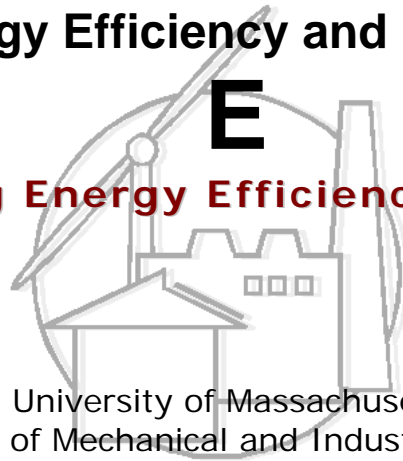


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**Computer Modeling of Thermal Performance of 2001 NFRC  
Testing Round Robin Window – U-Factor and CR Simulations  
Using WINDOW 5 and THERM 5**

*Prepared by:*

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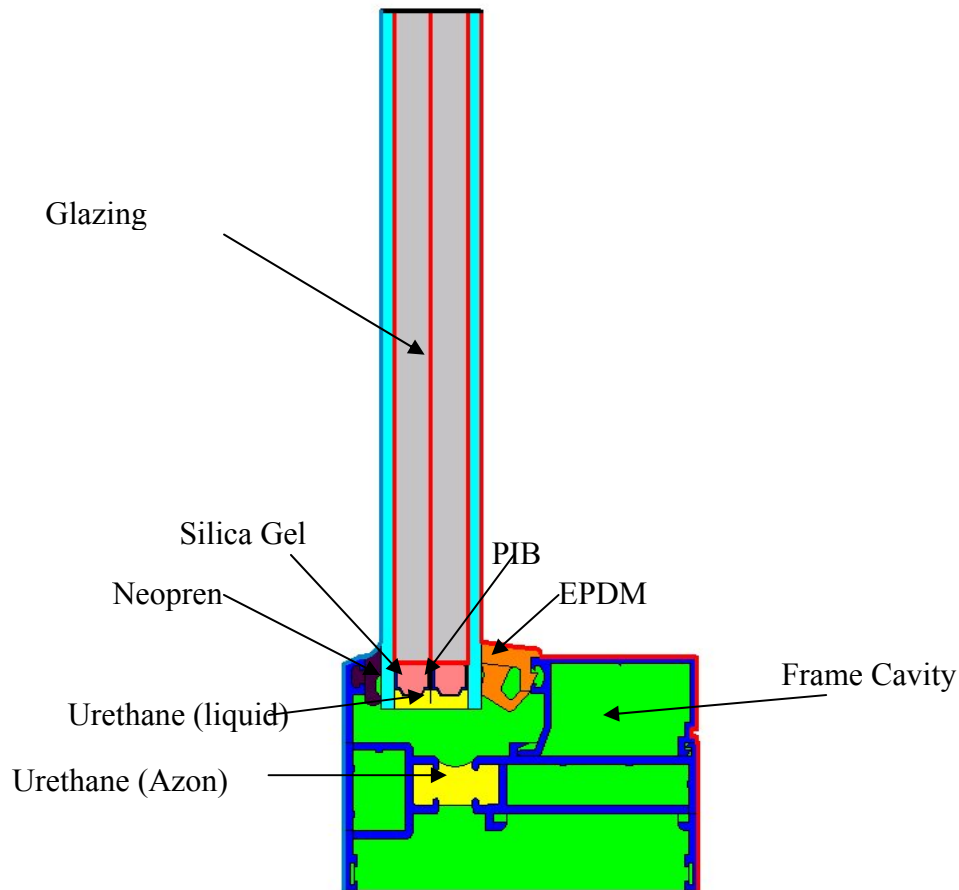
**April 2002**

## DESCRIPTION OF THE SPECIMEN

The product simulated here is a nominal 40" x 40" (1016mm x 1016mm) fixed window, which was the subject of NFRC 2001 testing round robin. The window consists of thermally broken Aluminum frame and triple-glazed, Heat Mirror IGU. The IGU consists of 2 layers of AFG glass, 0.122 in. thick and also 0.003" thick plastic sheet, with low emissivity coating on an indoor facing side (surface #4) and with emissivity  $\epsilon=0.052$ , manufactured by South Wall Technologies and normally known under the trade name Heat Mirror SC75. In addition, the glass is coated on indoor facing surface of the outdoor lite and on the outdoor facing surface of the indoor lite (surfaces 2 and 5). The fill gas is air, 0.338 in. wide for each gap. The overall thickness of this glazing unit is 0.92 in.

