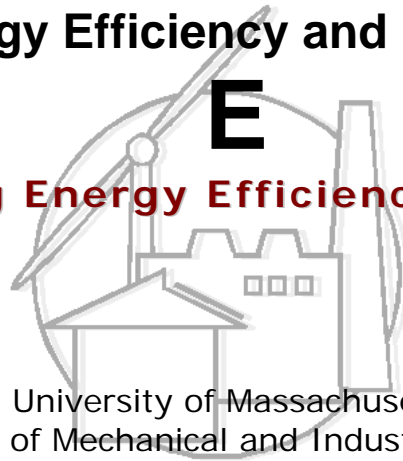


Center for Energy Efficiency and Renewable Energy

C E E R E

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**Computer Modeling of Heat Transfer For NFRC 1997 Testing
Round Robin Window – U-Factor and CR Simulations using
WINDOW 5 and THERM5**

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DESCRIPTION OF THE SPECIMEN

The product selected for simulation is a nominal 48'x48' aluminum-clad wood fixed window with high performance glazing. Thermo physical properties of different frame material are given in Table 1 and schematic representation of the material locations for a sill section is shown in Figure 1.

The glazing was dual-glazed, consisting of nominal 1" thick insulating glass fabricated from two 3/16" sheets of glass, and 5/8" air space. Low-E coating with emissivity of 0.04 is applied to surface #2. The spacer was specified to be a dual-sealed, U-shaped rolled spacer system, made of mild steel. The detailed reports from W5 are given in Appendix.

