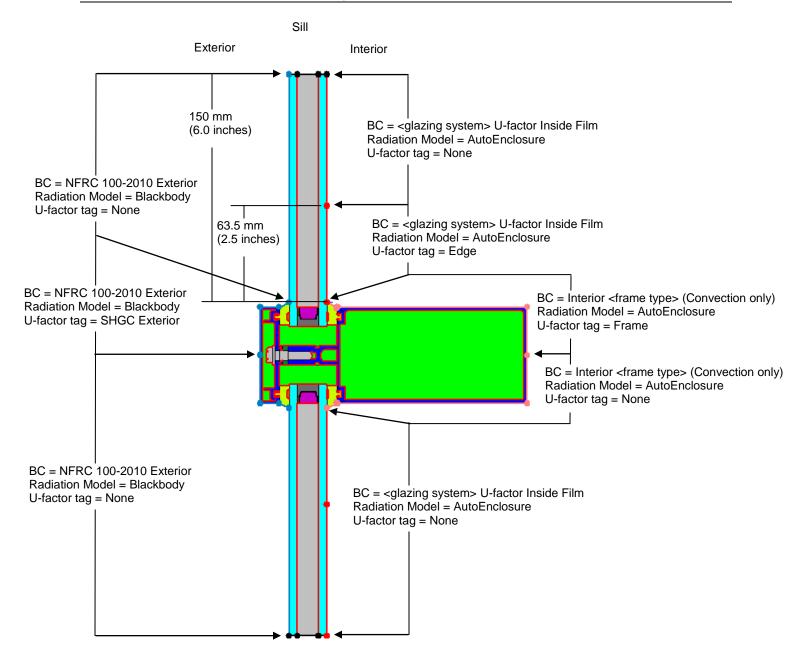
- Use the drawing for the intermediate horizontal.
- In **Therm File Properties** (File/Properties), set the **Cross Section Type** to "Head".
- Assign the Boundary Conditions as follows:
  - Interior Frame:
    - For the interior frame from the midpoint to the *bottom* sightline, set the **Boundary** Condition to "<frame type> Interior (Convection Only), and the U-factor Surface tag to "Frame".
    - For the interior frame from midpoint to the *top* sightline, set the **Boundary Condition** to "<frame type> Interior (Convection Only), and the **U-factor Surface** tag to "None".
  - Interior Glazing: Set the Boundary Conditions for each glazing system of the bottom of the glass to "<glazing system> U-factor Inside Film" and the U-factor Surface tag to "Edge" for the first 63.5 mm (2.5 inches) from the sightline, and "None" for the remainder of the glazing system.
  - Exterior Frame:
    - For the exterior frame from the midpoint to the *bottom* sightline, set the BoundaryCondition to "NFRC 100-2010 Exterior" and the U-factor Surface tag to "SHGC Exterior".
    - For the exterior frame from the midpoint to the *top* sightline, set the **BoundaryCondition** to "NFRC 100-2010 Exterior" and the **U-factor Surface** tag to "None".
  - Exterior Glazing: Set the BoundaryCondition to "NFRC 100-2010 Exterior" and the U-factor Surface tag to "None" for both exterior glazing systems.





### For the Sill:

- Use the drawing for the intermediate horizontal.
- In Therm File Properties (File/Properties), set the Cross Section Type to "Sill".
- Assign the Boundary Conditions as follows:
  - Interior Frame:
    - For the interior frame from the midpoint to the *top* sightline, set the **Boundary Condition** to "<frame type> Interior (Convection Only), and the **U-factor Surface** tag to "Frame".
    - For the interior frame from midpoint to the *bottom* sightline, set the **Boundary Condition** to "<frame type> Interior (Convection Only), and the **U-factor Surface** tag to "None".
  - Interior Glazing: Set the Boundary Conditions for each glazing system of the *top* of the glass to "<glazing system> U-factor Inside Film" and the U-factor Surface tag to "Edge" for the first 63.5 mm (2.5 inches) from the sightline, and "None" for the remainder of the glazing system.
  - Exterior Frame:
    - For the exterior frame from the midpoint to the *top* sightline, set the **BoundaryCondition** to "NFRC 100-2010 Exterior" and the **U-factor Surface** tag to "SHGC Exterior".
    - For the exterior frame from the midpoint to the *bottom* sightline, set the BoundaryCondition to "NFRC 100-2010 Exterior" and the U-factor Surface tag to "None".
  - Exterior Glazing: Set the BoundaryCondition to "NFRC 100-2010 Exterior" and the U-factor Surface tag to "None" for both exterior glazing systems.



*Figure 20-97. Sill Boundary conditions ( sill\_boundary.thm)* 

It is a good idea at this point to verify the orientation and the direction of the gravity arrows of these sections.

## In WINDOW:

Calculate these files and import into WINDOW. Use the files to create the whole product in the Window Library as applicable.

# 20.10 Garage / Rolling Doors

Garage doors and rolling doors are modeled differently than window products because there are more opaque sections to be modeled in THERM.

As with all other product modeling, all relevant cross sections must be modeled in THERM. Detailed illustrations of sections, elevations and model details, as well as the area-weighting methodology for calculating the whole product properties (based on THERM results from of each cross section) are defined in NFRC 100. The information in this manual covers the specific modeling procedures for the THERM cross-sections.

NFRC has defined nine regions within a door that need to be modeled. These regions include:

- Frame Area
- Lite Frame Area
- Divider area
- Edge-of-divider area
- Edge-of-Lite Area
- Center-of-lite area
- Door Core Area
- Panel Area
- Edge-of-Panel Area

NFRC 100 contains several figures which illustrate the location of the door sections to be modeled in THERM.

When modeling glazing options with caming, the NFRC default caming can be used.

A spreadsheet must be used to do the door area-weighting from the THERM files, because the current version of WINDOW does not area-weight doors. In THERM, the U-factor Surface Tags can have any name and as many U-factor Surface Tags can be defined as are needed to accurately describe the model.

### 20.10.1. Sectional Garage Door (Insulated and Non-Insulated)

The overall product U-factor is calculated based on the area weighted average of the U-factor of each component of the door. The components used for area weighting a sectional garage door are:

- Top Rail
- Bottom Rail
- End Stile
- Meeting Rail
- Door Panel Core
- Edge-of-Lite
- Center-of-Lite

The U-factor of each component is calculated using two dimensional heat transfer software THERM. The sectional garage doors with embossed or raised panels are not covered in this section. However, refer to the entry door section for the principles of modeling embossed or raised panels which can then be applied to sectional doors.

The boundary condition details and other modeling assumptions used on the simulation models for door components are discussed in the following sections.

### 20.10.1.1. Top Rail Model

A nominal 2 x 4 wood block is used in the Top Rail Model as shown in the figure below. The torsion spring assembly, and any non-continuous hardware, shall not be included in this model. The boundary condition (BC) type and U-factor tags used in the model are illustrated in the figure below.

THERM File Properties:

- Cross Section Type: Head
- Gravity Arrow: Down

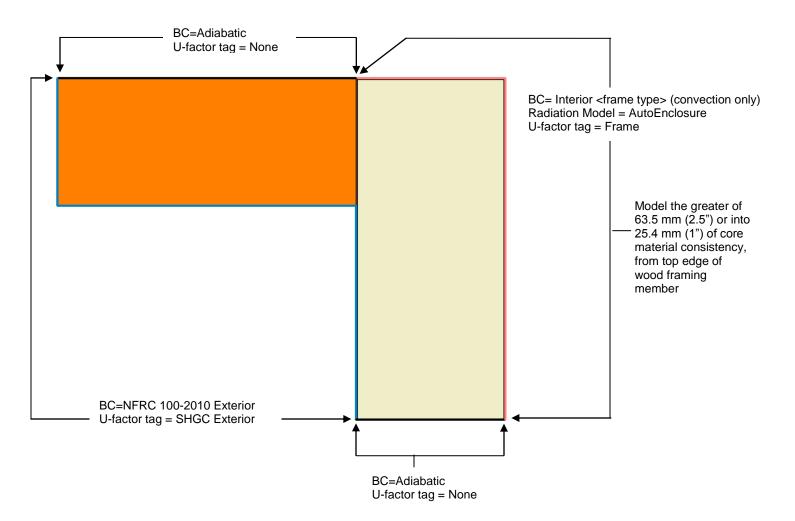


Figure 20-98. Top Rail Model.

## 20.10.1.2. Bottom Rail Model

A nominal 2 x 6 wood block is used in the bottom rail model of the garage door. Refer to the figure below for the boundary conditions and U-factor tag tags.

THERM File Properties:

- Cross-section Type: Sill
- Gravity Arrow: Down

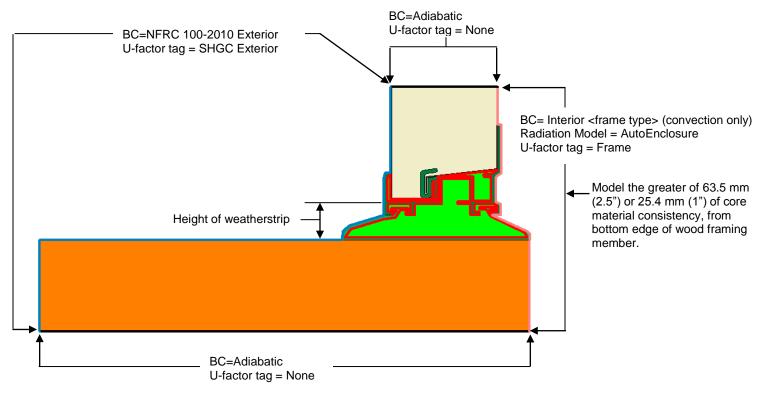


Figure 20-99. Bottom Rail Model.

## 20.10.1.3. End Stile Model

A nominal 2 x 4 wood block is used in the End Stile Model. The projected frame dimension shall incorporate a 1" uniform section of the garage door panel. Any non-continuous hardware, such as rollers, shall not be included in the model. The boundary condition type and the U-factor tag used on the End Stile model are shown in the figure below.

THERM File Properties:

- Cross-section Type: Jamb
- Gravity Arrow: Into the Screen

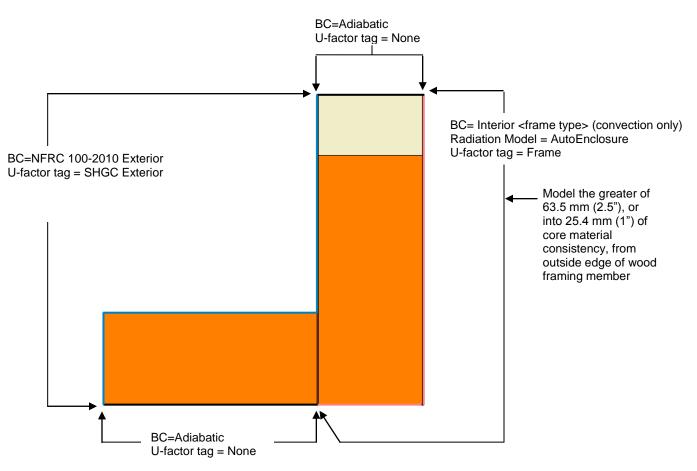


Figure 20-100. End Stile Model.

