

Project No. : QCT14-3454.01-R4  
Project: 178 mm Aluminum Curtainwall



Test Date(s): 01/19/2016 – 02/03/2016  
Report Date: 02/09/2016  
Report Revision Date: 02/07/2018

# Mock-up Performance Test Report

Project:

178 mm Aluminum Curtainwall

Rendered To:

FreMarq Innovations

**QUAST CONSULTING AND TESTING, INC.**

*Exterior Façade/Fenestration Consulting & Testing*

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## 178 mm Aluminum Curtainwall Performance Mock-up





QCT14-3454.01-R4  
178 mm 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 178 mm 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	+ 958 Pa	-----	
2	ASTM E283	Air Infiltration	+ 299 Pa	PASS	
3	ASTM E331	Static Water Penetration	+ 719 Pa	PASS	
4	AAMA 501.1	Dynamic Water Penetration	+ 719 Pa	PASS	
5	ASTM E330	Uniform Load Deflection	± 1916 Pa	PASS	
6	ASTM E283	Air Infiltration	+ 299 Pa	PASS	
7	ASTM E331	Static Water Penetration	+ 719 Pa	PASS	
8	AAMA 501.5	Thermal Cycling	-23°C - 82°C	PASS	
		Condensation Assessment	-23°C - 21°C	PASS	
9	ASTM E283	Air Infiltration	+ 299 Pa	PASS	
10	ASTM E331	Static Water Penetration	+ 719 Pa	PASS	
11	AAMA 501.1	Dynamic Water Penetration	+ 719 Pa	PASS	
12	ASTM E330	Uniform Load Proof Test	± 2874 Pa	PASS	
13	ASTM E330	Uniform Load Deflection	-1916 Pa	PASS	100 cycles
14	ASTM E283	Air Infiltration	+ 229 Pa	PASS	

### **Description of Test Specimen:**

Exterior wall mock-up made up of a 178 mm 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 4.88 m wide by 7.92 m 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 (25.4 mm insulating glass units) were set from the exterior against a continuous 6.4 mm 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 229 mm 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



**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 +958 Pa was applied for 10 seconds

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

Date: January 19, 2016

Temperature: 14.4°C

Barometric Pressure: 98.3 kPa

Test Pressure = 229 Pa

**Results: PASS**

Component	Area (m <sup>2</sup> )	Allowable (L/(s·m <sup>2</sup> ))	Net Air Infiltration (L/(s·m <sup>2</sup> ))
Fixed Wall	38.6	0.30	0.01

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

Date: January 21, 2016

Temperature: 17°C

Test Pressure: 719 Pa

Allowable: No uncontrolled water penetration

**Results: PASS.**

**4. Dynamic Water Penetration (AAMA 501.1-05)**

Date: January 21, 2016  
Temperature: 17°C  
Test Pressure: 719 Pa

Allowable: No uncontrolled water penetration

**Results: PASS**

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

Date: January 21, 2016  
Temperature: 17°C

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

- + 958 Pa preload
- + 1916 Pa design load
- 958 Pa preload
- 1916 Pa design load

Performance Criteria:

Deflection normal to wall plane shall be limited to 1/175 of clear span for spans up to 4.1 m and to 1/240 of clear span plus 6.4 mm for spans greater than 4.1 m.