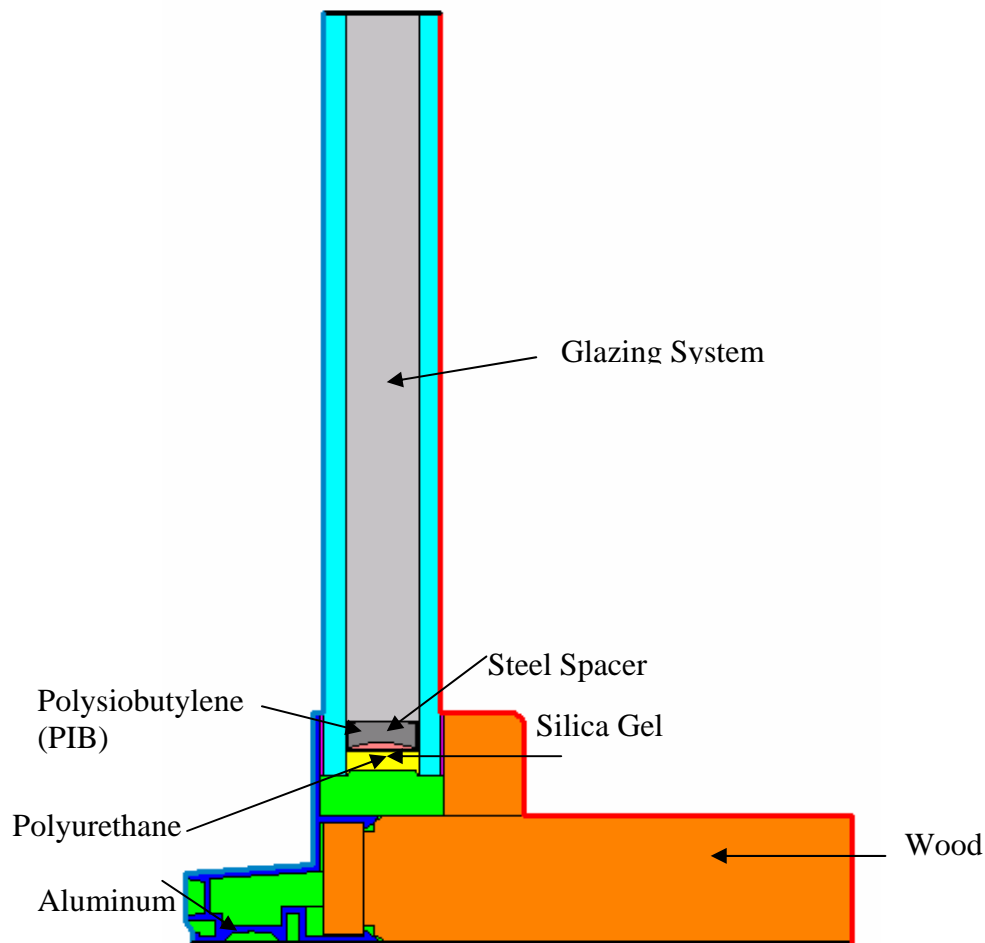


Fig. 1: Schematic Representations Of Frame Materials In A Jamb Cross-Section Of Frame

Table 1: Material Thermo Physical Properties

Material	<i>k</i> (Btu/h-ft-F)	ϵ
Aluminum	92.448	0.2
Polyurethane	0.0173	0.9
Polysio-butylene (PIB)	0.1387	0.9
Silica Gel (desiccant)	0.0173	0.9
Silicone	0.2080	0.9
Wood (Pine, Spruce, Fir)	0.0809	0.9
Steel-ANSI 1040 Mild	27.7344	0.2

U-factor calculations as well as CR calculations have been performed using the boundary conditions given in Table 2 with radiation enclosure.

Table 2: Boundary Conditions for Indoor and Outdoor Side of Window System for U-Factor Calculation and CR Calculation

<i>Boundary Conditions</i>		<i>Environmental Temperature (F) (°C)</i>	<i>h_c</i>		<i>Overall h</i>	ϵ
			<i>(Btu/h-ft²-F) (W/m²-K)</i>			
Outdoor Side	Glazing	-0.4 -18.0	4.58	26.00	N/A	0.84
	Frame		4.58	26.00	N/A	0.90
Indoor Side	Glazing	69.8 21.0	0.45	2.54	N/A	0.84
	Frame		0.45	2.54	N/A	0.90/0.20

Figure 2 and Figure 3 show isotherms for head, jamb and sill cross sections of the window system for U-factor calculations and CR calculations, respectively.