THERM 5 was used to model frame and edge of glass performance of all cross-sections. WINDOW 5 was used to model center of glass performance and to calculate overall indices for this window. The detailed report from WINDOW 5 is given in Appendix A.

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.



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

**Table 1: Material Thermo Physical Properties**

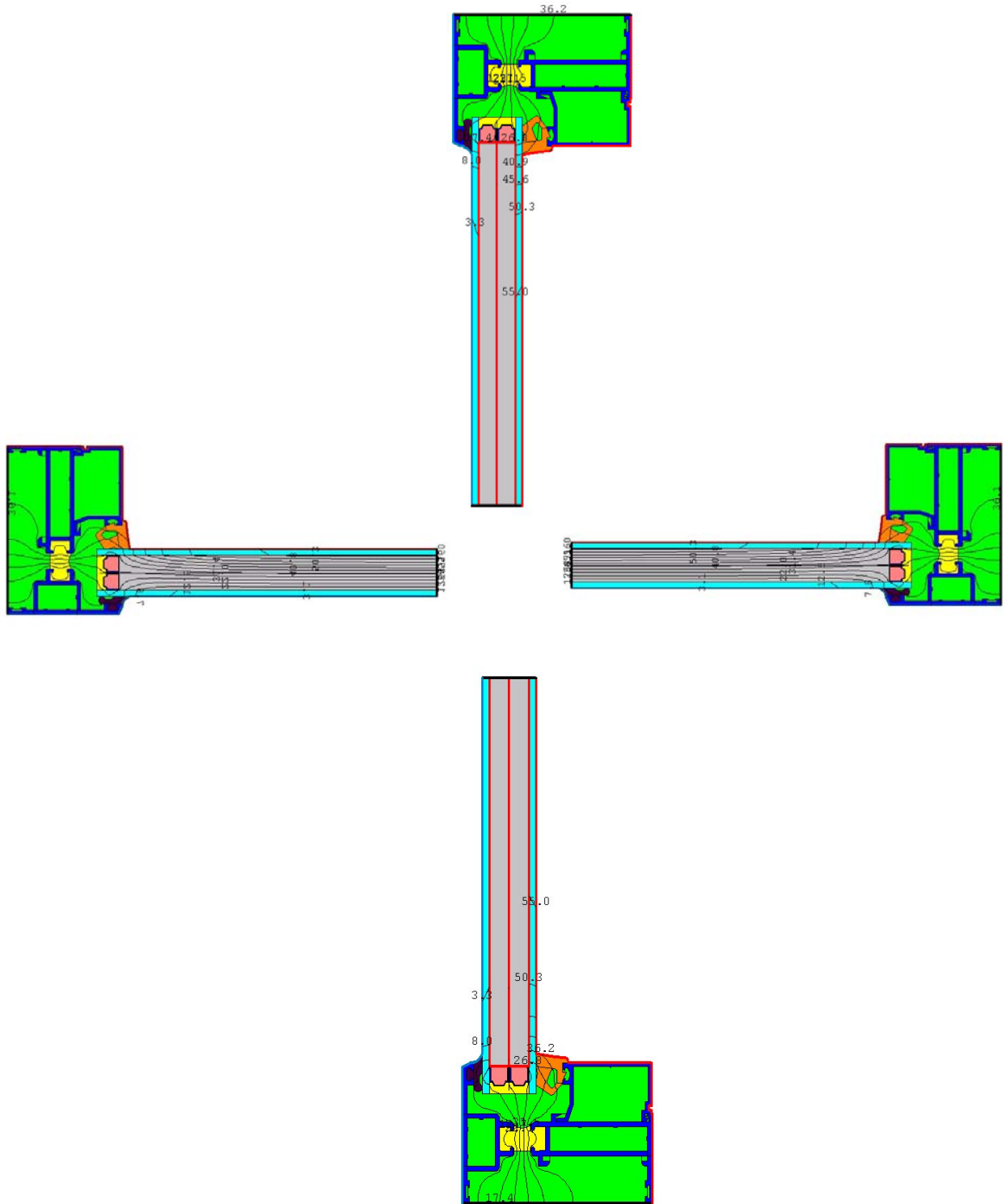
Material	$k$ (Btu/h-ft-F)	$\varepsilon$
Aluminum / Painted Al	92.44	0.2 / 0.9
Urethane	0.07	0.9
Urethane (liquid)	0.179	0.9
Urethane	0.070	0.9
Glass-clear	0.270	0.84
Silica Gel	0.017	0.9
Butyl Rubber	0.138	0.9
PIB	0.138	0.9
Neoprene	0.109	0.9
EPDM	0.144	0.9