# 20.10.1.4. Meeting Rail / Door Panel Core Model

The Meeting Rail Model is combined with the Door Panel Core Model, as shown in the figure on the following page. The meeting rail model shall include 63.5 mm (2.5") section of the each joining panel. The projected dimension of the panel core section shall be equal to:

([Height of the Panel]-5") / 2

- Cross-section Type: Horizontal Meeting Rail
- Gravity Arrow: Down

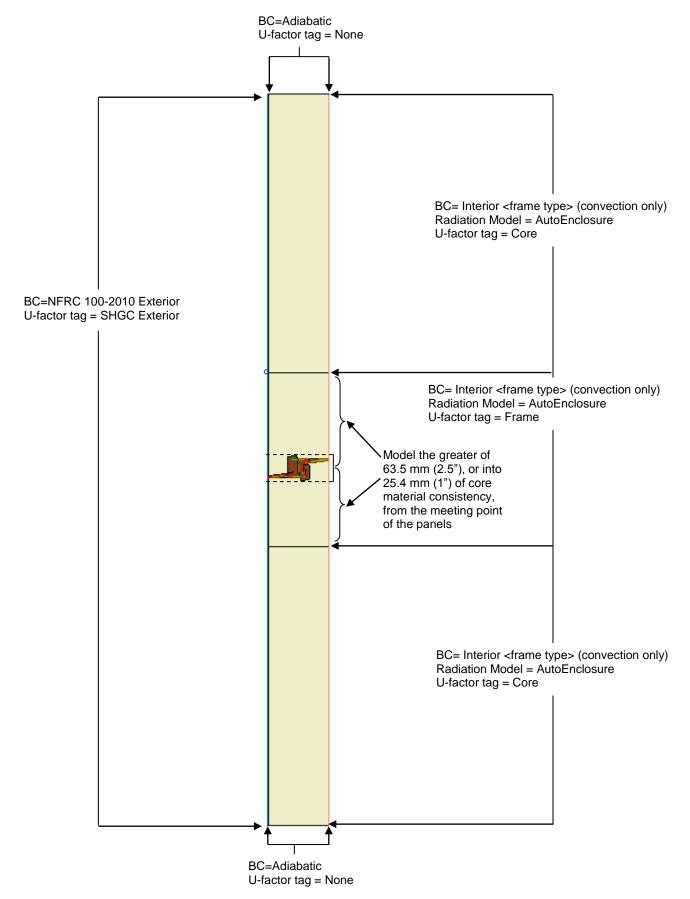


Figure 20-101. Meeting Rail and Door Panel Core Model.

# 20.10.1.5. Edge-of-Lite Model

The procedure for modeling edge-of-lite (edge-of-glazing) properties is the same procedure as for entry doors. See the entry door procedure in this manual for detailed instructions for modeling these cross-sections.

Below is a sample THERM cross section for the Door Lite Sill.

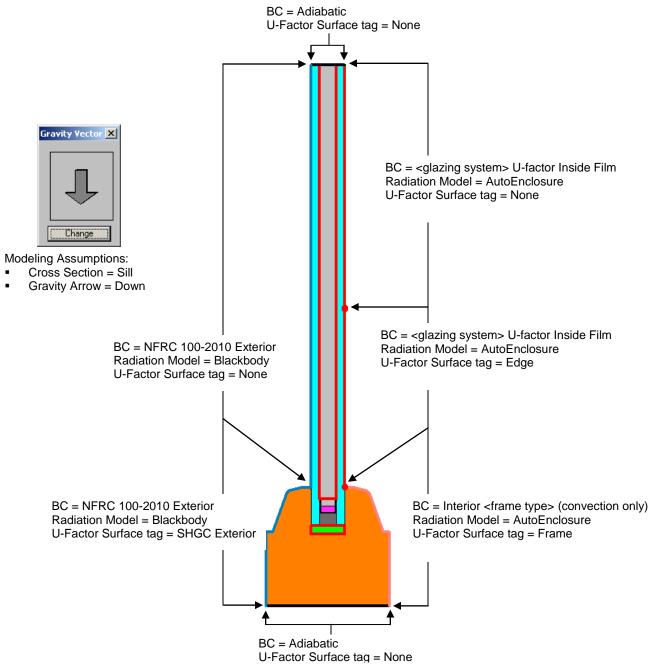


Figure 20-102. Edge-of-Lite model for the garage door lite.

# 20.10.2. Rolling Door

The overall product U-factor is calculated based on area weighted average of various component's U-factor. The components used for area weighting a rolling door are:

- Top Rail
- Bottom Rail
- End Stile
- Door Core

The U-factor of each component is calculated using two dimensional heat transfer software THERM.

The boundary condition details and other modeling assumptions used on the simulation models for door components are discussed in the following sections.

## 20.10.2.1. Top Rail Model

A nominal 2 x 4 wood block is used in the Top Rail Model as shown in the figure below. The torsion spring assembly, and any non-continuous hardware, shall not be included in this model. The boundary conditions (BC) and U-factor tags used in the model are described in the figure below.

- Cross-section Type: Head
- Gravity Arrow: Down

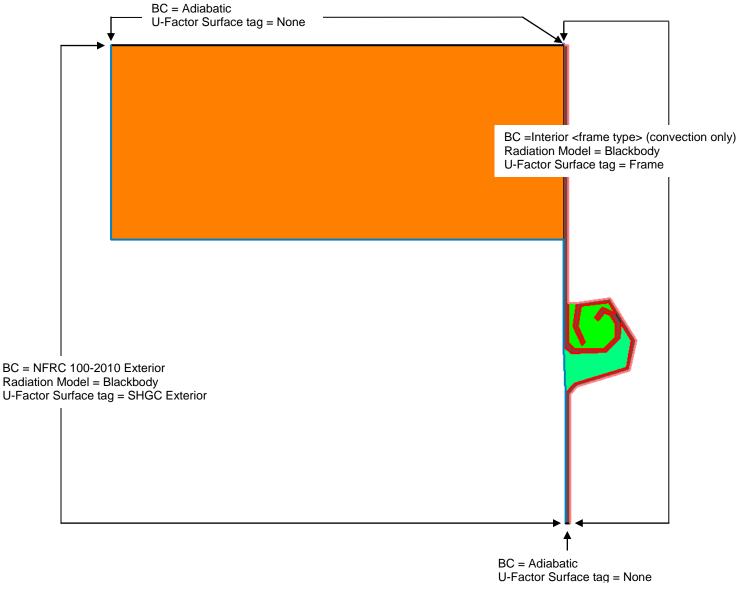


Figure 20-103. Top Rail Model for Rolling Door

# 20.10.2.2. Bottom Rail Model

A nominal 2 x 6 wood block is used in the bottom rail model of the rolling door. The figure below illustrates the boundary conditions and U-factor tags.

- Cross-section Type: Sill
- Gravity Arrow: Down

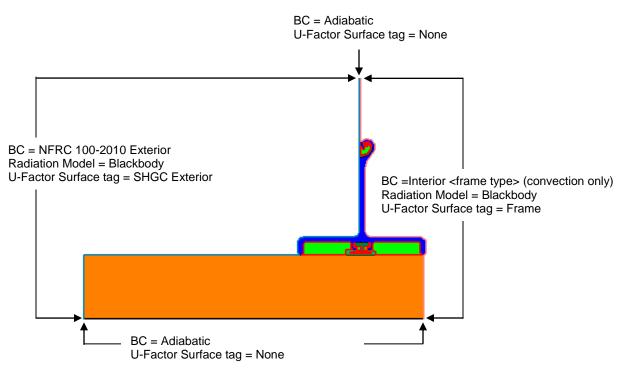


Figure 20-104. Bottom Rail Model for Rolling Door

## 20.10.2.3. End Stile Model

A nominal 2 x 4 wood block is used in the Stile Model. The boundary condition type and the U-factor tag used on Stile model are shown in the figure below

- Cross-section Type: Jamb
- Gravity Arrow: Into the Screen

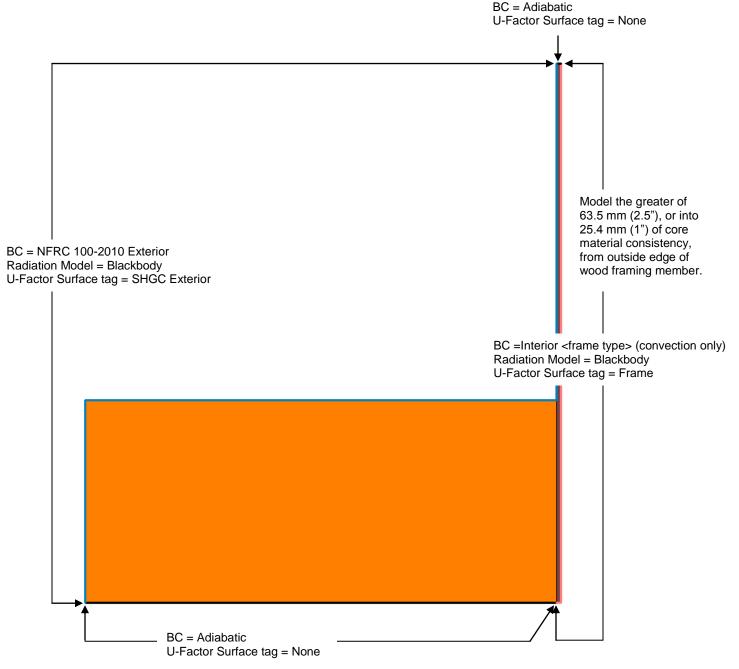


Figure 20-105. End Stile Model for Rolling Door

# 20.10.2.4. Door Core Model

The Door Core Model shall include two full slats and two half slats at each end. The details of the section where slats join shall be obtained from the manufacturer. The boundary conditions on door core model are specified in the figure below.

- Cross-section Type: Horizontal Meeting Rail
- Gravity Arrow: Down

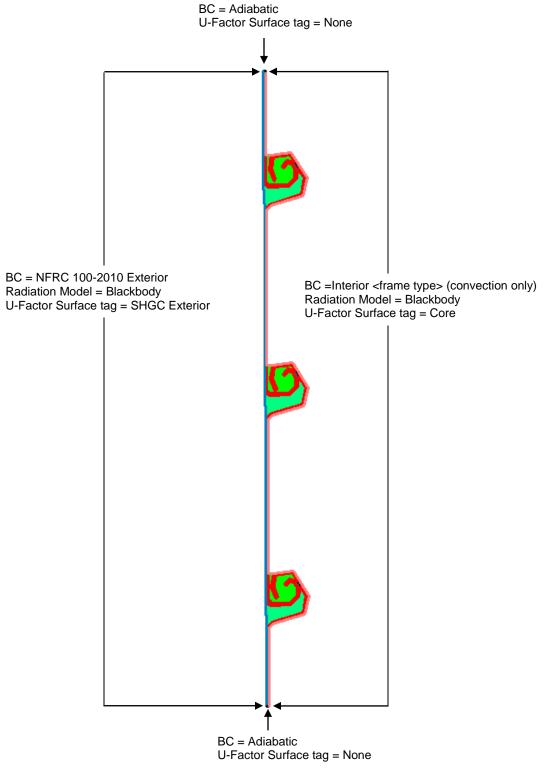


Figure 20-106. Door Core Model for Rolling Door

# 20.11. Creating a Laminate in Optics for NFRC

### 20.11.1. Overview

Optics can be used for the limited purpose of constructing laminates for NFRC certified simulations using the following criteria:

- Laminates *cannot* have embedded coatings, where embedded coatings are defined as a coating on a substrate that touches an interlayer
- Only NFRC glass layers with the NFRC approval indicator "#" can be used in these constructed laminates
- The glass layers can be tinted or coated as long as the coatings do not face the interlayer
- The interlayers in Optics do not have a "#" on them and therefore, only interlayers from the LBNL/NFRC "Approved Interlayer" list can be used (updated by LBNL with every IGDB release and available on the WINDOW Knowledge Base website), which means the data for those interlayers was submitted to the IGDB using the criteria specified in Section 1.2 of this document.