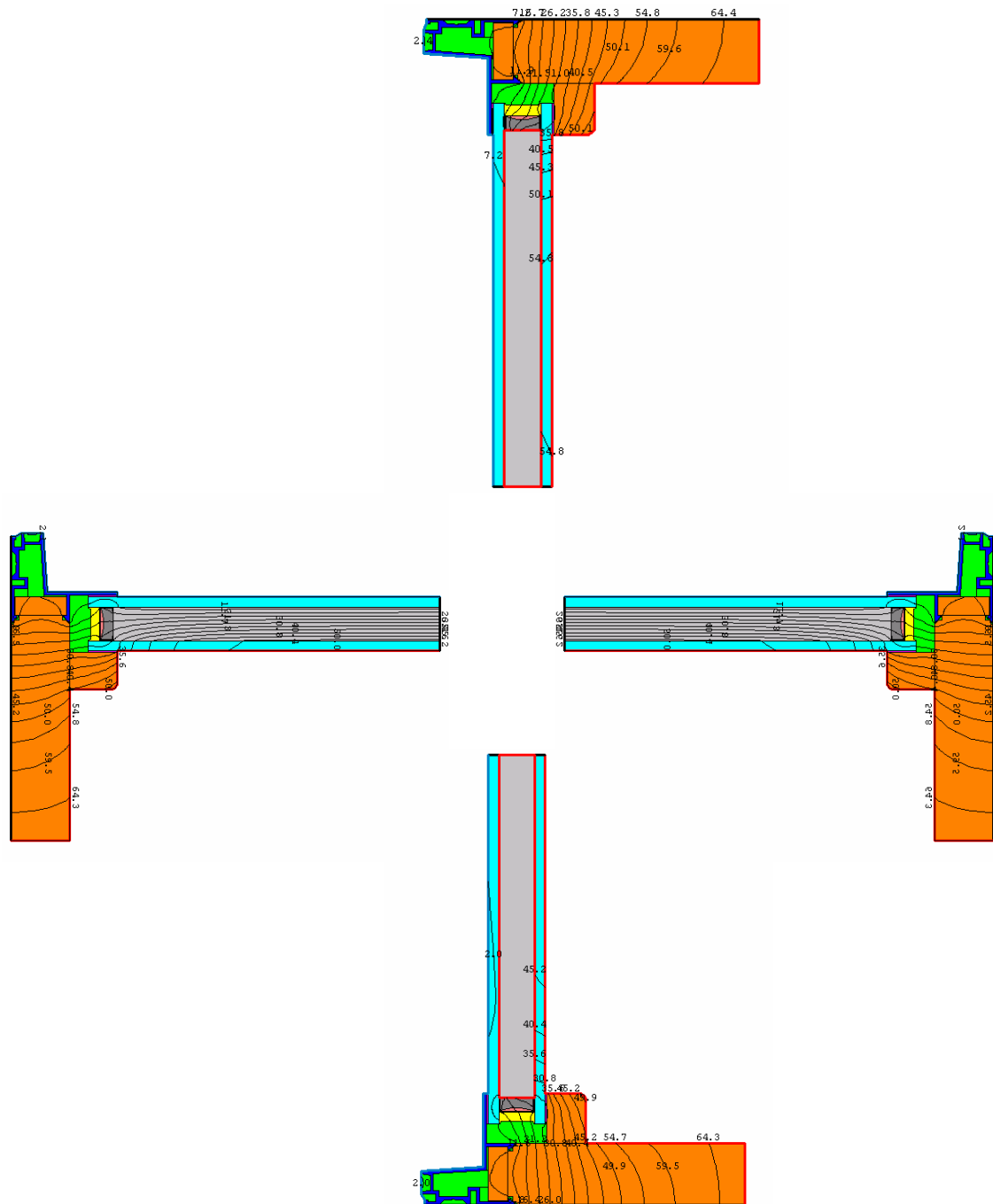


Fig3: Isotherms for Head, Jamb and Sill Cross Sections of The Window System for CR Calculation

The frame and edge cross-sections U-factors and overall U-factors for the model with radiation enclosure are given in Table 3, in which, both U-factor results in IP units and SI unites are taken from W5 report.

Table 3: Frame, Edge And Overall U-Factors

Cross Section	Project Y of frame (inches) mm		U-factor of frame (Btu/h-ft ² -F) W/m ² -K		U-factor of edge-of-glass (Btu/h-ft ² -F) W/m ² -K	
	Head	1.9690	50.013	0.4293	2.4377	0.3968
Sill	1.9690	50.013	0.4291	2.4369	0.3965	2.2515
Jamb Left	1.9690	50.013	0.4330	2.4586	0.3975	2.2572
Jamb Right	1.9690	50.013	0.4330	2.4586	0.3975	2.2572
			U-Factor (Btu/h-ft ² -F) W/m ² -K		SHGC	VT
Center of glass			0.302	1.715	0.405	0.708
Window assembly			0.339	1.924	0.347*	0.597

Note: * SHGC calculated using interior tag (interior developed surface area instead of exterior)

The results of CR calculation obtained are given in Table 4.

Table 4: CR Results for Therm5

CR	W5	Spreadsheet
CR _f	66.37	65.87
CR _g	65.62	65.49
CR _e	48.96	48.28
CR	49	48

COMPARISON WITH TEST DATA:

Figure 4 and Figure 5 show the temperature variation along the inside surface for Test Round Robin 97 window. The middle point in the graph corresponds to the center of glass temperature. Distance at X-axis corresponds to either the bottom of sill section to the top of the head section, or the left jamb section to the right jamb section. This window was tested in different test laboratory. The average temperature data from these test results have also been plotted against the simulated data in Figure 4 and Figure 5.