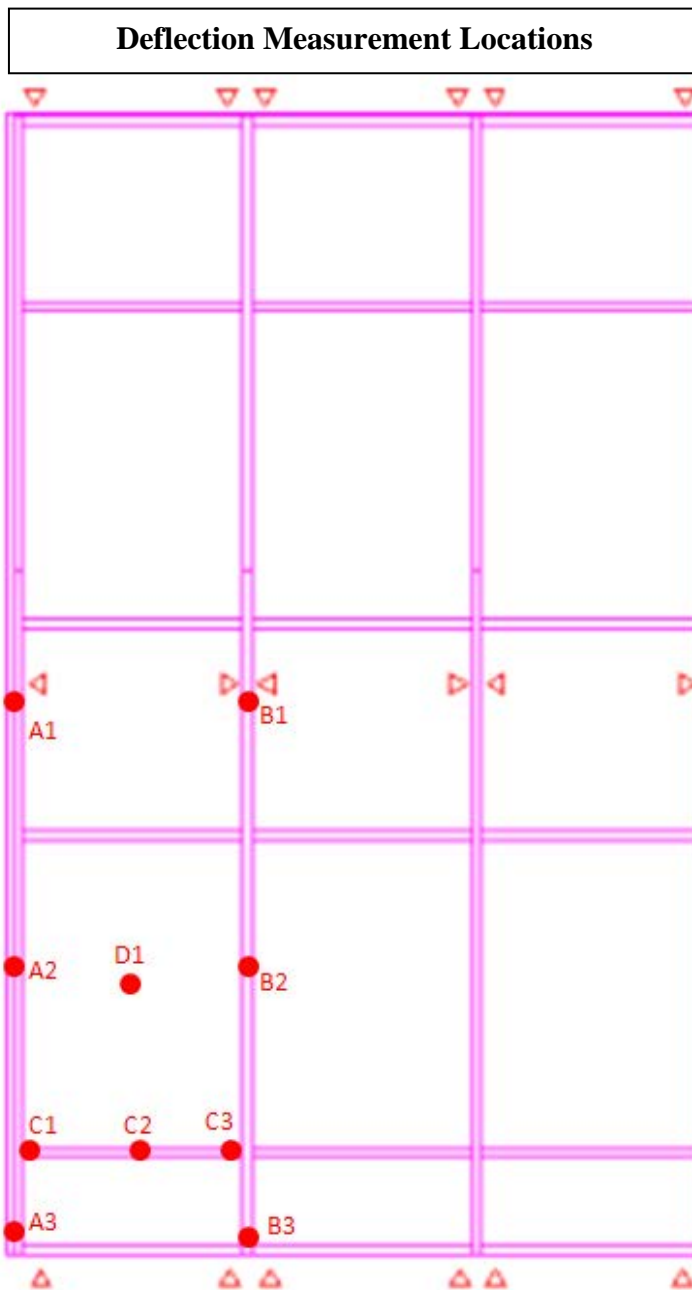
**Results: PASS**

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 (mm)	Net Deflection (mm)		Allowable Deflection (mm)
		+1916 Pa	-1916 Pa	
A (Jamb)	3759	4.06	6.10	21.34
B (Vertical Mullion)	3759	17.02	19.81	21.34
C (Horizontal Intermediate)	1524	1.52	2.29	8.64
D (Center of Glass)	-----	24.89	22.10	-----



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

Date: January 21, 2016  
 Temperature: 14°C  
 Barometric Pressure: 98.06 kPa

Test Pressure = 299 Pa

**Results: PASS**

Component	Area (m <sup>2</sup> )	Allowable (L/(s·m <sup>2</sup> ))	Net Air Infiltration (L/(s·m <sup>2</sup> ))
Fixed Wall	38.6	0.30	0.03

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

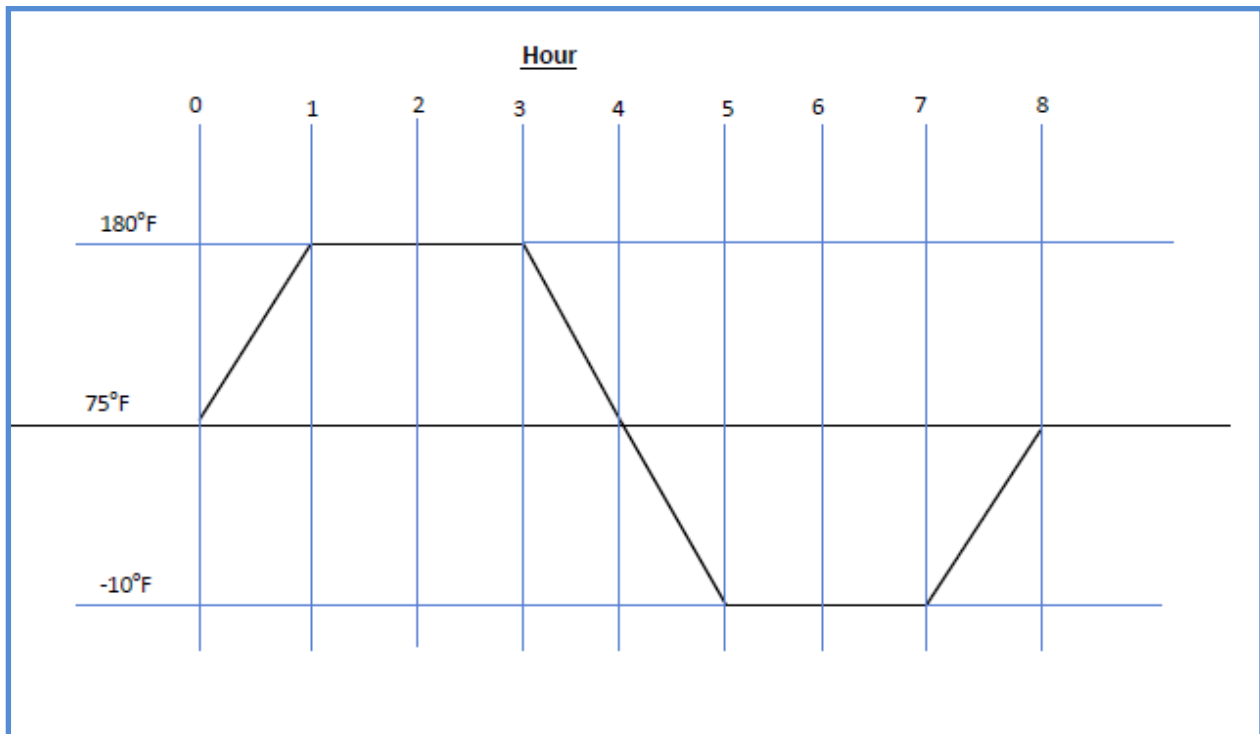
Date: January 21, 2016  
 Temperature: 14°C  
 Test Pressure: 719 Pa