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**

Boundary Conditions		Environmental Temperature $F$   $^{\circ}C$	$h_c$		Overall $h$	$\varepsilon$
			(Btu/h-ft <sup>2</sup> -F)	$W/m^2-K$		
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

Figure 3 shows isotherms for head, jamb and sill cross-sections of the TRR01 window from CR calculations runs.



**Figure 3. Isotherms for Head, Jamb and Sill Cross-Sections of the TRR01 Window (CR run)**

The frame and edge cross-sections U-factors and overall U-factors for the model with radiation enclosure are given in Table 3.

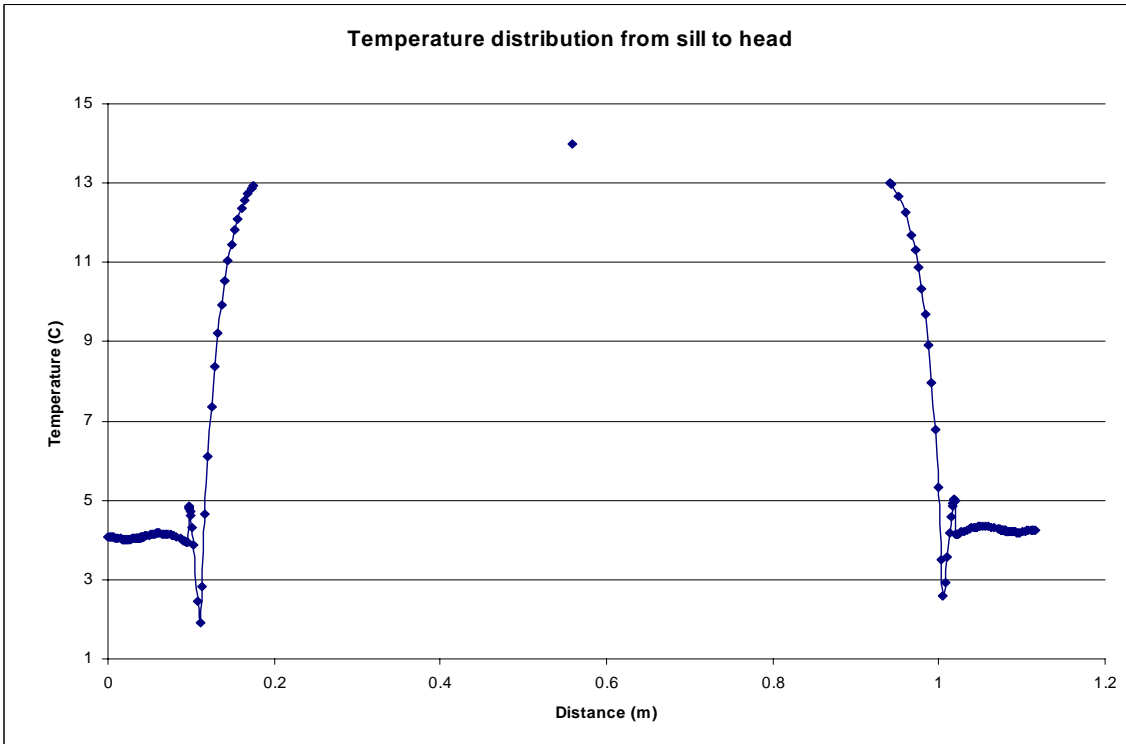
**Table 3: Frame, Edge And Overall U-Factors and CR value**