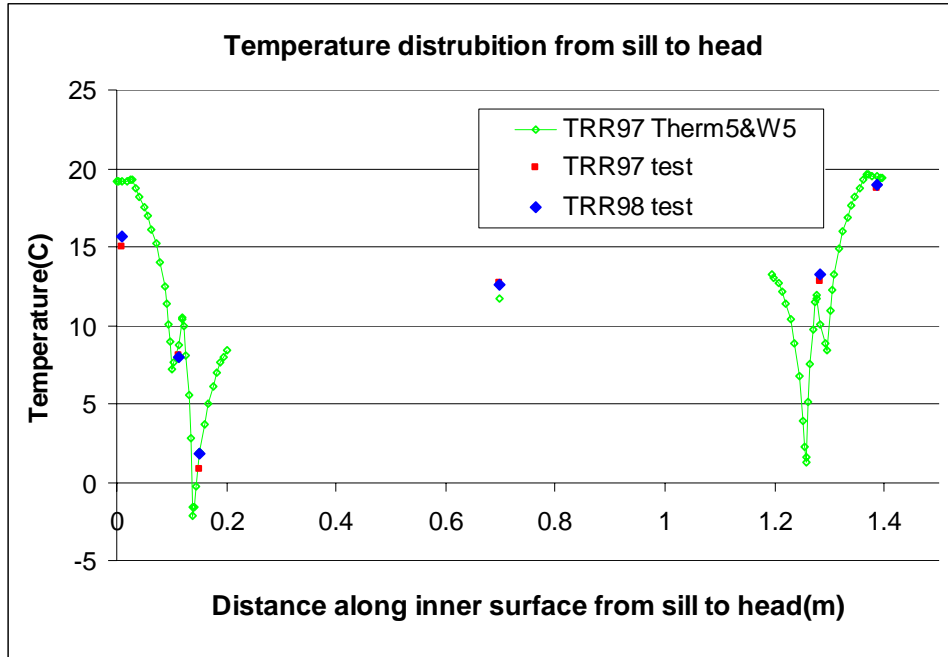


Figure 4. Temperature Distributions along Inside Surface (From Sill to Head)

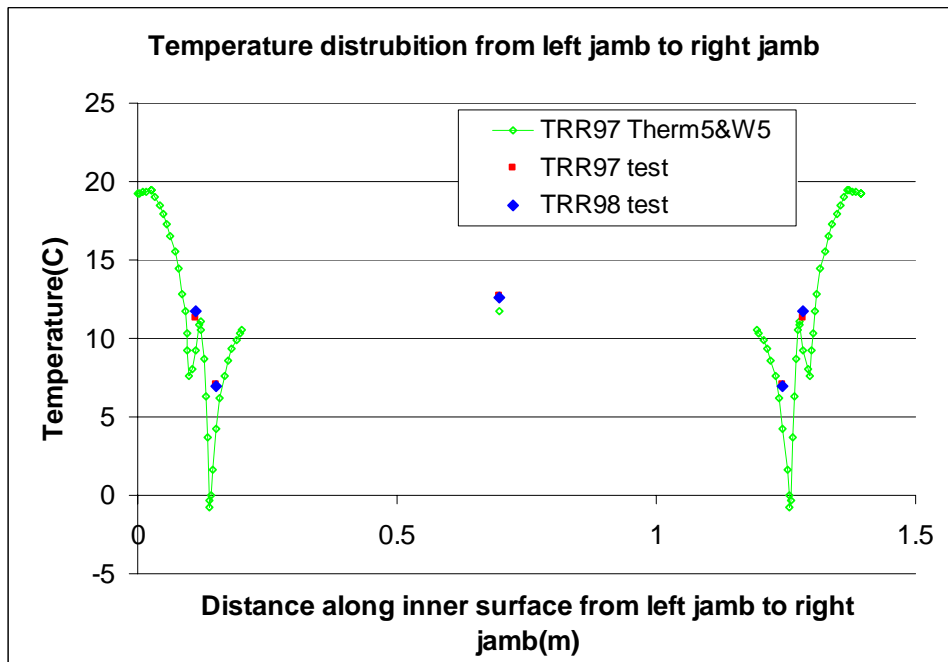


Figure 5. Temperature Distribution along Inside Surface (From Left Jamb to Right Jamb)