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 -23°C and 82°C for 3 complete cycles. During each of the cold cycles, the interior ambient conditions were maintained at 24°C.

Dates: January 27 through January 29, 2016



Results: PASS

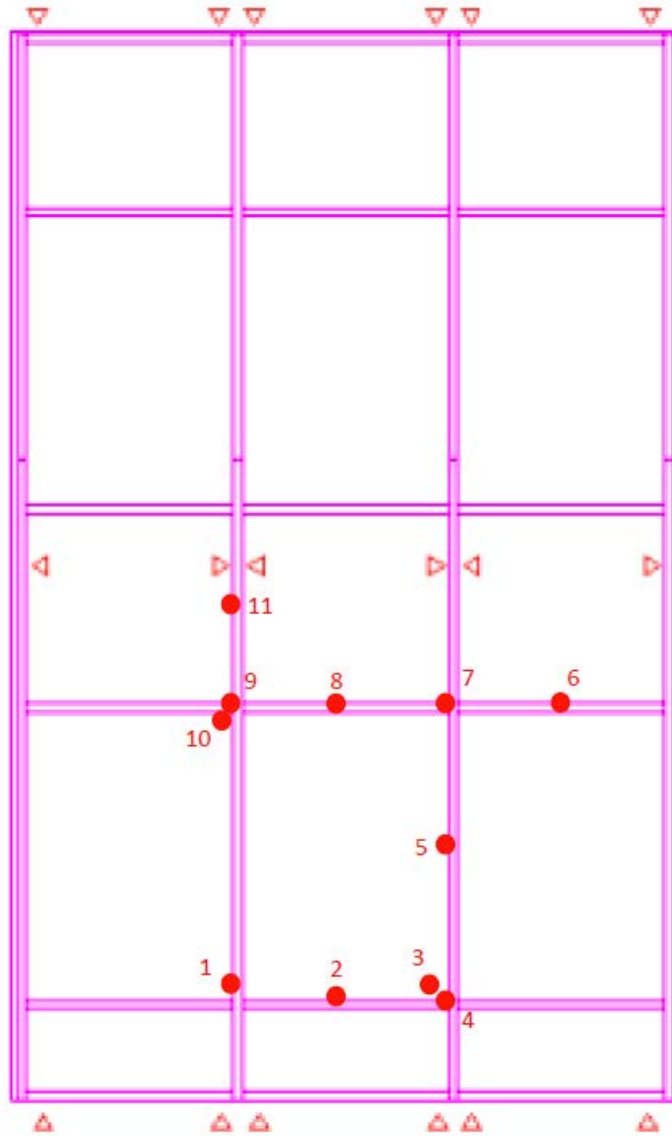
No physical damage or deterioration was visibly evident at the conclusion of the thermal cycling test.

**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. 21°C interior ambient air temperature at 30% RH yields a dew point temperature of 2.8°C.