For NFRC verification of the laminate construction submitted by simulators:

- Laminates constructed by simulators in Optics will not have a # next to them. The simulator shall provide base properties for the complete laminate assembly, including solar transmittance (solar, T), visible transmittance (photopic, T), solar reflectance front (solar, Rf), solar reflectance back (solar, Rb), visible reflectance front (photopic, Rf), visible reflectance back (photopic, Rb), Emissivity front (EmitF), Emissivity back (EmitB). These values are reported on the Optics screen when the laminate is calculated, and also in the WINDOW Detailed Report from the Glazing System Library. This requirement is satisfied by submitting a WINDOW "mdb" database file which includes this laminate.
- An IA (or anyone else wanting to check the results) can recreate the laminate from the specified layers and verify the calculated values
- NFRC simulators shall assign numbers to the laminates starting with 30,000. The numbers do not have to be unique between simulation laboratories or even between projects in the same laboratory. These laminates are not stored in a central NFRC database.
- The naming convention for the laminate should describe the layers used to construct the laminate, using the IGDB Layer ID for glass layers and the interlayer name (from the Optics program) for the interlayer. If a glass layer is flipped, add the "F" designator to the end of the layer number. The total number of characters (not including extension, but including "/" separators in the name) cannot exceed 45.

<glass layer ID><F if layer is flipped>/<interlayer name from Optics>/<glass layer ID><F if layer is
flipped>

For example:

102/030keepsafe/2026F

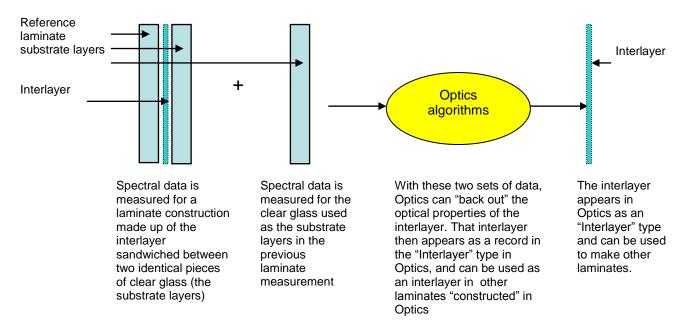
## 20.11.2. Laminate Interlayer Data

Optics can accurately calculate the optical properties of laminates as long as the component layers with the following characteristics (the records matching these characteristics can be found on the windows.lbl.gov website in the WINDOW Knowledge Base under the NFRC section):

- Interlayers are measured with transparent glass with a solar transmittance Tsol > 0.820 and Tvis > 0.890. This ensures that a "constructed" laminate in Optics will always have a similar or lower transmittance than the reference laminate which determines the interlayer properties
- No glass layers have coatings next to interlayers (embedded coatings).
- Substrate layers (the base glass to which the interlayers are applied) are measured separately from the interlayers. This is the responsibility of the manufacturer submitting data to the IGDB, as discussed below.

As discussed in the LBNL document which contains guidelines for submitting data to the IGDB, "an interlayer is an adhesive layer used to join components in a laminate. The optical properties of laminate layers cannot be measured directly. Instead they are calculated from the spectral properties of a 'reference laminate' which consists of the interlayer laminated between two glass layers of known optical properties. To submit data for an interlayer, both the spectral optical properties of the reference laminate, and the glass layers used in the reference laminate should be submitted."

This means that in order for an interlayer to be added to the Optics "Interlayer" type, and therefore used in making laminate constructions in Optics, the spectral data for a "reference" laminate which contains that interlayer is submitted to the IGDB as follows:



## Figure 20-107. How Optics "deconstructs" measured data to obtain interlayer information.

Optics can do an accurate calculation for the interlayer properties from the reference laminate as long as the substrate glass layers have a high solar and visible transmittance, hence the requirement of Tsol > 0.820 and Tvis > 0.890. This ensures that laminates that are later created in Optics with this interlayer will almost always have a lower solar and visible transmittance then the reference laminate.

### 20.11.3. Constructing a Laminate in Optics

#### 20.11.3.1. Building a New Laminate

When Optics starts, you can start building a laminate immediately by switching to the 'Laminate' tab and adding layers (see "20.11.3.3. Add Layers to a Laminate").

Glazing System	Lamina	te	←	+
Layer:	#1	#2	2	#3
Filename				

*Figure 20-108. Click on the Laminate tab to start constructing a laminate.* 

If you have created a laminate already, but want to start over with an empty laminate:

- Make sure the 'Laminate' tab is selected
- Choose menu option File|New Laminate
- You will be prompted to save the current laminate if one already exists

**Note:** if you created new layers and did not save the layers or did not save the laminate (which would save any new layers), the new layers will be lost when you start a new laminate

### 20.11.3.2. Wavelength Sets

Use the NFRC default wavelength set, which is called "Optics". This setting is shown on startup of the program, and also can be viewed (and changed if necessary) from the menu option **Tools|Select Wavelength Set**.

### 20.11.3.3. Add Layers to a Laminate

You can add monolithic, coated, and interlayer type layers to a laminate. There are a number of 'rules' for building laminates:

- 1. The first and last layer in a laminate must be a non-interlayer type (e.g. monolithic or coated)
- 2. You can place as many interlayers as you like adjacent to each other, but you must separate rigid non-interlayers with at least one interlayer.
- 3. For NFRC certified simulations, you can NOT place a coating next to an interlayer.

If you break rule 1 or 2, the operation will be cancelled.

Use the 'Add Interlayer' tab above the database to add interlayers. To add other layers, use the 'Add Glazing' tab. Only those database records with enough data to be loaded into a laminate will be shown in these views – if you want to see all records in the database, including those which cannot be used in laminates, use the 'View All' tab. If you try to load an invalid layer into a laminate from the 'View All' view of the database, an error message will be displayed.

### 20.11.3.4. Add Glazings to a Laminate

You can add monolithic, coated, and interlayer type layers to a laminate as long as you follow the laminatebuilding 'rules' (see "20.11.3.3. Add Layers to a Laminate" above).

To add layers from the current database to a laminate:

Select the first available (unoccupied) layer in the laminate by clicking on its layer button – if you select an occupied layer, it will be replaced (see "20.11.3.8. Replace a Layer in a Laminate")

Click on the "Layer button", in this case		Glazing System	Laminat	e 🔸	¥
		Layer:	#1	#2	#3
layer	unoccupied				
layer					
		solar, Rf			
		solar, Rb			
		photopic, T			
		photopic, Rf	solar, T		
		EmitF			
		EmitB			

*Figure 20-109. Click on the #1 layer button to add the first glass layer.* 

• Select the 'Add glazing' tab in the database

Add Glazing	Add Interlayer 🗍 Add	Embedded Coating	Edit Laminat	e 🛛 View All 🗍 S	chematic			
Туре 🛆								
Туре 🛆	FileName	ProductName	Nominal (m	Nominal (in)	Thickness	Manufacturer	NFRC_ID	Acceptance
Monolithic	CLEAR_3.DAT	Generic Clear Gl	3 mm	double - 1/8 "	3.048	Generic	102	#
Monolithic	BRONZE_6.DAT	Generic Bronze	6 mm	1/4 "	5.7404	Generic	101	#
Monolithic	CLEAR_6.DAT	Generic Clear Gl	6 mm	1/4 "	5.715	Generic	103	#
Monolithic	GRAY_3.DAT	Generic Grey Gl	3 mm	double - 1/8 "	3.1242	Generic	104	#
Monolithic	BRONZE_3.DAT	Generic Bronze	3 mm	double - 1/8 "	3.1242	Generic	100	#

Figure 20-110. Select the glass layer from the Add Glazing tab.

- Double-click on the layer in the database or
- Using the mouse, drag the layer from the database over the layer button where you want to add the layer and release the mouse button
   *or*
- Select the layer in the database, then choose the menu option Database|Add/Replace Layer or
- Select the layer in the database, then right-click to display the pop-up menu then choose Add/Replace Layer

If you are replacing a layer, a dialog box will appear to confirm that you want to replace the existing layer.

**Note:** Select a layer in the database by clicking on it with the mouse, or by browsing to it by pressing the up and down arrow.

### 20.11.3.5. Add Interlayers

To add an interlayer to a laminate:

- Select the first available (unoccupied) layer by clicking on a layer button
- Select the 'Add Interlayer' tab
- Select the interlayer you want to add, and load it into the laminate (see "20.11.3.3. Add Layers to a Laminate")

	Butte Inter	on for layer			•	n the Add ver tab.	lesired interlayer for the laminate n, double click the mouse, and that ill be added as the next layer in the minate View All Schematic							
Glazing System	Laminate		→		Add Glazing Add	d Interlayer Add E	imbedded Coa	ting   Edit La	minate   View All   S	ichematic				
Layer:	#1	#2	#3	Lamin.	Interlayer Databas	e - Drag column he	ader here to gr	oup.						
Filename	CLEAR			CalcLa	Product name	Manufacturer	Nominal (mil)	Code	Appearence	Material	Reference			
solar, T	0.834			N/A	Butacite® NC010	DuPont	15		Clear	PVB	15PVB6.DUP			
solar, Rf	0.075			N/A	Butacite® NC010	DuPont	30		Clear	PVB	30PVB6.DUP			
solar, Rb	0.075			N/A	Butacite® NC010	DuPont	60		Clear	PVB	60PVB6.DUP			
photopic, T	0.899			N/A	Butacite® 0637	DuPont	30	0637600 🛡	Blue	PVB	AZURBLUE.DUP			
photopic, Rf	0.083			N/A	Butacite® 2377	DuPont	30	2377300	Blue-Green	РVB	BLUGREEN.DUP			
photopic, Rb	0.083			N/A	Butacite® 0360	DuPont	30	0360900	Dark Brown	РVB	BRN_DARK.DUP			
EmitF	0.840			N/A	Butacite® 0365	DuPont	30	0365500	Light Brown	PVB	BRN_LITE.DUP			
EmitB	0.840			N/A	Butacite® 0362	DuPont	30	0362800	Medium Brown	РVB	BRN MEDM.DUP			

The selected Interlayer has been added as then 2<sup>nd</sup> layer in the laminate construction

Glazing System	Lamina	te 🔫 –	-		Add Glazing Add	l Interlayer Add E	mbedded Coat	ing 🛛 Edit Lami	nate 🛛 View All 🗍 So	hematic	
Layer:	#1	#2	#3	Lamin.	Interlayer Databas	e - Drag column he	ader here to gro	up.			
Filename	CLEAR	BLUGR		CalcLa	Product name	Manufacturer	Nominal (mil)	Code	Appearence	Material	Reference
solar, T	0.834	0.859		N/A	Butacite® NC010	DuPont	15		Clear	PVB	15PVB6.DUP
solar, Rf	0.075	0.000		N/A	Butacite® NC010	DuPont	30		Clear	PVB	30PVB6.DUP
solar, Rb	0.075	0.000		N/A	Butacite® NC010	DuPont	60		Clear	PVB	60PVB6.DUP
photopic, T	0.899	0.834		N/A	Butacite® 0637	DuPont	30	0637600	Blue	PVB	AZURBLUE.DUP
photopic, Rf	0.083	0.000		N/A	Butacite® 2377	DuPont	30	2377300	Blue-Green	PVB	BLUGREEN.DUP
photopic, Rb	0.083	0.000		N/A	Butacite® 0360	DuPont	30	0360900	Dark Brown	PVB	BRN_DARK.DUP
EmitF	0.840	0.000		N/A	Butacite® 0365	DuPont	30	0365500	Light Brown	РVB	BRN_LITE.DUP
EmitB	0.840	0.000		N/A	Butacite® 0362	DuPont	30	0362800	Medium Brown	PVB	BRN MEDM.DUP

Figure 20-111. Select the desired interlayer from the Add Interlayer tab for layer #2.

