

Project No. : QCT14-3454.01-R3
Project: 7" Aluminum Curtainwall



Test Date(s): 01/19/2016 – 02/03/2016
Report Date: 02/09/2016
Report Revision Date: 03/01/2016

Mock-up Performance Test Report

Project:

7" Aluminum Curtainwall

Rendered To:

FreMarq Innovations

QUAST CONSULTING AND TESTING, INC.

Exterior Façade/Fenestration Consulting & Testing

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7" Aluminum Curtainwall Performance Mock-up





QCT14-3454.01-R3
7" Aluminum Curtainwall

February 9, 2016



MOCK-UP PERFORMANCE REPORT

Rendered to:

FreMarq Innovations
8300 Highland Drive
Wausau, WI 54455

Project Scope: Quast Consulting and Testing, Inc. (QCT) was contracted by FreMarq Innovations to conduct mock-up performance testing for a 7" aluminum curtainwall system. Testing was conducted at Quast Consulting and Testing, Inc. laboratory, located in Mosinee, Wisconsin.

Test Procedure:

Testing was conducted in accordance with applicable AAMA and ASTM test methods.

Dates Tested: January 19, 2016 – February 3, 2016

Project No: QCT14-3454.01

Client: FreMarq Innovations

Curtainwall Fabricator: FreMarq Innovations



Summary of Test Results:

Test No.	Test Method	Test		Results	Notes
1	ASTM E330	Static Preload	+20 psf	-----	
2	ASTM E283	Air Infiltration	+6.24 psf	PASS	
3	ASTM E331	Static Water Penetration	15 psf	PASS	
4	AAMA 501.1	Dynamic Water Penetration	15 psf	PASS	
5	ASTM E330	Uniform Load Deflection	±40 psf	PASS	
6	ASTM E283	Air Infiltration	+6.24 psf	PASS	
7	ASTM E331	Static Water Penetration	15 psf	PASS	
8	AAMA 501.5	Thermal Cycling	-10°F / 180°F	PASS	
		Condensation Assessment	-10°F / 70°F	PASS	
9	ASTM E283	Air Infiltration	+6.24 psf	PASS	
10	ASTM E331	Static Water Penetration	15 psf	PASS	
11	AAMA 501.1	Dynamic Water Penetration	15 psf	PASS	
12	ASTM E330	Uniform Load Proof Test	±60 psf	PASS	
13	ASTM E330	Uniform Load Deflection	-40 psf	PASS	100 cycles
14	ASTM E283	Air Infiltration	+6.24 psf	PASS	



Description of Test Specimen:

Exterior wall mock-up made up of a 7" aluminum curtainwall system. All framing members in the curtainwall consisted of extruded aluminum with a pultruded fiberglass insert. The curtainwall contained all vision glass totaling 3 lites wide by 5 lites tall. There were two full height m/f stacking mullions. The framing was anchored to the chamber at the head and sill and to an intermediate floor slab at the mid-span. The overall mock-up size was 16' wide by 26' tall.

The mock-up chamber was constructed inside QCT's facility and consisted of a rough opening and simulated building structure made up of structural steel tubes that contained one simulated intermediate building floor slab. The intermediate floor slab and perimeter opening were utilized in anchorage of the mock-up components.

Glazing:

All glass lites (1" insulating glass units) were set from the exterior against a continuous ¼" EPDM gasket. The glass was secured from the exterior with a continuous aluminum pressure plate lined with an EPDM gasket. The pressure plate was attached to the curtainwall stem with #14 x 1-1/4" HWH SS SMS fasteners located 9" o.c.

Frame Construction:

Window wall framing members were square cut and assembled utilizing screw splines incorporated into the design of the aluminum extrusions.

Perimeter Seals:

The mock up utilized a continuous interior and exterior perimeter seal consisting of Dow Corning 791 silicone building sealant.

Drawings:

4 pages total



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Witness: The following individuals were present for all or part of the mock up testing.

<u>Name</u>	<u>Representation</u>
Todd Frederick	FreMarq Innovations
Mark Breese	FreMarq Innovations
Jerry Sasman	Quast Consulting and Testing
Eric Jehn	Quast Consulting and Testing
Brian Sasman	Quast Consulting and Testing



Test Results:

Note: All locations referenced are viewed from the exterior.