Cross Section	Name of THERM data file (ext .THM)	Projected frame width		Frame		Edge-of-Glass		U-Factors
		in.	mm	Btu/h.ft <sup>2</sup> ·F	W/m <sup>2</sup> ·K	Btu/h.ft <sup>2</sup> ·F	W/m <sup>2</sup> ·K	
Head	trr01_liqHead_09NCI_et	2.403	61.036	0.9141	5.1907	0.2885	1.6382	U-Factors
Sill	trr01_liqSill_09NCI_et	2.403	61.036	0.9134	5.1868	0.2875	1.6329	
Jamb	trr01_liqJamb_09N_et	2.403	61.036	0.9462	5.3731	0.2876	1.6334	
<b>Overall</b>				<b>41.33</b>		<b>56.38</b>		<b>CR</b>
		<b>U-Factor</b>		<b>SHGC</b>	<b>VT</b>	<b>CR</b>		
		Btu/hr.ft <sup>2</sup> ·F	W/m <sup>2</sup> ·K					
Center of glass		0.222	1.2605	0.312	0.534	74.16		
<b>Window Assembly</b>		<b>0.396</b>	<b>2.2939</b>	<b>0.260 (0.268)*</b>	<b>0.413</b>	<b>41</b>		

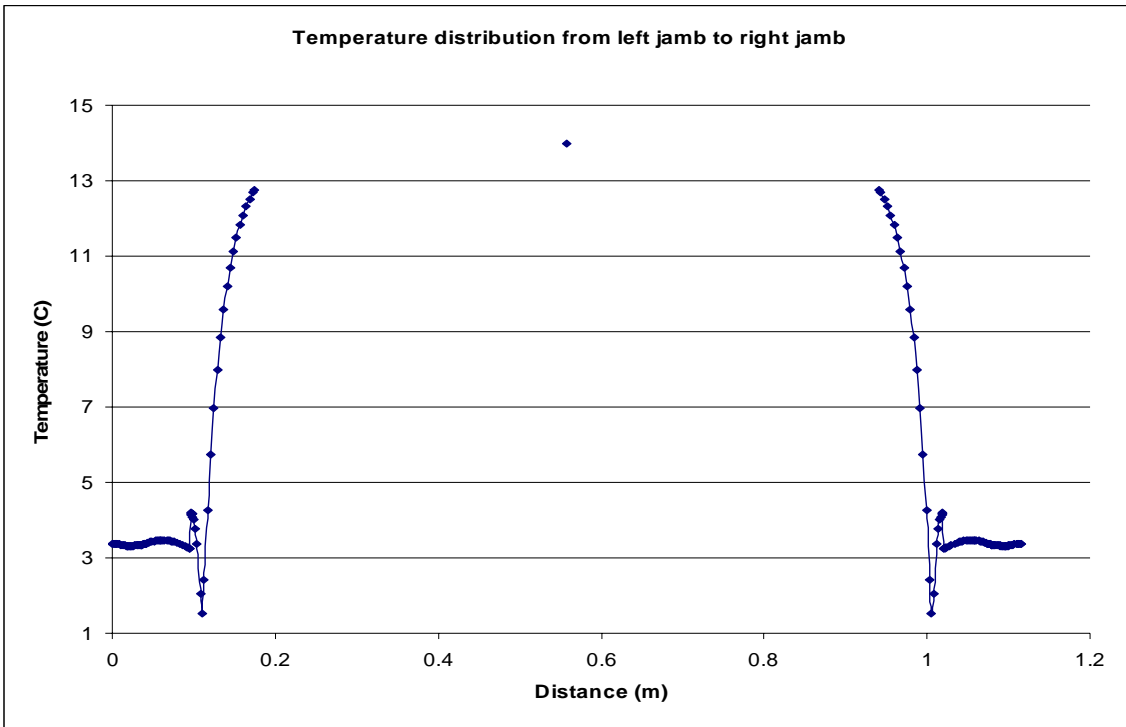
**Note:** \*SHGC calculated using exterior tag

**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.



**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 – W5 Report

Window 5.0 v5.0.83 Report

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ID: 6  
 Name: Trr01Ufactor  
 EnvCond: 1 NFRC 100-2002

Type: Casement, custom  
 Tilt: 90  
 Size: 0  
 Width: 1016.0 inches  
 Height: 1016.0 inches  
 Area: 1.03 ft2

U-value: 0.396 Btu/h-ft2-F  
 SHGC: 0.257  
 Vt: 0.413  
 CI: 54.3

## Data for Glazing Systems

ID	Name	COG Area ft2	#Lay	Tilt	Uc Btu/h-ft2	SCc	SHGCc	Vtc	RHG
10	Trr01N	0.588	3	90	0.222	0.36	0.31	0.53	75