Appendix A – WINDOW 5 Report

Window 5.0 v5.0.85 Report Page 1 05/09/02 14:29:31

ID: 2
 Name: TRR97_CI
 EnvCond: 1 NFRC 100-2002

Type: Casement, custom
 Tilt: 90
 Size: 0
 Width: 1219.2 mm
 Height: 1219.2 mm
 Area: 1.49 m2

U-value: 1.924 W/m2-K
 SHGC: 0.345
 Vt: 0.597
 CI: 49.0

Data for Glazing Systems

ID	Name	COG Area m2	#Lay	Tilt	Uc W/m2	SCc	SHGCc	Vtc	RHG
10	TRR97	0.984	2	90	1.715	0.47	0.41	0.71	305

Glass and Gas Data for Glazing System '10 TRR97'

ID	Name	D(mm)	Tsol	1 Rsol	2 Rsol	Tvis	1 Rvis	2 Rvis	Tir	1 Emis	2 Emis	Keff	
Outside													
2013	EE172-5.CIG	*	4.8	.417	.296	.418	.787	.056	.043	.000	.840	.042	.900
1	Air		15.9									.040	
2003	CLR-5.CIG	*	4.8	.811	.072	.072	.897	.080	.080	.000	.840	.840	.900
Inside													

Frame Data

Location	ID	Name	Source	Frame Area m2	Edge Area m2	Uframe W/m2-K	Uedge
Header	22	TRR97w5H.THM	Therm	0.058	0.067	2.4377	2.2530
Left Jamb	23	TRR97w5J.THM	Therm	0.058	0.067	2.4586	2.2572
Right Jamb	23	TRR97w5J.THM	Therm	0.058	0.067	2.4586	2.2572
Sill	24	TRR97w5S.THM	Therm	0.058	0.067	2.4369	2.2515

Gas Data

ID	Name	Type	Cond W/m-K	Visc kg/m-s	Cp J/kg-K	Dens kg/m3	Pran
1	Air	Pure	0.0241	0.0000	1006.1033	1.2883	0.7197

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Environmental Conditions: 1 NFRC 100-2002

	Tout (C)	Tin (C)	WndSpd (m/s)	Wnd Dir	Solar (W/m2)	Tsky (C)	Esky
Uvalue	-18.0	21.0	5.50	Windward	0.0	-18.0	1.00
Solar	32.0	24.0	2.80	Windward	783.0	32.0	1.00

Frame Library Data

ID	Name	Source	U-value		Edge Corr	GlzSys Width mm	GlzSys Uc W/m2-K	Width (PFD) mm	Abs
			Frame W/m2-K	Edge W/m2-K					
22	TRR97w5H.THM	Therm	2.4377	2.2530	N/A	25.375	1.715	50.01	0.50
23	TRR97w5J.THM	Therm	2.4586	2.2572	N/A	25.375	1.715	50.01	0.50
24	TRR97w5S.THM	Therm	2.4369	2.2515	N/A	25.375	1.715	50.01	0.50

Divider Library Data

ID	Name	Source	U-value		Edge Corr	GlzSys Width mm	GlzSys Uc W/m2-K	Width (PFD) mm	Abs
			Div W/m2-K	Edge W/m2-K					

No Dividers for this Glazing System

Temperature Distribution (degrees C)

	Winter		Summer	
	Out	In	Out	In
Lay1	-15.7	-15.4	41.8	42.3
Lay2	11.3	11.7	30.4	30.2

Appendix B – AutoCAD drawing

