



Report No.: QCT-TH-10591.01-R1

Test Date: 01/16/16

Report Date: 1/18/16

Expiration Date: 1/18/21

NFRC 102-2010 THERMAL PERFORMANCE TEST REPORT

Rendered To:

FreMarq Innovations
8300 Highland Drive
Wausau, WI 54401

Series/Model: Aluminum Curtainwall
Type: Glazed Wall System (Curtain Wall)



Report No.: QCT-TH-10591.01-R1

Page 1 of 8
Report Date: 1/18/16

**NFRC 102-2010 THERMAL PERFORMANCE
TEST REPORT**

Rendered To:
FreMarq Innovations
8300 Highland Drive
Wausau, WI 54401

Test Sample Identification:

Series/Model: Aluminum Curtainwall

Product Type: Glazed Wall System (Curtain Wall)

Thermal Break: Fiberglass

Overall Size: 2000mm x 2000mm (79" x 79")

NFRC Standard Size: 2000mm x 2000mm (79" x 79")

Test Sample Submitted by: FreMarq Innovations

Test Sample Submitted for: Validation for Initial Certification (production line unit) & plant qualification

Test Procedure:

U-factor tests were performed in a Guarded Hot Box in accordance with NFRC 102-2010, *Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems*.

Test Results Summary:

Standardized U-factor (U_{st}): 0.31 Btu/(hr·ft²·F) CTS Method



Test Sample Description:

Size Specification:	Frame	Exterior Sash	Interior Sash
Size (inches) Non-Standard	79" x 79"	N.A.	N.A.
Daylight Opening (inches)	35-3/4" x 75" (2)	N.A.	N.A.

Construction:	Frame	Exterior Sash	Interior Sash
Corners	Square Cut	N.A.	N.A.
Fasteners	Screws	N.A.	N.A.
Sealant	N.A.	N.A.	N.A.

Finish:	Frame	Exterior Sash	Interior Sash
Material	Aluminum	N.A.	N.A.
Exterior Color	Silver	N.A.	N.A.
Exterior Finish	Anodized	N.A.	N.A.
Interior Color	Black	N.A.	N.A.
Interior Finish	Anodized	N.A.	N.A.

Spacer:				
Code	Spacer Type	Primary Sealant	Secondary Sealant	Desiccant
SS-D	XL-Edge Spacer	PIB	Silicone	Yes

Reinforcement Description:	
Location	Material
None.	N.A.

Grid:		
Size	Type	Pattern
None	N.A.	N.A.

Glazing Method:	Frame	Exterior Sash	Interior Sash
	Exterior	N.A.	N.A.

Glazing Information:	
Layer 1	6mm VE2-42 Clear (e= 0.04)
Gap 1	1/2" Argon 90%
Layer 2	6mm Clear
Gap 2	N.A.
Layer 3	N.A.
Gas Fill Method	Single-Probe*

*Stated per Client/Manufacturer

Not Applicable (N.A.)



Measured Test Data:

Heat Flows	Quantity	Units
1. Total Measured Metering Box Input (Q_{total})	1017.18	Btu/hr
2. Surround Panel Thickness	8	inches
3. Surround Panel Conductivity (C_{sp})	0.0238	Btu/(hr·ft ² ·F)
4. Surround Panel Heat Flow (Q_{sp})	33.10	Btu/hr
5. Metering Box Wall Plus Flanking Loss (Q_{mb+fl})	0.03	Btu/hr
6. EMF vs. Heat Flow Equation (Equivalent Information)	4366.5(EMF)+14.277	
7. Test Specimen Heat Flow (Q_s)	984.04	Btu/hr

Areas	Quantity	Units
8 Specimen Projected Area (A_s)	43.34	ft ²
9. Specimen Interior Total (3-D) Surface Area (A_{hi})	57.03	ft ²
10. Specimen Exterior Total (3-D) Surface Area (A_{he})	46.48	ft ²
11. Metering Box Opening Area (A_{mb})	64.00	ft ²
12. Metering Box Baffle Area Warm Side (A_{b1})	58.50	ft ²
13. Climate Room Baffle Area Cold Side (A_{b2})	80.00	ft ²
14. Surround Panel Interior Exposed Area (A_{sp})	20.66	ft ²

Test Conditions	Quantity	Units
15. Metering Room Air Temperature (t_h)	69.80	deg F
16. Climate Room Air Temperature (t_c)	-0.40	deg F
17. Guard Room Air Temperature (t_g)	74.21	deg F
18. Metering Room Average Relative Humidity	23.00	%
18-5. Metering Room Maximum Relative Humidity	23.81	%
18-6. Metering Room Minimum Relative Humidity	22.13	%
19. Climate Room Wind Speed (Perpendicular Flow)	15.15	mph
20. Total Pressure Differential Across Test Specimen	-0.01	psf
23. Surround Panel Warm Side Surface Temperature (t_{sp1})	68.08	deg F
24. Surround Panel Cold Side Surface Temperature (t_{sp2})	0.76	deg F

Thermal Transmittance	Quantity	Units
25. Specimen Thermal Transmittance (U_s)	0.32	Btu/(hr·ft ² ·F)
26. Standardized Thermal Transmittance (U_{ST} (CTS))	0.31	Btu/(hr·ft ² ·F)



Calculated Test Data:

CTS Method	Quantity	Units
27. Test Specimen Room Side Surface Emitance (ϵ_1)	0.84	N.A.
28. Metering Box Baffle Emitance (ϵ_{b1})	0.95	N.A.
29. Equivalent Room Side Surface Temperature (t_1)	54.34	deg F
30. Equivalent Climate Side Surface Temperature (t_2)	3.62	deg F
31. Room Side Baffle Temperature (t_{b1})	68.48	deg F
32. Climate Side Baffle Temperature (t_{b2})	0.31	deg F
33. Room Side Surface Heat Transfer Coefficient (h_h)	1.47	Btu/(hr·ft ² ·F)
34. Climate Side Surface Heat Transfer Coefficient (h_c)	5.65	Btu/(hr·ft ² ·F)
35. Test Specimen Conductance (C_s)	0.4477	Btu/(hr·ft ² ·F)
36. Convection Coefficient (K_c)	0.38	Btu/(hr·ft ² ·F)
37. Room Side Radiative Heat Flow (Q_{r1})	478.73	Btu/hr
38. Room Side Convective Heat Flow (Q_{c1})	505.31	Btu/hr
39. Room Side Radiative Heat Flux (q_{r1})	11.05	Btu/(hr·ft ²)
40. Room Side Convective Heat Flux (q_{c1})	11.66	Btu/(hr·ft ²)
41. Standardized Warm Side Surface Conductance (h_{STh})	1.19	Btu/(hr·ft ² ·F)
42. Standardized Cold Side Surface Conductance (h_{STc})	5.28	Btu/(hr·ft ² ·F)

Test Duration

- The environmental systems were started on
1/15/16 4:56 PM
- The test parameters were considered stable for two consecutive four hour test periods from
1/16/16 3:11 AM to 1/16/16 11:11 AM
- The thermal performance test results were derived from
1/16/16 7:11 AM to 1/16/16 11:11 AM

Glazing Deflection (inches)*:

Left Glazing	Right Glazing	
0.942	0.929	Edge thickness
0.94	0.911	Center thickness upon receipt of specimen in laboratory (after stabilization)
0.937	0.91	Center thickness at laboratory ambient conditions before testing
0.935	0.908	Center thickness width at test conditions

*Deflection determined using glass and gap meter



References:

The sample was inspected for the formation of frost or condensation, which may influence the surface temperature measurements. The sample showed no evidence of condensation at the conclusion of the test.

A full calibration of the Quast Consulting and Testing, Inc. 'thermal test chamber' in Mosinee, Wisconsin was conducted in 10/28/2015 in accordance with Quast Consulting and Testing, Inc. calibration procedure. A calibration check was performed in 07/26/2015.

"This test method does not include procedures to determine the heat flow due to either air movement through the specimen or solar radiation effects. As consequence, the thermal transmittance results obtained do not reflect performances which are expected from field installations due to not accounting for solar radiation, air leakage effects, and the thermal bridge effects that have the potential to occur due to the specific design and construction of the fenestration system opening. The latter can only be determined by in-situ measurements. Therefore, it is important to recognize that the thermal transmittance results obtained from this test method are for ideal laboratory conditions and should only be used for fenestration product comparisons and as input to thermal performance analyses which also include solar, air leakage and thermal bridge effects."

The test sample was installed in a vertical orientation, the exterior of the specimen was exposed to the cold side. The direction of heat transfer was from the interior (warm side) to the exterior (cold side) of the specimen.

"Rating included in this report are for submittal to an NFRC licensed Inspection Agency (IA) and are not meant to be used for labeling purposes. Only those values identified on a valid Certification Authorization Report (CAR) are to be used for labeling purposes." The rating values were rounded in accordance to the NFRC unit conversions and rounding policy document (NFRC 601-2010).

Quast Consulting and Testing, Inc. is a NFRC accredited testing laboratory and all tests conducted in full compliance with NFRC approved procedures.

The Standardized Thermal Transmittance (U_{st}) was determined using CTS Method per NFRC 102, Section 8.2.A.

The experimental uncertainty associated for this test was 3.5%.



Report No.: QCT-TH-10591.01-R1

Page 7 of 8
Report Date: 1/18/16

Detailed drawings, data files, a copy of this report and other pertinent project documentation will be retained by Quast Consulting and Testing, Inc. for a period of four years from the original test date. At the end of this retention period, such materials shall be discarded without notice and the service life of this report will expire. Results obtained were secured by using the designated testing methods. This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. This report is the exclusive property of the client so named herein and represents only the product tested. This report may not be reproduced, except in full, without the written consent of Quast Consulting and Testing, Inc.

This report is not complete without all attachments; see Appendix.

Appendix A: Drawings (18 pages).

A handwritten signature in black ink, appearing to read 'Andrew Tange', is written over a light gray rectangular background.

Test Performed By
Andrew Tange, Test Engineer

A handwritten signature in black ink, appearing to read 'Brian M. Sasman', is written over a light gray rectangular background.

Individual-In-Responsible-Charge
Brian M. Sasman P.E.



Report No.: QCT-TH-10591.01-R1

Page 8 of 8
Report Date: 1/18/16

Revision No.	Date	Description
.01	1/18/16	Original report issued.
R1	06/10/16	Issued to FreMarq Innovations