## 20.11.3.6. Flip Layers in a Laminate

To flip layers in a laminate:

- Select the layer to flip by clicking a layer button
- Choose the menu option Edit|Flip Layer or
- Right-click on the layer button to display the pop-up menu and select Flip Layer

• If flipping the layer would place a coating adjacent to an interlayer, and this will break the laminatebuilding rules (see "20.11.3.3. Add Layers to a Laminate") and the laminate cannot be constructed for NFRC certification.

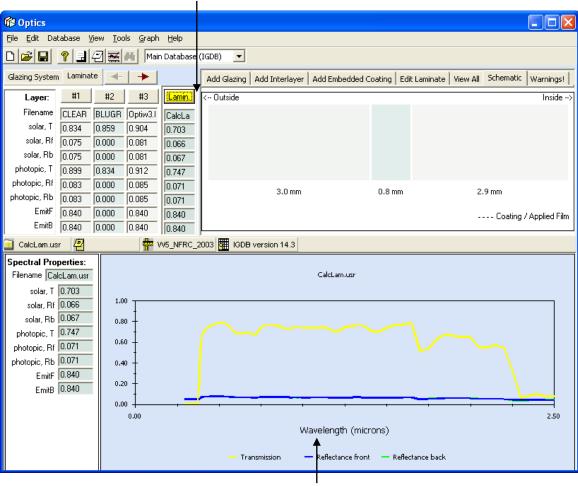
**Note:** Check the schematic view and the layer spectral averages if you are not sure which way a layer is oriented.

If any glass layers are flipped, make sure to add an "F" to the NFRC ID in the name of the final laminate.

### 20.11.3.7. View the Properties of a Laminate

To view the calculated spectral data, spectral averages and other properties of a laminate:

- Select the laminate by clicking on the 'Lamin.' layer button
- The laminate is now the current layer, so its spectral data and spectral averages are displayed in the lower part of the screen



Click on the Lamin. Button and Optics will calculate and display the calculated properties of the laminate construction in the column below that button.

When the Lamin. Button above is selected, the graph below displays the properties of the entire laminate construction.

Figure 20-112. Click on the Lamin button to view the optical properties of the entire laminate structure.

• To view a schematic diagram of the laminate, select the 'Schematic' tab in the upper right part of the screen

- To view the spectral data in a table, choose menu option **View|Spectral Data Grid**.
- To view calculation warnings for the laminate data, select the 'Warnings' tab in the upper right part of the screen
- To see more information about the laminate, choose menu option View/View Details

## 20.11.3.8. Replace a Layer in a Laminate

Replace a layer in a laminate in the same way as you would replace a layer in a glazing system – you must respect the laminate-building rules (see "20.11.3.3. Add Layers to a Laminate").

You cannot insert layers into a laminate – you must delete and add layers from the interior side of the laminate to modify the structure.

## 20.11.3.9. Delete a Layer in a Laminate

You can only delete the last (interior side) layer in a laminate. To delete the last layer:

- Select the last layer by clicking the layer button
- Choose the menu option Edit|Delete Layer or
- Right-click on the layer button to display the pop-up menu and select **Delete Layer**

## 20.11.3.10. Save a Laminate

To save a laminate to the user database:

- Select the laminate by clicking on the 'Lamin.' layer button
- Click the 'Save' button on the toolbar: or
- Choose the menu option File|Save filename or
- Right-click the layer button to display the pop-up menu and select **Save** *filename*

Note: To save the laminate under a different name, choose the menu item Save As...

## 20.11.3.11. Edit a Laminate

To edit a laminate saved in the user database:

- Make sure the 'Laminate' tab is selected above the layer buttons
- Select the 'Edit Laminate' tab in the upper right part of the screen or
- Choose the menu option **File**|**Edit Laminate**
- Load the laminate you wish to edit like you would add a layer into any layer position the current laminate will be cleared, and the saved laminate loaded.

**Note:** You cannot edit laminates in 'Glazing' mode, you must switch to 'Laminate' mode first. In order to use the edited laminate in a glazing system, save the laminate to the user database, switch to 'Glazing' mode and re-load the laminate layer into the glazing system from the user database.

Note: You cannot use a laminate as a component of another laminate

## 20.11.3.12. Calculation Warnings for Laminates

The optical properties of most laminates without coatings can be calculated without generating warnings, except that it is likely that some components will not have spectral data across the whole range of the selected wavelength set (see "20.11.3.2. Wavelength Sets"), so the wavelength set will be truncated.

### 20.11.3.13. Viewing Calculation Warnings for Laminates

To view calculation warnings for a laminate:

- Select the laminate by clicking on the 'Lamin.' layer button
- Select the 'Warnings' tab

The example below shows a warning message that says:

Results could not be calculated at all wavelengths in the selected wavelength set. Wavelength set truncated to: 0.300 – 2.500 um

This message does not indicate a problem because the solar optical properties in WINDOW are calculated between 0.300 and 2.500 um.

🏫 Optics						
<u>File E</u> dit Dal	tabase 👌	<u>/</u> iew <u>T</u> oo	ls <u>G</u> raph	<u>H</u> elp		
	? 🔳	2	Main Main	n Database	(IGDB)	<b>•</b>
Glazing System	n Lamina	te 📕	-		Add Glaz	ing Add Interlayer Add Embedded Coating Edit Laminate View All Schematic Warnings!
Layer:	#1	#2	#3	Lamin.	WI (um)	Warning Description
Filename	CLEAR	BLUGR	Optiw3.1	102/Blu		
TUV, T	0.715	0.035	0.869	0.030		102/Bluegreen.dup/9811.usr - Laminate
SPF, T	10.855	139.846	2.512	159.164	N/A	Results could not be calculated at all wavelengths in the selected wavelength set.
TDW, T	0.842	0.626	0.897	0.559		Wavelength set truncated to: 0.300 - 2.500 µm
EmitF	0.840	0.000	0.840	0.840		
EmitB	0.840	0.000	0.840	0.840		
🧾 CalcLam.us	sr 🖉			AV5_NFRC_2	2003 🚟 I	3DB version 14.5

*Figure 20-113.* An example of a warning that is not relevant for the calculations WINDOW will be doing with the *laminate.* 

### 20.11.3.14. Save the Laminate to a User Database to Import into WINDOW5

User databases have the same format as the IGDB, but they are used to store data that the user has imported, or generated with Optics. It is not possible to add layers to the IGDB, so all new layers are saved to the user database.

The default user database is **UserGlazing.mdb** in the **\LBNL Shared** directory of your program installation. You can specify the location of the user database – this allows you to use as many user databases as you like (one at a time) with Optics.

To create a new (empty) user database:

Click on the Database menu, and select the choice "Create new user database".



Figure 20-114. Use the Database/Create new user database option to create a blank user database.

The program will ask you for a database name and location. Name the database as appropriate and put it in whatever directory is desired – the default directory for the default Optics User Database (called UserGlazing.mdb) is the "C:\Users\Public\LBNL\LBNL Shared" directory, but any user database can be put in any directory, as long as the path is specified (Tools menu,

Save new user	database as			? 🛛
Savejn:	🗀 LBNL Shared	•	🗢 🗈 📸 🖬 •	
My Recent Documents Desktop My Documents My Computer	<ul> <li>Bitterice</li> <li>Standards</li> <li>Version 14.2 Final</li> <li>Version 14.3 Final</li> <li>Version 14.3 for testime</li> <li>Version 14.4 for testime</li> <li>Version 14.5 for check</li> <li>Copy of IGDB Update.1</li> <li>Empty UserGlazing.mdl</li> <li>Glazing-14.0.mdb</li> <li>Glazing-14.3.mdb</li> <li>Glazing-14.5.mdb</li> <li>Glazing-14.5.mdb</li> <li>Glazing.mdb</li> </ul>	g 🛃 WS-IGDB14.3Updat ing ndb	mdb mdb	
My Network Places		DpticsDatabse.mdb Jatabase (*.mdb)	•	<u>S</u> ave Cancel

Figure 20-115. Specify the name of the new user database as well as the location where it will be stored.

• Set the default user database to the newly created database from Tool/Options

Main database (IGDB)	C:\Program Files\LBNL\LBNL Shared\(
User database	NL Shared\RobinOpticsDatabaes.mdb
Default I/O folder:	c:\temp\
Standards / Wavelengthsets folder:	

Figure 20-116. Define the location for the User Database from the Tool/Options menu, setting the "User database" field

You can save a layer to the user database if it has a different filename to any layer currently in the user database or in the IGDB. If you save a layer that has components (such as a coated layer that has a substrate, or a laminate which has component layers), the component layers will be saved to the user database at the same time (unless they already exist in the IGDB or user database). This allows you to load and edit those layers at a later time.

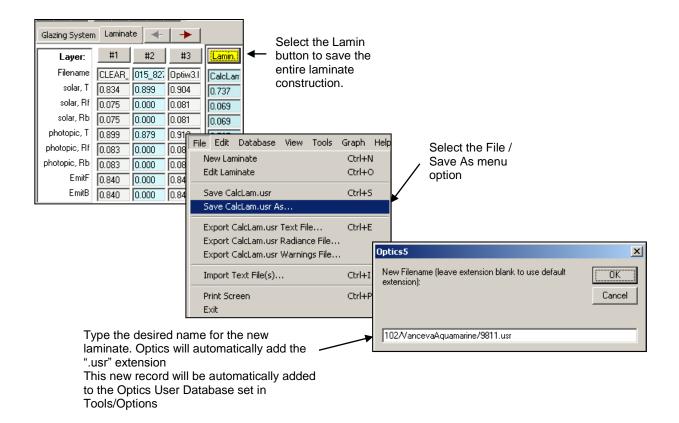
If you want to save an unmodified layer from the IGDB to the user database, you must change its filename first.