1. **Preload** of +20 psf was applied for 10 seconds

2. **Air Infiltration (ASTM E283-12)**

Date: January 19, 2016

Temperature: 58°F

Barometric Pressure: 29.04" Hg

Test Pressure = 6.24 psf

Results: PASS

Component	Area (ft ²)	Allowable (CFM/ft ²)	Net Air Infiltration (CFM/ft ²)
Fixed Wall	416	0.06 CFM/ft ²	0.002 CFM/ft ²

3. **Static Water Penetration (ASTM E331-09)**

Date: January 21, 2016

Temperature: 62°F

Test Pressure: 15.0 psf

Allowable: No uncontrolled water penetration

Results: PASS.



4. Dynamic Water Penetration (AAMA 501.1-05)

Date: January 21, 2016
Temperature: 62°F
Test Pressure: 15.0 psf

Allowable: No uncontrolled water penetration

Results: PASS

5. Uniform Load Deflection Test (ASTM E330-14M)

Date: January 21, 2016
Temperature: 62°F

The specimen was subjected to the following loads, each for a duration of 10 seconds:

- + 20 psf preload
- + 40 psf design load
- 20 psf preload
- 40 psf design load

Performance Criteria:

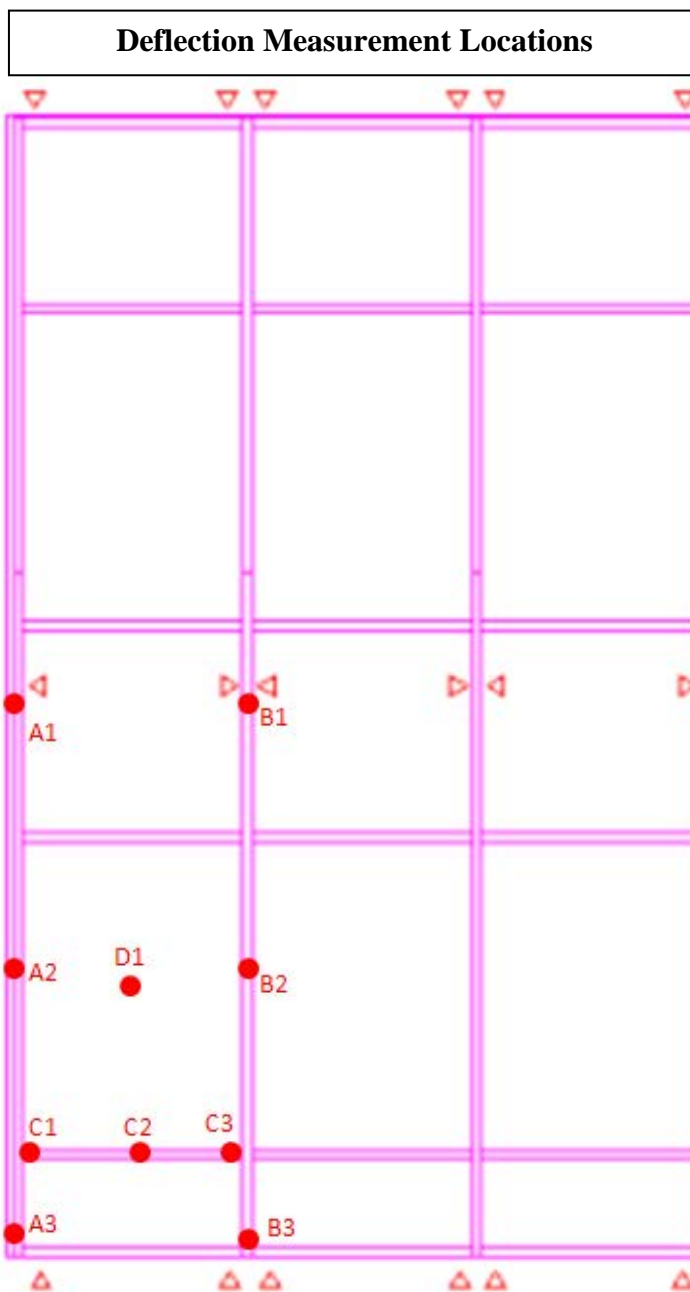
Deflection normal to wall plane shall be limited to $1/175$ of clear span for spans up to 13'-6" and to $1/240$ of clear span plus $1/4$ " for spans greater than 13'-6".