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 (°C)
-----	Interior Ambient Air	21.2
-----	Exterior Ambient Air	-23.6
1	Vertical Mullion	18.9
2	Horizontal Intermediate	18.8
3	Horizontal Intermediate	18
4	Vertical Mullion	18.1
5	Vertical Mullion	19.2
6	Horizontal Intermediate	20.3
7	Vertical Mullion	19.4
8	Horizontal Intermediate	19.1
9	Vertical Mullion	19.2
10	Horizontal Intermediate	20.5
11	Vertical Mullion	19.2

**Hot Cycle**

Thermocouple Number	Description	Temperature (°C)
-----	Interior Ambient Air	22.2
-----	Exterior Ambient Air	82.7
1	Vertical Mullion	23.5
2	Horizontal Intermediate	23.4
3	Horizontal Intermediate	22.4
4	Vertical Mullion	23.1
5	Vertical Mullion	23.8
6	Horizontal Intermediate	22.7
7	Vertical Mullion	25.7
8	Horizontal Intermediate	26.9
9	Vertical Mullion	26.6
10	Horizontal Intermediate	26.1
11	Vertical Mullion	27.7



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

Date: February 2, 2016  
Temperature: 17°C  
Barometric Pressure: 97.28 kPa

Test Pressure = 299 Pa

**Results: PASS**

Component	Area (m <sup>2</sup> )	Allowable (L/(s·m <sup>2</sup> ))	Net Air Infiltration (L/(s·m <sup>2</sup> ))
Fixed Wall	38.6	0.30	0.01

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

Date: February 3, 2016  
Temperature: 16°C  
Test Pressure: 719 Pa

Allowable: No uncontrolled water penetration

**Results: PASS**

**11. Dynamic Water Penetration (AAMA 501.1-05)**

Date: February 3, 2016  
Temperature: 16°C  
Test Pressure: 719 Pa

Allowable: No uncontrolled water penetration

**Results: PASS**



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

Date: February 3, 2016  
Temperature: 16°C

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

- + 1437 Pa preload
- + 2874 Pa proof load
- 1437 Pa preload
- 2874 Pa 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 (mm)	Net Permanent Set (mm)		Allowable Permanent Set (mm)
		+2874 Pa	-2874 Pa	
A (Jamb)	3759	0.25	0.51	7.62
B (Vertical Mullion)	3759	0.51	0.51	7.62
C (Horizontal Intermediate)	1524	0.25	0.00	3.05
D (Center of Glass)	-----	0.51	1.78	-----

Note: Permanent set measurement locations same as Design Load Test



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

Date: February 23, 2016  
Temperature: 16°C

Starting at 0 Pa, the chamber was pressurized to -1916 Pa and held for 3 seconds, then allowed to return to 0 Pa. A total of 100 cyclic loads were applied to the specimen.

- 1916 Pa 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: 16°C  
Barometric Pressure: 96.60 kPa

Test Pressure = 299 Pa

**Results: PASS**

Component	Area (m <sup>2</sup> )	Allowable (L/(s·m <sup>2</sup> ))	Net Air Infiltration (L/(s·m <sup>2</sup> ))
Fixed Wall	38.6	0.30	0.01





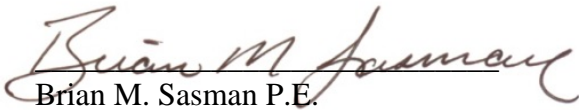
**Summary**


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 (4p)

QUAST CONSULTING and TESTING, INC.

QUAST CONSULTING and TESTING, INC.

  
Brian M. Sasman P.E.