## Glass and Gas Data for Glazing System '10 Trr01N'

ID	Name	D(inches)	Tsol	1 Rsol	2 Tvis	1 Rvis	2 Tir	1 Emis	2 Keff
Outside									
9942	CMFTE2_3.AFG	0.122	.686	.101	.124	.830	.088	.096	.000
	1 Air	0.338							
9943	HMSC75.SWT	0.003	.370	.460	.467	.754	.128	.105	.000
	1 Air	0.338							
9942	FCMFTE2_3.AFG	0.122	.686	.124	.101	.830	.096	.088	.000
Inside									

## Frame Data

Location	ID	Name	Source	Frame Area ft2	Edge Area ft2	Uframe Btu/h-ft2-F	Uedge
Header	21	trr01_liqHead	09NCI.THM	0.058	0.053	5.1855	1.6516
Left Jamb	20	trr01_liqJamb	09N.THM	0.058	0.053	5.3835	1.6366
Right Jamb	20	trr01_liqJamb	09N.THM	0.058	0.053	5.3835	1.6366
Sill	22	trr01_liqSill	09NCI.THM	0.058	0.053	5.1965	1.6474

Gas Data

ID	Name	Type	Cond Btu/h- ft-F	Visc lb-s/ ft2	Cp Btu/lb- F	Dens lb/ft3	Pran
1	Air	Pure	0.0241	0.0000	1006.1033	1.2883	0.7197

Environmental Conditions: 1 NFRC 100-2002

	Tout (F)	Tin (F)	WndSpd (mph)	Wnd Dir	Solar (Btu/h-ft2)	Tsky (F)	Esky (F)
Uvalue	-0.4	69.8	12.30	Windward	0.0	-0.4	1.00
Solar	89.6	75.2	6.26	Windward	248.2	89.6	1.00

Frame Library Data

ID	Name	Source	U-value Frame Btu/h- ft2-F	U-value Edge Btu/h- ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h- ft2-F	Width (PFD)	Abs
21	trr01_liqHead	09NCI.THMTerm	5.1855	1.6516	N/A	23.444	1.263	61.04	0.50
20	trr01_liqJamb	09N.THMTerm	5.3835	1.6366	N/A	23.444	1.263	61.04	0.50
22	trr01_liqSill	09NCI.THMTerm	5.1965	1.6474	N/A	23.444	1.263	61.04	0.50

Divider Library Data

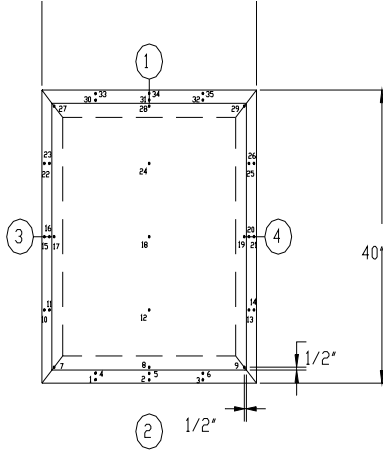
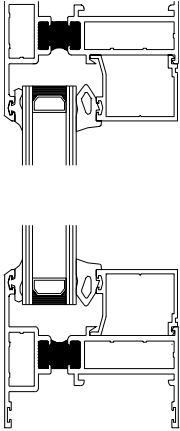
ID	Name	Source	U-value Div Btu/h- ft2-F	U-value Edge Btu/h- ft2-F	Edge Corr	GlzSys Width inches	GlzSys Uc Btu/h- ft2-F	Width (PFD)	Abs
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No Dividers for this Glazing System

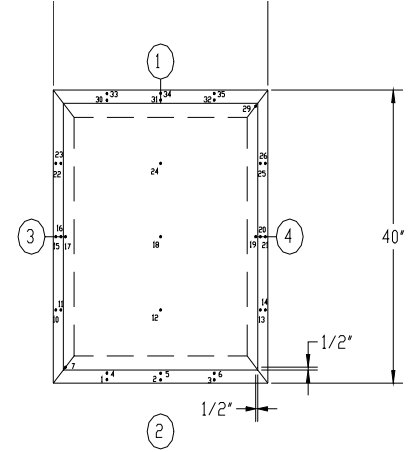
Temperature Distribution (degrees F)

	Winter		Summer	
	Out	In	Out	In
Lay1	2.6	2.9	112.0	112.9
Lay2	28.1	28.1	128.9	128.9
Lay3	56.9	57.2	98.5	98.0

# Appendix B: AutoCAD Drawings



Warm Side looking from metering side



Cold side looking from metering side

SCALE: FULL