Results: PASS

No physical damage or failures were visibly evident after application of design loads. Measured live load deflections met specified performance criteria.

Member Net Deflection

Member	Member Span (in)	Net Deflection (in)		Allowable Deflection (in)
		+40 psf	-40 psf	
A (Jamb)	148	0.16	0.24	0.84
B (Vertical Mullion)	148	0.67	0.78	0.84
C (Horizontal Intermediate)	60	0.06	0.09	0.34
D (Center of Glass)	-----	0.98	0.87	-----





6. Air Infiltration (ASTM E283-12)

Date: January 21, 2016
Temperature: 58°F
Barometric Pressure: 28.96" Hg

Test Pressure = 6.24 psf

Results: PASS

Component	Area (ft ²)	Allowable (CFM/ft ²)	Net Air Infiltration (CFM/ft ²)
Fixed Wall	416	0.06 CFM/ft ²	0.006 CFM/ft ²

7. Static Water Penetration (ASTM E331-09)

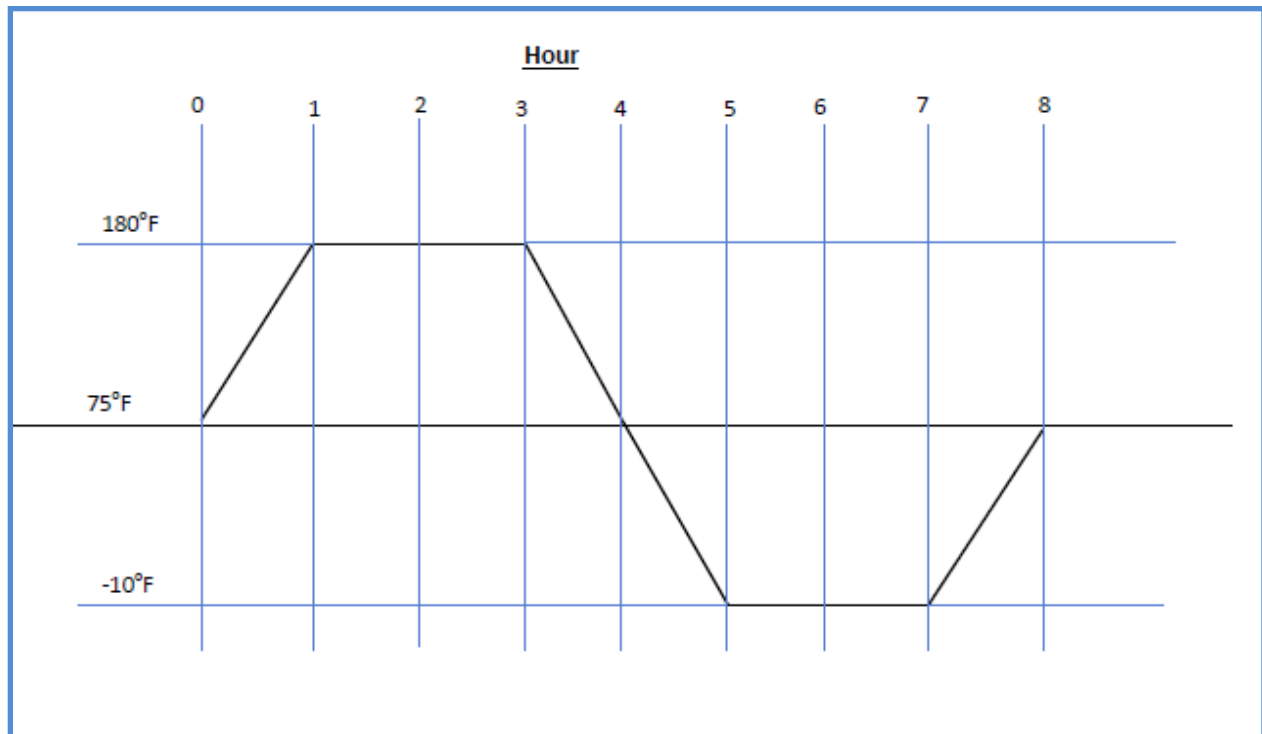
Date: January 21, 2016
Temperature: 58°F
Test Pressure: 15.0 psf

Allowable: No uncontrolled water penetration

Results: PASS

8. Thermal Cycling (AAMA 501.5-07): *“Test Method for Thermal Cycling of Exterior Walls”* The mock-up was enclosed from the exterior with an insulated thermal chamber. Exterior ambient temperature was cycled between -10°F and 180°F for 3 complete cycles. During each of the cold cycles, the interior ambient conditions were maintained at 75°F.