To save a layer to the user database:

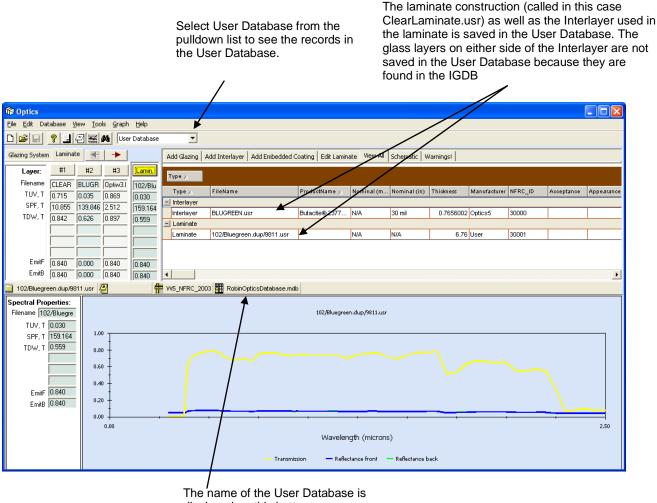
- Select the layer or system to save by clicking on a layer button
- Click the 'Save' button on the toolbar: or
- Choose menu option File|Save filename or
- Right-click to display the pop-up menu and select the option Save filename
- If the layer or system you saved had components, or if the save operation fails, you will be asked 'Do you want to view the details of the save operation?'. If you answer yes, you can view information about components that were saved to the user database, and components that were not saved to the user database along with an explanation of why some components were not saved.

Note: to change the filename and save in one operation, choose menu option Save As.. instead.

**Note:** You cannot save data for a layer with the same filename as another layer in the IGDB or your current user database. If a conflict is detected, Optics will ask you to rename the layer before saving it, or cancel the import. The most common reason a component is not saved is that its filename already exists in the IGDB or user database. In this case Optics assumes that the component layer information is already available and does not need to be saved again.



*Figure 20-117. Save the final laminate using the naming convention of slass layer ID>/<interlayer name/><glass layer ID>.* 



displayed on this button

Figure 20-118. Select the User Database to see the constructed laminates (and the associated interlayers)

## 20.11.3.15. Importing the Laminate into WINDOW from the Optics User Database

In WINDOW, in **File/Preferences**, go to the Optical Data tab, and set the second option, Optics User Database, to your Optics user database (which by default is called UserGlazing.mdb, but it can have any name with the "mdb" extension) -- you can browse to the file with the browse button (its default location is in *C:\Users\Public\LBNL\LBNL Shared* directory).

Use the following database for optical data: C IGDB or IGDB Update \LBNL Shared\Glazing_IGDB29_Chromogenic.mdb Browse C Optics 5 User database
\LBNL Shared\Glazing_IGDB29_Chromogenic.mdb Browse
Optics 5 User database
C:\Users\Public\LBNL\LBNL Shared\UserGlazing.i Browse

*Figure 20-119.* Using the File/Preferences menu, click on the radio button for the "Optics User database" and use the Browse button to specify the file with the full directory path.

In WINDOW5, go to the **Glass Library List View**, click on the **Import** button, select "IGDB or Optics User Database" as the format, and click **OK**.

Import		×
Format	IGDB or Optics User Database	
✓ Avoid cro for identi	eating duplicate records in export database by searching cal records	
	OK Cancel	

Figure 20-120. Import the data from the Optics User Database.

The program will open the user database set in the **File/Preferences** dialog box (the name will be displayed at the top of the dialog box) and you will see the glass layers that can be imported in to the existing library.

_	Program F ect Cano	iles\LBNL\Optics5\hb3.mdb	d D	1 records found.							x
	NFRC_ID	FileName	ProductName	Manufacturer	Acceptance	Thickness	ef	eb	Appearance	Conductivity	Database_Version
						mm				W/m-K	
•	30009	102/VancevaAquamarine/9811.usr		User		6.4	0.84	0.84		0.82	User

*Figure 20-121.* You will see all the entries in the specified user database.

You can select the records you want to import (use **Shift Click** to select contiguous records, **Ctl Click** to select multiple non-contiguous records, or **Select All** to select all records). Then click the **Select** button, which will import the selected records into the **Glass Library**.

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Detailed View G	lass Library	(C:\Program Files\LBNL\WINDOW63\w	v6.mdb)														
Calc	ID	Name	ProductName	Manufacturer	Source	Mode	Color	Thickness	Tsol	Rsol1	Rsol2	Tvis	Rvis1	Rvis2	Tir	emis1	emis2
New								mm									
Casu	1470	1 Eurofloat4.EGS	Eurofloat 4mm	Euroglas GmbH	IGDB v17.4			3.800	0.850	0.077	0.077	0.904	0.083	0.083	0.000	0.840	0.840
<u><u>C</u>opy</u>	1414	5 SSTSTNeutral50EF6.GTS	Silverstar Sunstop T	Glas Trösch AG	IGDB v17.4			5.800	0.455	0.158	0.090	0.506	0.153	0.122	0.000	0.756	0.840
Delete	1470	0 Eurofloat3.EGS	Eurofloat 3mm	Euroglas GmbH	IGDB v17.4			2.800	0.866	0.079	0.079	0.907	0.083	0.083	0.000	0.840	0.840
ind	1470	1 Eurofloat4.EGS	Eurofloat 4mm	Euroglas GmbH	IGDB v17.4			3.800	0.850	0.077	0.077	0.904	0.083	0.083	0.000	0.840	0.840
	1470;	2 Eurofloat10.EGS	Eurofloat 10mm	Euroglas GmbH	IGDB v17.4			9.800	0.764	0.071	0.071	0.886	0.081	0.081	0.000	0.840	0.840
	1470	6 Eurowhite5.EGS	Eurowhite 5mm	Euroglas GmbH	IGDB v17.4			4.800	0.895	0.083	0.083	0.910	0.087	0.087	0.000	0.840	0.840
	1470	7 Eurowhite8.EGS	Eurowhite 8mm	Euroglas GmbH	IGDB v17.4			7.800	0.884	0.082	0.082	0.908	0.087	0.087	0.000	0.840	0.840
Advanced	1470	8 Eurowhite6.EGS	Eurowhite 6mm	Euroglas GmbH	IGDB v17.4			5.800	0.891	0.083	0.083	0.909	0.087	0.087	0.000	0.840	0.840
26 records found.	1470	g Eurofloat6.EGS	Eurofloat 6mm	Euroglas GmbH	IGDB v17.4			5.800	0.820	0.075	0.075	0.898	0.082	0.082	0.000	0.840	0.840
Import	1471	0 Eurofloat5.EGS	Eurofloat 5mm	Euroglas GmbH	IGDB v17.4			4.800	0.835	0.076	0.076	0.901	0.083	0.083	0.000	0.840	0.840
	1471	1 Eurofloat8.EGS	Eurofloat 8mm	Euroglas GmbH	IGDB v17.4			7.800	0.791	0.073	0.073	0.892	0.082	0.082	0.000	0.840	0.840
Export	1471	2 Eurowhite12.EGS	Eurowhite 12mm	Euroglas GmbH	IGDB v17.4			11.800	0.869	0.081	0.081	0.905	0.086	0.086	0.000	0.840	0.840
<u>R</u> eport	1471	3 Eurowhite10.EGS	Eurowhite 10mm	Euroglas GmbH	IGDB v17.4			9.800	0.876	0.082	0.082	0.906	0.086	0.086	0.000	0.840	0.840
Print	3000	9 102/VancevaAquamarine/9811.usr		User	IGDB User vl			6.374	0.737	0.069	0.069	0.787	0.074	0.074	0.000	0.840	0.840
		<b></b>															1
NFRC only	<u> </u>																

The laminate has now been imported from the Optics user database to the WINDOW Glass Library. It can now be used in the Glazing System Library to create a glazing system.

Figure 20-122. The laminate has now been added to the WINDOW Glass Library.

# 20.12. Creating an Applied Film Layer in Optics for NFRC Certification

## 20.12.1. Overview

Glazing layers with applied films can be constructed using Optics for NFRC certified simulations using the following criteria:

- The substrate for the applied film *cannot* have embedded coatings, where embedded coatings are defined as a coating on a substrate that touches the applied film.
- Only NFRC glass layers with the NFRC approval indicator "#" can be used as the substrate for applied film layers
- The glass layers used as the substrate for the applied film can be tinted or coated as long as the coatings do not face the applied film
- Only the layers of the Type "Applied Films" in Optics that have a "#" on them and are also on the "Approved Applied Films List" (updated by LBNL with every IGDB release and available on the WINDOW Knowledge Base website) can be used. This means that the data for those applied films was submitted to the IGDB using the criteria specified in Section 1.2 of this document, and that the Applied Film manufacturers are participating in the NFRC rating program.

For NFRC verification of the laminate construction submitted by simulators:

Glass Layers with an applied film constructed by simulators in Optics will not have a # next to them
when imported into WINDOW. The simulator shall specify in simulation reports the NFRC ID's of
the applied film and the substrate, which shall all meet the # criteria, such as:

2802 / 5038

- The simulator shall provide the properties for the applied film layer, including solar transmittance (solar, T), visible transmittance (photopic, T), solar reflectance front (solar, Rf), solar reflectance back (solar, Rb), visible reflectance front (photopic, Rf), visible reflectance back (photopic, Rb), Emissivity front (EmitF), Emissivity back (EmitB). These values are reported on the Optics screen when the laminate is calculated, and also in the WINDOW5 Detailed Report from the Glazing System Library. This requirement can be met by submitting the Optics User Database containing the applied film glass layers with the certification documentation.
- An IA (or anyone else wanting to check the results) can open the Optics User Database to verify the film and substrates used, as well as recreate the applied film layer from the specified film and substrate to verify the calculated values

## 20.12.2. Film Data

There are two types of films in Optics; the difference between them is how they were measured for submittal to the International Glazing Database:

- **Films:** These films were measured without a substrate and may appear in and be inputs to Optics calculations. However, the IGDB submittal process no longer accepts this type of submittal, and **they cannot be used for the NFRC Applied Film procedure**. Data in this category can be resubmitted to the IGDB, measured as an applied film with a substrate, and thus be added to the Applied Film category.
- Applied Films: These films are measured with a substrate. For the purposes of the NFRC Applied
  Film procedure, the only films that can be used are those that were measured with a clear substrate,
  the substrate having the properties of Tsol > 0.820 and Tvis > 0.890

Optics can accurately calculate the optical properties of applied films on glass layers as long as the applied films were measured following the guidelines listed below (and only applied films submitted with these characteristics will be included in the "Approved Applied Films" list for use in NFRC certified product calculations):

## 20.12.2.1. IGDB Submittal for Applied Films

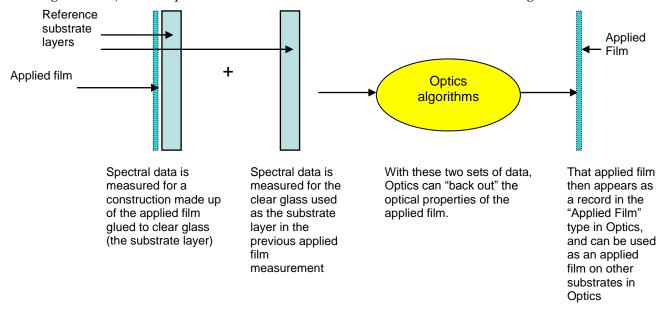
As discussed in the LBNL document which contains guidelines for submitting data to the IGDB, "an applied film glazing is an adhesive backed film applied to a Monolithic substrate." If the measured data submitted to the IGDB includes the substrate information, Optics can apply the film to another substrate.

This means that in order for an applied film to be added to the Optics "Applied Film" type, and therefore used in making applied film glass layers in Optics, the spectral data for the "reference" substrate to which that applied film was attached, is submitted to the IGDB as follows:

- Applied films are measured with transparent glass with a solar transmittance greater than 0.820 (Tsol > 0.820) and a visible transmittance greater than 0.890 (Tvis > 0.890). Glass that meets this criteria includes 3mm clear glass, 3 mm low-iron glass, 6 mm low-iron glass. This ensures that an applied film layer in Optics will always have a similar or lower transmittance than the reference substrate which determines the applied film properties
- Substrate layers (the base glass to which the applied films are applied) are measured separately, without the applied films attached, and submitted to the IGDB. This is the responsibility of the manufacturer submitting data to the IGDB, as discussed below.