Dates: January 27 through January 29, 2016



Results: PASS

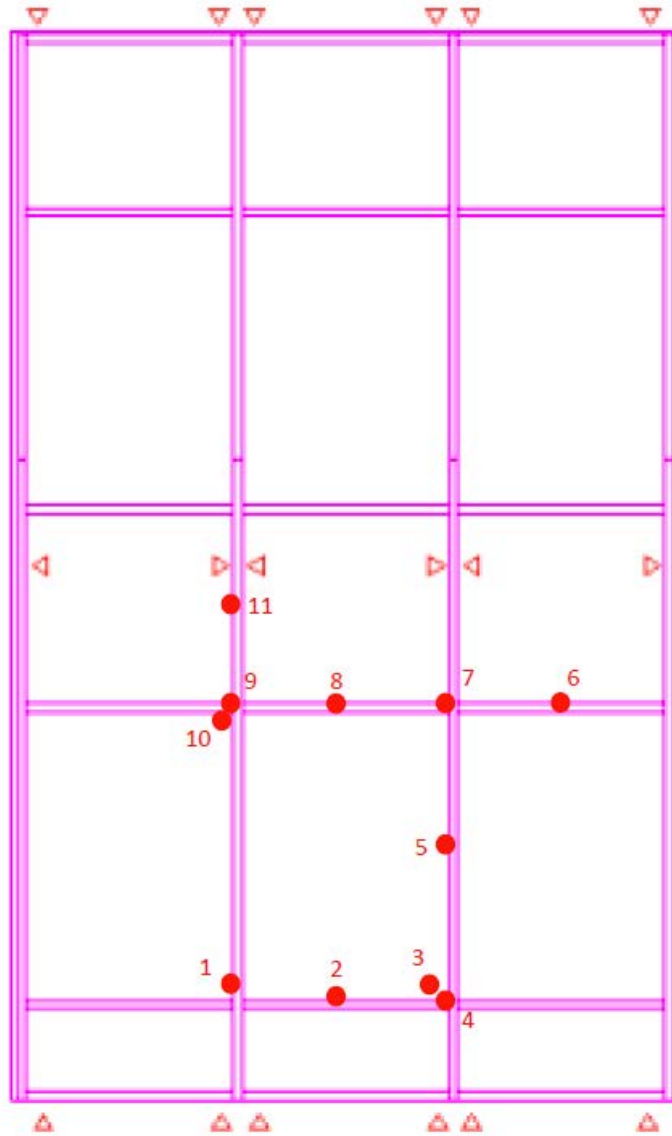
No physical damage or deterioration was visibly evident at the conclusion of the thermal cycling test.

Condensation Evaluation: PASS

During the Thermal Cycling test, the interior side of the mock-up was instrumented with thermocouples to measure interior surface temperatures. Upon thermal stabilization of the cold cycle, interior surface temperatures were measured and compared to the design dew point temperature. 70°F interior ambient air temperature at 30% RH yields a dew point temperature of 37.1°F.

Interior surface temperatures were measured at locations indicated on the following page.

All measured interior surface temperatures were above the design dew point temperature.



Temperature Measurement Locations



Cold Cycle

Thermocouple Number	Description	Temperature (°F)
-----	Interior Ambient Air	70.1
-----	Exterior Ambient Air	-10.4
1	Vertical Mullion	66.1
2	Horizontal Intermediate	65.8
3	Horizontal Intermediate	64.4
4	Vertical Mullion	64.6
5	Vertical Mullion	66.5
6	Horizontal Intermediate	68.6
7	Vertical Mullion	66.9
8	Horizontal Intermediate	66.3
9	Vertical Mullion	66.5
10	Horizontal Intermediate	68.9
11	Vertical Mullion	66.6