The applied film manufacturer can submit to the IGDB two spectral data files, single 3 mm clear with the applied film on a clear substrate and the clear substrate by itself. With this data in the IGDB, simulators, using this Applied Film Procedure, can then create the other two cases, the single 6 mm clear with the film, and the single 6 mm gray with the film, to do the SHGC and VT calculations.

This will allow a film manufacturer to submit to the IGDB several different films with the same clear substrate, if they are all measured on the same clear 3 mm substrate (from the same glass batch). For example, if a film manufacturer wanted to submit data for 20 different applied films, they would submit one spectral data file for the substrate of all 20 measurements (assuming the substrates for each film all came from the same glass batch), and 20 spectral data files, one for each film on the substrate, resulting in 21 files submitted.



Each of the 20 spectral data files for the films applied to the substrate would reference the substrate spectral data file.

Additionally, the glass manufacturer will not have to submit spectral data for the applied films attached to 6 mm clear or 6 mm gray cases, as they can be simulated in Optics from the applied film on the 3 mm clear substrate.

## 20.12.3. Using this Procedure for NFRC 200:

NFRC 200 specifies a procedure for calculating SHGC and VT for attachments, which applies to "Applied Films". This procedure specifies that reference glazing systems shall be calculated "with and without the film installed" from the following glass layers.

- Single 3 mm clear
- Single 6 mm clear
- Single 6 mm gray

The first case, "Single 3 mm clear" is what the applied film manufacturers submit to the IGDB and will be in that database. The other two cases, "Single 6 mm clear" and "Single 6 mm gray" can now be calculated with Optics.

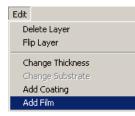
# 20.12.4. Creating a Layer with an Applied Film in Optics

## 20.12.4.1. Adding an Applied Film to an Uncoated Layer

You can apply a film to a monolithic layer in Optics to create a new applied film layer.

To apply a film to a monolithic layer follow the steps below:

- Click on the Glazing System tab
- Add the desired layer to a layer column under the **Glazing System** tab
- Select the monolithic layer by clicking on the desired layer number button
- Add an Applied Film to the selected glazing layer in one of the following ways:
  - Choose the menu option Edit | Change/Add Film



*Figure 20-123. Select a monolithic glass layer, click on the Layer button, and select the Edit/Add Film menu choice* 

- OR
  - Right click on the selected glazing layer button and select the choice "Add Film"
- The Change Glazing dialog box will appear. The film name box is highlighted in blue click on it to select an applied film from the database (you must select an "Applied Film" layer , not a "Film" layer). You must choose a film that is on the "Approved Applied Films" list.
- The new film will be added to the side you select in the 'Apply Film to' section of the dialog box:
- You will be prompted to enter a new name for the glazing
- If you want to keep the new layer, save it to the user database (see "Saving Layers to the User Database").

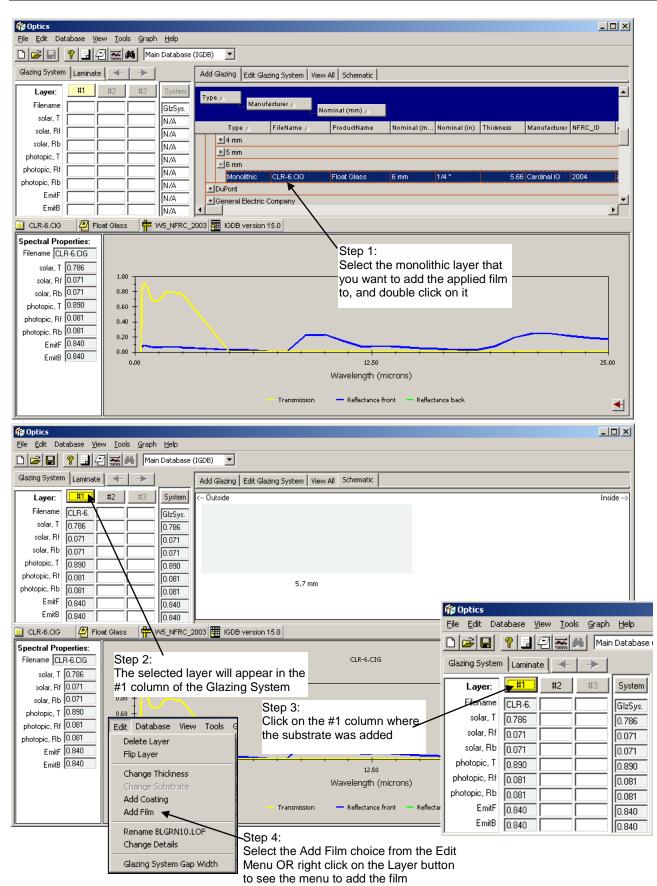


Figure 20-124. Select a monolithic glass layer, click on the Layer button, and select the Edit/Add Film menu choice

hange G	alazing									
– Existing	g Glazing —		Nev	v Glazing						
Filenam	ie:	CLEAR_3.DAT	Filer	name:	CLEAR_3.DA	T				
Product	t Name:	Generic Clear Glas		duct Name:	Generic Clear					
Appeara	ance:	Clear	Арр	earance:	Clear					
NFRC II	D:	102		CID:	102					
Glazing	Туре:	Monolithic		ing Type:	Monolithic					
Material				erial:					ck on the	
	n. ate Filename:	Glass			Glass				hlighted Fi	
		N/A		strate Filename:	N/A				me box, wł en the <b>Sele</b>	
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Thickne	ess (mm):	3.048	Thic	:kness (mm):	3.048				log box.	
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Film L	list		+ A	pplied Film Im						
f <b>il</b> Sel	lect new film	or applied film	+ A							
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fit Sel	lect new film Database (IGD	or applied film DB)	+ A							
Main	lect new film Database (IGD	or applied film	+ A	lm 						
Main	lect new film Database (IGE e ∠ Ma Type ∠	or applied film DB) ▼ nufacturer ∠ FileName ∠	roductName	Nominal (mm)		Thickness	Manufacturer		Acceptance	
Main	ect new film Database (IGE e A Mai Type A Applied Film	or applied film DB) ▼ nufacturer ▲ FileName ▲ SLGYCL03.SWT	roductName Solis® Select G	Nominal (mm)	N/A	Thickness 3.3274	Manufacture Southwall	1548		App Gra
Main	ect new film Database (IGE e A Mai Type A Applied Film Applied Film	or applied film DB) ▼ nufacturer ▲ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT	roductName Solis® Select G Solis® Select G	Nominal (mm)	N/A N/A	Thickness 3.3274 5.715	Manufacturer Southwall Southwall	1548 1549	Acceptance	App Gra- Gra-
Main	ect new film Database (IGE e A Mai Type A Applied Film	or applied film DB) ▼ nufacturer ▲ FileName ▲ SLGYCL03.SWT	roductName Solis® Select G	Nominal (mm)	N/A	Thickness 3.3274 5.715 3.0584	Manufacture Southwall	1548		App Gra
Main	ect new film Database (IGE e A Mai Type A Applied Film Applied Film Applied Film	or applied film DB) ▼ nufacturer ▲ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt	roductName Solis® Select G Solis® Select G V-Kool® 40	Nominal (mm) N/A N/A N/A	N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047	Manufacturei Southwall Southwall Southwall	1548 1549 1561	Acceptance	App Gra Gra Lt. C
Main Type	ect new film Database (IGE e A Mar Type A Applied Film Applied Film Applied Film Applied Film Applied Film	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70	Nominal (mm) N/A N/A N/A N/A N/A	N/A N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047 3.047	Manufactures Southwall Southwall Southwall Southwall	1548 1549 1561 1562	Acceptance # #	App Gra Cra Lt. C Cles
Main	ect new film Database (IGE e A Mar Type A Applied Film Applied Film Applied Film Applied Film Applied Film	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	In Nominal (mm) N/A N/A N/A N/A N/A N/A	N/A N/A N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047 3.047	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563	Acceptance # # #	App Gra Gra Lt. C Cles Cles
f <b>i≰ Sel</b> Main Type ▼Film	ect new film Database (IGE e A Mar Type A Applied Film Applied Film Applied Film Applied Film Applied Film	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	In Nominal (mm) N/A N/A N/A N/A N/A N/A	N/A N/A N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047 3.047	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563	Acceptance # # #	App Gra Gra Lt. C Cles Lt.G
Main Type	ect new film Database (IGE e A Mar Type A Applied Film Applied Film Applied Film Applied Film Applied Film	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	In Nominal (mm) N/A N/A N/A N/A N/A N/A	N/A N/A N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047 3.047	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563	Acceptance # # #	App Gra Gra Lt. C Cles Cles
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f <b>i≰ Sel</b> Main Type ▼Film	ect new film Database (IGE e A Mar Type A Applied Film Applied Film Applied Film Applied Film Applied Film	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	Nominal (mm)           NA           N/A           N/A           N/A           N/A           N/A           N/A           N/A	N/A N/A N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047 3.047	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563	Acceptance # # #	App Gra Gra Lt. C Cles Lt.G
f <b>i≰ Sel</b> Main Type ▼Film	ect new film Database (IGE e A Mar Type A Applied Film Applied Film Applied Film Applied Film Applied Film	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	Nominal (mm)           NA           N/A           N/A           N/A           N/A           N/A           N/A           N/A	N/A N/A N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047 3.047	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563	Acceptance # # #	App Gra Gra Lt. C Cles Lt.G
f <b>i≰ Sel</b> Main Type ▼Film	ect new film Database (IGE e A Mar Applied Film Applied Film Applied Film Applied Film Applied Film Applied Film	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	Nominal (mm)           NA           N/A           N/A           N/A           N/A           N/A           N/A           N/A	N/A N/A N/A N/A N/A Vk75.swt	Thickness 3.3274 5.715 3.0584 3.047 3.047 3.0711	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563	Acceptance # # #	App Gra Gra Lt. C Cles Lt.G
<mark>ff≹ Sel</mark> Main Type ▼Film	Lect new film Database (IGE e A Mar Type A Applied Film Applied Film Applied Film Applied Film Applied Film Applied Film n	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	Nominal (mm)           NA           N/A           N/A           N/A           N/A           N/A           N/A           N/A	N/A N/A N/A N/A N/A	Thickness 3.3274 5.715 3.0584 3.047 3.047 3.0711	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563	Acceptance # # # # # # #	App Gra Gra Lt. C Cles Cles
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<mark>ff≹ Sel</mark> Main Type ▼Film	Lect new film Database (IGE Applied Film Applied Film Applied Film Applied Film Applied Film Applied Film n	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	In Nominal (mm) N/A N/A N/A N/A N/A	N/A N/A N/A N/A N/A Vk75.swt	Thickness 3.3274 5.715 3.0584 3.047 3.047 3.0711	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563 1560	Acceptance	App Gra Gra Lt. C Cles Lt.G
<mark>ff≹ Sel</mark> Main Type ▼Film	Lect new film Database (IGE Applied Film Applied Film Applied Film Applied Film Applied Film Applied Film n	or applied film DB) ▼ FileName ▲ SLGYCL03.SWT SLGYCL06.SWT Vk40.swt Vk70.swt Vk75.swt	roductName Solis® Select G Solis® Select G V-Kool® 40 V-Kool® 70 V-Kool® 75	In Nominal (mm) N/A N/A N/A N/A N/A	N/A N/A N/A N/A N/A Vk75.swt	Thickness 3.3274 5.715 3.0584 3.047 3.047 3.0711	Manufacturer Southwall Southwall Southwall Southwall Southwall	1548 1549 1561 1562 1563 1560	Acceptance # # # # # # # # # # # # # # # # # # #	App Gra Gra Lt. C Cles Lt.G

Figure 20-125. Choose the film to apply

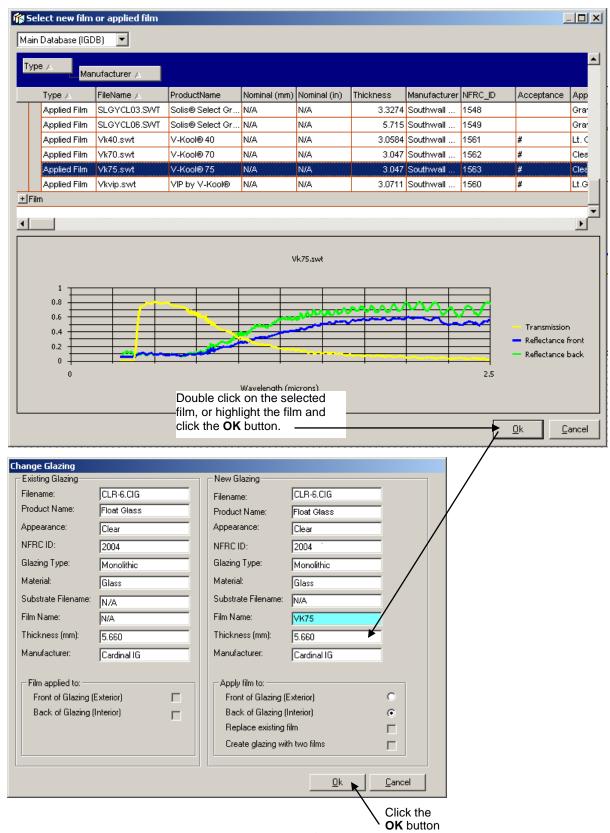


Figure 20-126. Apply the film to the substrate

	ears saying a no new glazing (gla	ew name must be ss layer)			
tics5		*		×	
	ecome the substrate of	the new glazing. You have to	supply a name for the new		
·····				· • • • • • • • •	
			Dptics5		x
/pe a new name ame should be th e applied film.	for the glazing ( e NFRC IDs of t	glass layer). Then the glass layer and —	New Filename (leave extension):	extension blank to	
dialog box appea formation fields o change the NFR	f the new glass				
otics5				¥	×
	overation fields (Dradi			to operation. Do	
Une or more or the Inr	ormation rields (Produ	Icchame, Apearence, NFRG	L ID) has been reset by t	ne operation. Do	you want to review/change these fields?
		Yes	No		
Change Glazing Existing Glazing Filename: Product Name: Appearance: NFRC ID: Glazing Type: Material:	2004/1563.usr 30000 Applied film N/A	New Glazing Filename: Product Name: Appearance: NFRC ID: Glazing Type: Material:	2004/1563.usr 300010 Applied film N/A		The Change Glazing dialog box will be displayed. Change the NFRC ID to an appropriate (and unique for your user database) number.
Substrate Filename: Film Name: Thickness (mm): Manufacturer:	CLR-6.CIG VK75 5.660 User	Substrate Filename: Film Name: Thickness (mm): Manufacturer:	CLR-6.CIG VK75 5.660 User		
Front of Glazing ( Back of Glazing (			<u>D</u> k	Cancel	

Figure 20-127. Give the new applied film layer a name and a new NFRC ID number if needed to ensure uniqueness.

# 20.12.4.2. Adding an Applied Film to a Coated Layer

You can apply a film to the uncoated side of a coated glazing, creating a double-coated layer with the coating on one side and the film on the other.

To apply a film to a coated layer:

- Click on the **Glazing System** tab
- Add the desired layer to a layer column under the **Glazing System** tab
- Select the coated layer by clicking on the desired layer number button
- Choose the menu option Edit | Change/Add Film
- OR
- Right click on the selected glazing layer button and select the choice "Add Film"
- The Change Glazing dialog box will appear. The film name box is highlighted in blue click on it to select an applied film from the database (you must select an "Applied Film" layer , not a "Film" layer). You must choose a film that is on the "Approved Applied Films" list.
- The new film will be applied to the uncoated side of the glazing to create a double-coated layer with the film on one side and the coating on the other – this is indicated in the 'Apply Film to' section of the dialog box.
- You will be prompted to enter a new name for the glazing. Use the naming convention specified in the beginning of this document, i.e., NFRC IDs for both the glazing layer and the applied film.
- If you want to keep the new layer, save it to the user database (see "Saving Layers to the User Database").

## 20.12.4.3. Adding an Applied Film to a Laminate

In the same manner as adding an applied film to either a coated or an uncoated layer, a film can be applied to a laminate. This laminate can already exist in the IGDB or can be a laminate constructed using the NFRC Laminate Procedure. The laminate is treated as a glass layer in the Glazing System tab, and the applied film is then added to that layer.

### 20.12.4.4. Change a Film

To change the film applied to an applied film layer:

- Select the applied film layer by clicking on the appropriate layer button
- Choose the menu option Edit | Change/Add Film
- The Change Glazing dialog box will appear The film name box is highlighted in blue click on it to select an applied film from the database (you must select an "Applied Film" layer , not a "Film" layer). You must choose a film that is on the "Approved Applied Films" list.
- The new film will replace the current film this is indicated in the 'Apply Film to' section of the dialog box
- You will be prompted to enter a new name for the glazing. Use the naming convention specified in the beginning of this document, i.e., NFRC IDs for both the glazing layer and the applied film.
- If you want to keep the new layer, save it to the user database (see "Saving Layers to the User Database").

## 20.12.4.5. Saving Layers to the User Database

You can save a glazing layer with an applied film to the user database if it has a different filename from any layer currently in the user database or in the IGDB. If you save a layer that has components (such as a glazing layer that has an applied film), the component layers will be saved to the user database at the same time (unless they already exist in the IGDB or user database). This allows you to load and edit those layers at a later time.

To save a layer to the user database:

• Select the layer or system to save by clicking on a layer button

Click the 'Save' button on the toolbar: *or*Choose menu option File | Save *filename or*Right-click to display the pop-up menu and select the option Save *filename*

• If the layer or system you saved had components, or if the save operation fails, you will be asked 'Do you want to view the details of the save operation?'. If you answer yes, you can view information about components that were saved to the user database, and components that were not saved to the user database along with an explanation of why some components were not saved.

Note: to change the filename and save in one operation, choose menu option Save As.. instead.

**Note:** You cannot save data for a layer with the same filename as another layer in the IGDB or your current user database. If a conflict is detected, Optics will ask you to rename the layer before saving it, or cancel the import. The most common reason a component is not saved is that its filename already exists in the IGDB or user database. In this case Optics assumes that the component layer information is already available and does not need to be saved again.

## 20.12.4.6. Renaming a Layer

To rename a layer with an applied film:

- Select the layer you want to rename by clicking on a layer button.
- Choose menu option Edit | Rename filename or

Right-click on the layer button to display the pop-up menu, and select item **Rename** *filename* 

• Enter a new filename and click 'OK'

If you want to save the layer under the new name, save it to the user database (see "Saving Layers to the User Database"). You could also achieve the same result by using the File |Save As... menu option to rename and save the layer in one operation.

# 20.13. Framed Intermediate Pane

### 20.13.1. Overview

For a product that has an intermediate pane with it's own frame, the modeling steps are as follows: In WINDOW:

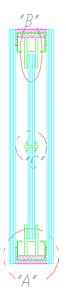
• Create the glazing system, including the intermediate pane.

In THERM:

 Model the head, sill and jamb sections including the intermediate pane and frame, using the glazing system created in WINDOW. Model caming, if applicable.

In WINDOW:

- Import the THERM cross sections into the Frame (and Divider if modeling caming) Libraries.
- Model the whole product using the Glazing System, Frame and Divider components.



*Figure 20-128.* An example of a framed intermediate pane. Section A is modeled for the Sill/Jamb, Section B is modeled for the Head, and Section C is modeled as a Divider.

### 20.13.2. THERM Modeling Details

The THERM modeling is relatively straightforward, with a few details to be aware of shown below.

The head and sill are modeled normally, except that the extra frame for the intermediate pane is also modeled. The sightline will remain defined as the highest interior point on the window/door frame.

If the glazing system is gas filled, any frame cavity opening into the glazing cavity must also be gas filled.

## Example Sill

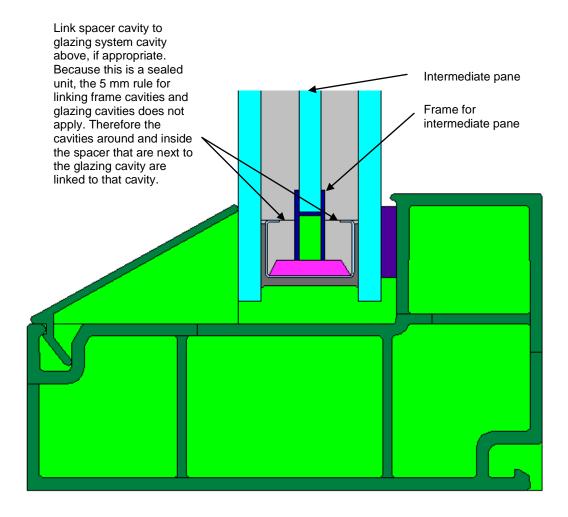


Figure 20-129. Example sill with framed intermediate pane

## **Example Head**

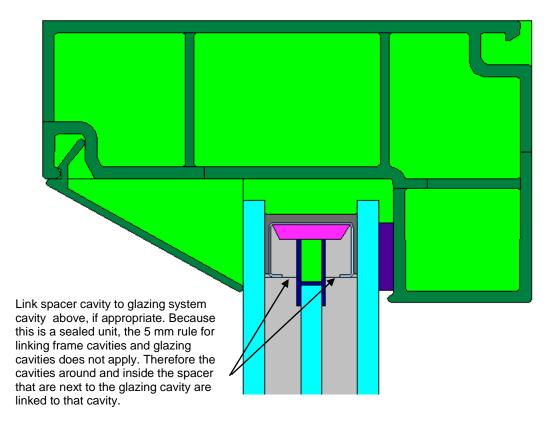


Figure 20-130. Example head with framed intermediate pane

# Example Caming / Divider

Caming, if it exists, is modeled as a Divider.

# 20.14 Complex Glazing Database (CGDB)

The Complex Glazing Database (CGDB) is provided by LBNL for modeling complex glazing products. Over time, more products will be added to the database, as methodologies are developed to measure the properties of the complex glazing products, and manufacturers submit data to LBNL to be included in the CGDB.

The current version of the CGDB is located on the LBNL website:

http://windows.lbl.gov/software/CGDB

There is a version of the database for each version of WINDOW (at the time of this writing, WINDOW 6 and WINDOW 7). The databases are basically just WINDOW databases that only have the complex glazing records in them, so the products are easily imported into any WINDOW database (keeping in mind the program version compatibility).