Hot Cycle

Thermocouple Number	Description	Temperature (°F)
-----	Interior Ambient Air	71.9
-----	Exterior Ambient Air	180.8
1	Vertical Mullion	74.3
2	Horizontal Intermediate	74.1
3	Horizontal Intermediate	72.3
4	Vertical Mullion	73.5
5	Vertical Mullion	74.8
6	Horizontal Intermediate	72.9
7	Vertical Mullion	78.2
8	Horizontal Intermediate	80.4
9	Vertical Mullion	79.9
10	Horizontal Intermediate	78.9
11	Vertical Mullion	81.8



9. Air Infiltration (ASTM E283-12)

Date: February 2, 2016
Temperature: 62°F
Barometric Pressure: 28.73" Hg

Test Pressure = 6.24 psf

Results: PASS

Component	Area (ft ²)	Allowable (CFM/ft ²)	Net Air Infiltration (CFM/ft ²)
Fixed Wall	416	0.06 CFM/ft ²	0.002 CFM/ft ²

10. Static Water Penetration (ASTM E331-09)

Date: February 3, 2016
Temperature: 60°F
Test Pressure: 15.0 psf

Allowable: No uncontrolled water penetration

Results: PASS

11. Dynamic Water Penetration (AAMA 501.1-05)

Date: February 3, 2016
Temperature: 60°F
Test Pressure: 15.0 psf

Allowable: No uncontrolled water penetration

Results: PASS



12. Uniform Load Proof Test (ASTM E330-14M)

Date: February 3, 2016
Temperature: 60°F

The specimen was subjected to the following loads, each for a duration of 10 seconds:

- + 30.0 psf preload
- + 60.0 psf proof load
- 30.0 psf preload
- 60.0 psf proof load

Performance Criteria:

Permanent set of framing members shall not exceed 0.2% of the length of the member.

Results: PASS

No physical damage or failures were visibly evident after application of design loads.
Measured permanent sets met specified performance criteria.

Member Permanent Set

Member	Member Span (in)	Net Permanent Set (in)		Allowable Permanent Set (in)
		+60 psf	-60 psf	
A (Jamb)	148	0.01	0.02	0.30
B (Vertical Mullion)	148	0.02	0.02	0.30
C (Horizontal Intermediate)	60	0.01	0.00	0.12
D (Center of Glass)	-----	0.02	0.07	-----

Note: Permanent set measurement locations same as Design Load Test



13. Uniform Load Test (ASTM E330-14M)

Date: February 23, 2016
Temperature: 61°F

Starting at 0 psf, the chamber was pressurized to -40 psf and held for 3 seconds, then allowed to return to 0 psf. A total of 100 cyclic loads were applied to the specimen.

- 40.0 psf design load

Results: PASS

No physical damage or failures were visibly evident after application of design loads.

14. Air Infiltration (ASTM E283-12)

Date: February 29, 2016
Temperature: 60°F
Barometric Pressure: 28.53" Hg

Test Pressure = 6.24 psf

Results: PASS

Component	Area (ft ²)	Allowable (CFM/ft ²)	Net Air Infiltration (CFM/ft ²)
Fixed Wall	416	0.06 CFM/ft ²	0.002 CFM/ft ²



Summary

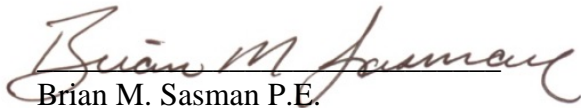
This performance test report is prepared for the convenience of our customer and endeavors to provide accurate and timely test results. It contains a summary of observations made by a qualified representative of Quast Consulting and Testing, Inc. This report is intended to help in your Quality Assurance Program, but it does not represent a continuous nor exhaustive evaluation. A copy of this report and all associated documentation will be retained by QCT for a period of ten years. This report is the exclusive property of the client so named herein and is applicable only to the specimen tested. This report is not complete without all attachments and may not be reproduced except in full.

Attachments:

Exhibit A: Drawings (13p)

QUAST CONSULTING and TESTING, INC.

QUAST CONSULTING and TESTING, INC.


Brian M. Sasman P.E.


Tim R. Quast
Reviewer



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Revision Log

Revision #	Date	Description
0	2-9-2016	Original report issued to Steelglaze Corporation.
R1	2-26-2016	Hot cycle surface temperatures added to report. Cyclic negative design load test added.
R2	3-1-2016	Addition of test #14 Air Infiltration
R3	6-10-2016	Issue to FreMarq Innovations.