And by default will be installed into the following directory:

C:\Users\Public\LBNL\LBNL Shared

When you want to import records from the CGDB into the Shading Layer Library of your current WINDOW working database, follow these steps:

### 1. Shading Layer Library: Import the frit product from the CGDB into the Shading Layer Library

In the Shading Layer Library List View, click the Import button and browse to the CGCB database.

Detailed View				chell\Documents\My Training for Software A	pproval Complex	
Calc		ID	N	ame	ProductName	
New						-
<u></u>	•		Venetian A0		19	50
		2	Venetian A45			60
Delete		3	Venetian A90	Import		60
- Find		4	Venetian B0	-		60
ID 💌		5	Venetian B45	Format	Window 5 or 6 Database	60
		6	Venetian B90	🧩 Import database	slic\LBNL\LBNL Shared(W63-CGDB-1.2.mdb) Browse	60
		7	Venetian CO			60
Advanced		8	Venetian C45	for identical rec	duplicate records in export database by searching cords	60
17 records found		Э	Venetian C80			60
	_	10	Venetian C90		Cancel	60
		11	Venetian D0			60
Export		12	Venetian D45		19	30
Rep <u>o</u> rt		13	Venetian D90		19	30
Print		17	White Frit		G	ie
		22	Clear Frit (no pigmer	nt)	G	ie
		3000	Slim White VB Close	ed	Slim White Venetian Blind P	'e
		3002	Slim White Open		Slim White Venetian Blind P	'e

Figure 20-131. Browse to the CGDB database to import the frit records into the Shading Layer Library

When the CGDB dialog box appears, highlight the records to import and click the Select button (or click the Select All button to import all the records in the CGDB file). At this point, for NFRC certification, only the Fritted Glass and Venetian Blind products (which can be either Type = Venetian Blind, or Type = BSDF) can be used, so you may want to only select these products to import from the CGDB.

C:\L Sele		lic\LBNL\LBNL Shared\W63-CGDB-1.2.mdb	ID <b>1</b> 05 records found.			×
	ID	Name	ProductName	Manufacture	Туре	<b>_</b>
•	5000	Viraspan(TM) Medium Gray (V-948) 30%	Viraspan(TM) Ceramic Frit, Medium Gray (V-948) 30% Coverage	Viracon	Fritted glass	
	5001 6000	Simulated Sandblast (V-1086) 70% Hexcel Screen2 (S2) 3%, White Pearl (WS)	Translucent Frit, Simulated Sandblast (V-1086) 70% Coverage Hexcel Screen2 (S2) 3%, White Pearl (SA-9)	Viracon Nysan	Fritted glass BSDF	
	6001	GreenScreen Eco 3%, Pewter Platinum (WS)	GreenScreen Eco 3%, Pewter Platinum (SA-2)	Nysan	BSDF	

Figure 20-132. Select the desired records to be imported into the Shading Layer Library

The selected records will be imported into the Shading Layer Library.

Calc		ID	Name	ProductName	Manufacturer	Туре	
New							
Com	•	1	Venetian A0		ISO 15099 appendix	Venetian	S
<u><u>C</u>opy</u>		2	Venetian A45		ISO 15099 appendix	Venetian	S
Delete		3	Venetian A90		ISO 15099 appendix	Venetian	SI
Find		4	Venetian B0		ISO 15099 appendix	Venetian	S
ID 🔹		5	Venetian B45		ISO 15099 appendix	Venetian	SI
		6	Venetian B90		ISO 15099 appendix	Venetian	SI
		7	Venetian C0		ISO 15099 appendix	Venetian	S
Advanced		8	Venetian C45		ISO 15099 appendix	Venetian	SI
9 records found.		9	Venetian C80		ISO 15099 appendix	Venetian	SI
Import		10	Venetian C90		ISO 15099 appendix	Venetian	SI
		11	Venetian D0		ISO 15099 appendix	Venetian	SI
E <u>x</u> port		12	Venetian D45		ISO 15099 appendix	Venetian	SI
Rep <u>o</u> rt		13	Venetian D90		ISO 15099 appendix	Venetian	SI
Print		17	White Frit		Generic	Fritted glass	
		22	Clear Frit (no pigment)		Generic	Fritted glass	
		3000	Slim White VB Closed	Slim White Venetian Blind	Pella	Venetian	W
		3002	Slim White Open	Slim White Venetian Blind	Pella	Venetian	W
		5000	Viraspan(TM) Medium Gray (V-948) 30%	Viraspan(TM) Ceramic Frit, Medium Gray (V-948) 30% Coverage	Viracon	Fritted glass	
		5001	Simulated Sandblast (V-1086) 70%	Translucent Frit, Simulated Sandblast (V-1086) 70% Coverage	Viracon	Fritted glass	

Figure 20-133. The records selected from the CGDB will be imported into the WINDOW Shading Layer Library

Chading I

## 2. Shading Layer Library -- Fritted Glass Records

Highlight one of the fritted glass records and click on Detailed View to see the frit coverage and associated Glass Library records. You will see that there are several glass layers referenced, one for the substrate and two for the specular and diffuse optical data. If these records are not already in the Glass Library, they will automatically be imported when the Frit layer is imported into the Shading Layer Library.

If the frit coverage in the imported record does not correspond to the coverage of your product, change the value and save the record.

ID #: 5001					
Name: Simulated Sandblast (V-1086) 70%					
Product Name: Translucent Frit, Simulated Sandblast (V-1086) 7					
Manufacturer: Viracon					
Type: Fritted glass					
	The "Glass sub changed.	ostrate" ca	nnot be		
	Frit coverage: e appropriate val than the defaul	lue if it is d			
Fritted glass       Glass substrate       9803 CLEAR5.LOF	The referenced optical data files will automatically	Glass Library NFRC Trainin	(C:\Users\rdmitchell\Docu g for Software Approval I	ments\My Dropbox\nfrc\Training\\ Complex	W6 T6
Glass substrate 9803 CLEAR5.LOF	optical data files will automatically be imported into	Glass Library NFRC Trainin	(C:\Users\rdmitchell\Docu g for Software Approval I Name	ments\My Dropbox\nfrc\Training\\ Complex ProductName	W6 T6 Source
Glass substrate 9803 CLEAR5.LOF	optical data files will automatically	NFRC Trainin	g for Software Approval I	Complex	1
Glass substrate 9803 CLEAR5.LOF	optical data files will automatically be imported into	NFRC Trainir	g for Software Approval I Name	Complex	Source
Glass substrate 9803 CLEAR5.LOF	optical data files will automatically be imported into	NFRC Trainir	g for Software Approval I Name 1086Specular.lbl	Complex ProductName	Source
Glass substrate 9803 CLEAR5.LOF	optical data files will automatically be imported into	NFRC Trainin ID 60000 60001	g for Software Approval I Name	Complex ProductName Translucent Frit, Simulated San	Source CGDB v1.01 CGDB v1.01

Figure 20-134. The necessary records will be imported into the Glass Library for the frit layer

### 3. Shading Layer Library – Venetian Blind Records

Highlight one of the Venetian blind records and click on Detailed View to see the details of the Venetian blind definition.

The Detailed View will show the Blind Geometry, which includes Permeability Factor (automatically calculated by the program based on the slat geometry), Slat Width, Slat Spacing, Tilt, and Rise.

ID #:	3001	
Name:	Slim W	hite VB 45
Product	Name:	Slim White Venetian Blind
/lanufac	cturer:	Pella
уре:		Venetian blind, horizontal
Material:		31100 White Venetian Blind Slat (whit 💌
enetian	Blind	
Slat widtl	h:	14.808 mm
Slat widtl Spacing:	h:	14.808 mm 12.700 mm
Slat widtl Spacing:	h:	12.700 mm 45 degrees
Slat widtl Spacing: Tilt:	h: :	12.700 mm
Slat widtl Spacing: Tilt: Tilt angle	h: :	12.700 mm 45 degrees 45.0000 $\stackrel{\frown}{\rightarrow}$ degrees
/enetian Slat widtl Spacing: Tilt: Tilt angle Blind thic Rise:	h: :	12.700 mm 45 degrees 45.0000 $\stackrel{\frown}{\rightarrow}$ degrees

*Figure 20-135. Set the Tilt as needed to define the slat geometry* 

# Tilt:

Rather than entering a value for the Tilt angle, it is much better to select from the Tilt pulldown list, and the program will determine the actual tilt based on the curvature of the blind (derived from the Rise value)

• Retracted Open: "fully open (0°)

Venetian Blind			
Slat width:	14.8 mm	•	
Spacing:	12.0 mm		
Tilt:	fully open (0°) 💌		
Tilt angle:	closed (90°) 45 degrees		
	fully open (0°) -45 degrees closed (-90°)		
Rise:	Custom angle		
Help			

- Closed: depending on the direction of the slat curvature, either
  - Closed (90)

Venetian Blind			
Slat width:	14.8 mm	<b>.</b>	
Spacing:	12.0 mm		1
Tilt:	closed (-90°)		X
Tilt angle:	-88 A degrees		1
Blind thickness:	0.5 mm		1
Rise:	0.838 mm		)
Help			1

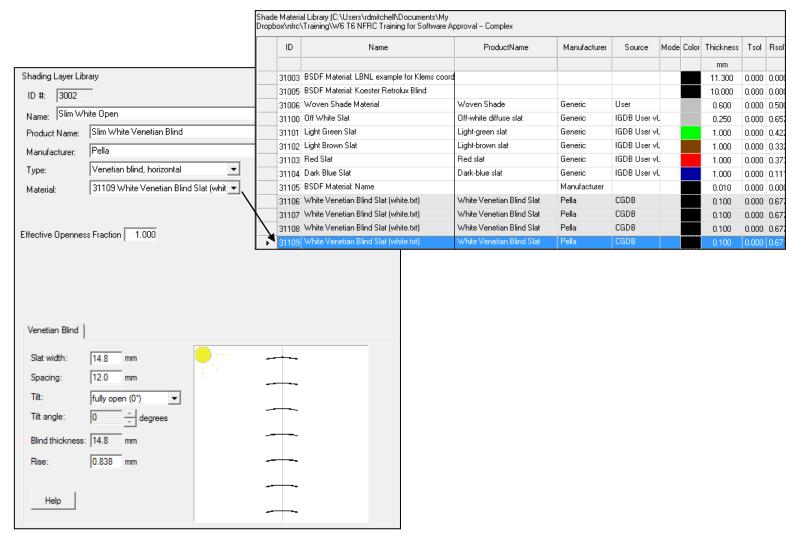
• Closed (-90)

Venetian Blind			
Slat width:	14.8 mm		
Spacing:	12.0 mm		
Tilt:	closed (90°)	}	
Tilt angle:	88 Address	4	
Blind thickness:	0.5 mm	4	
Rise:	0.838 mm	(	
		1	
Help		1	

### 4. Shade Material Library - Venetian Blind Records

When a record from the CGDB Shading Layer Library is imported into a working WINDOW database, the associated Shade Material Records are also imported.

For example, for the Venetian blind Shading Layer Library record below, the associated record in the Shade Material Library is automatically imported and associated with the Shading Layer.



*Figure 20-136. When a Shading Layer Library record is imported from the CGDB, the associated Shade Material Library record is imported automatically.*