  
Tim R. Quast  
Reviewer

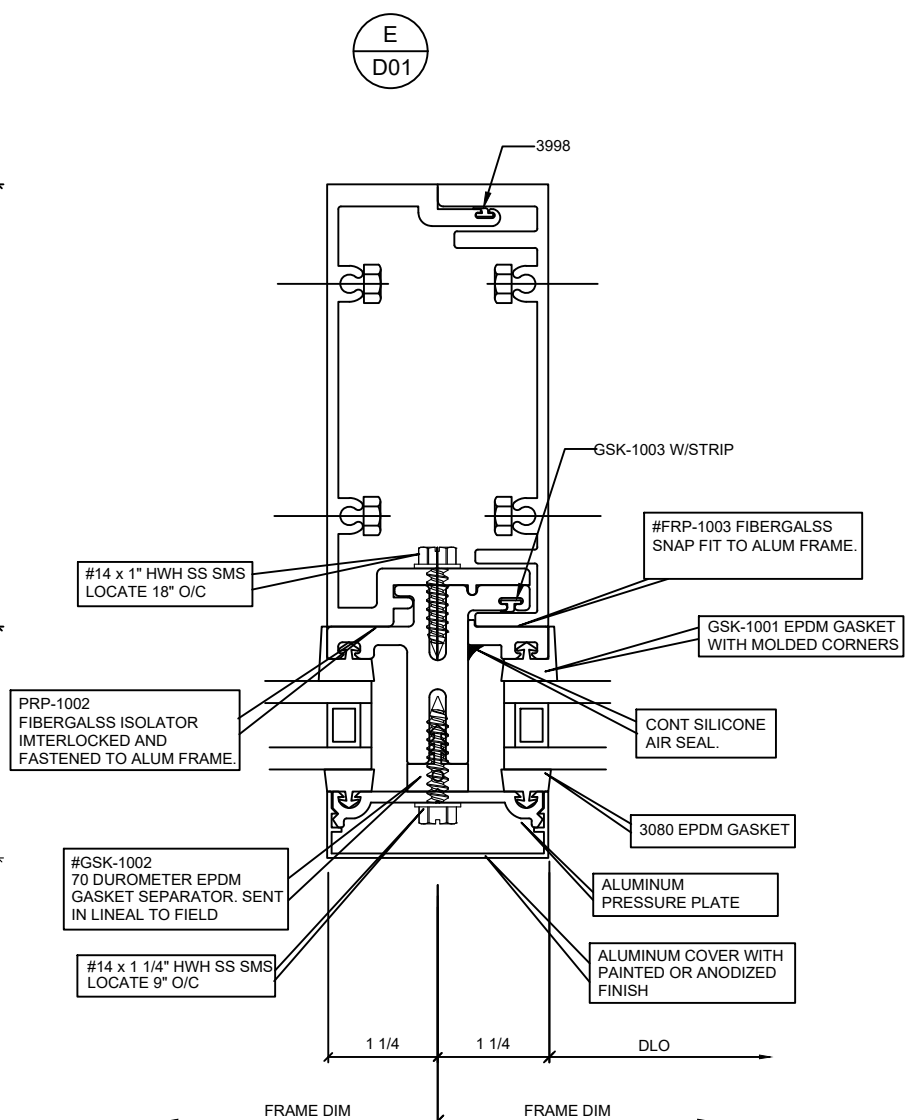
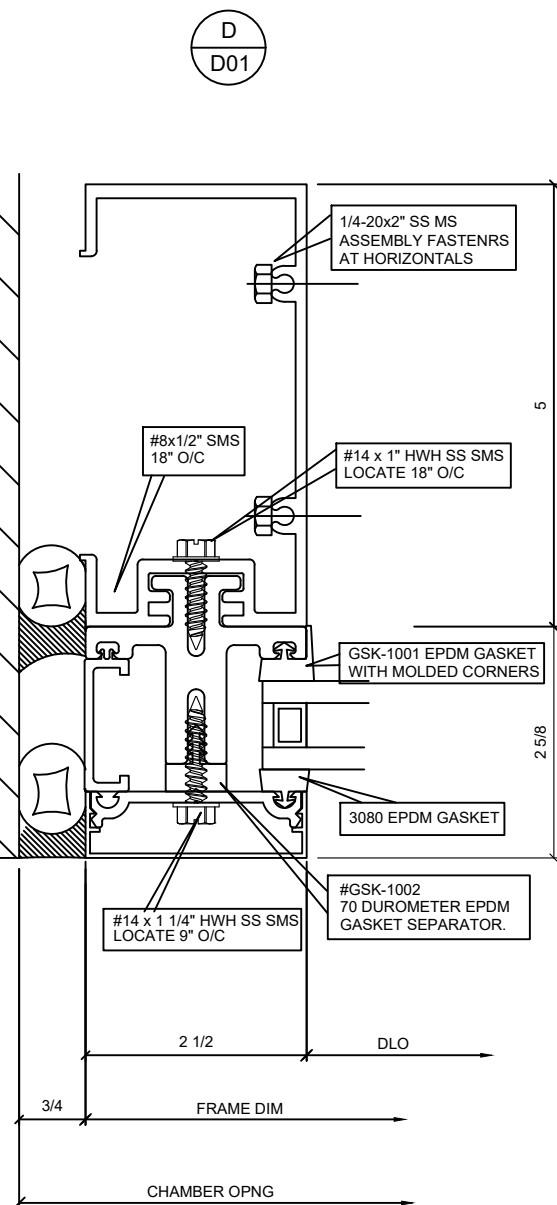
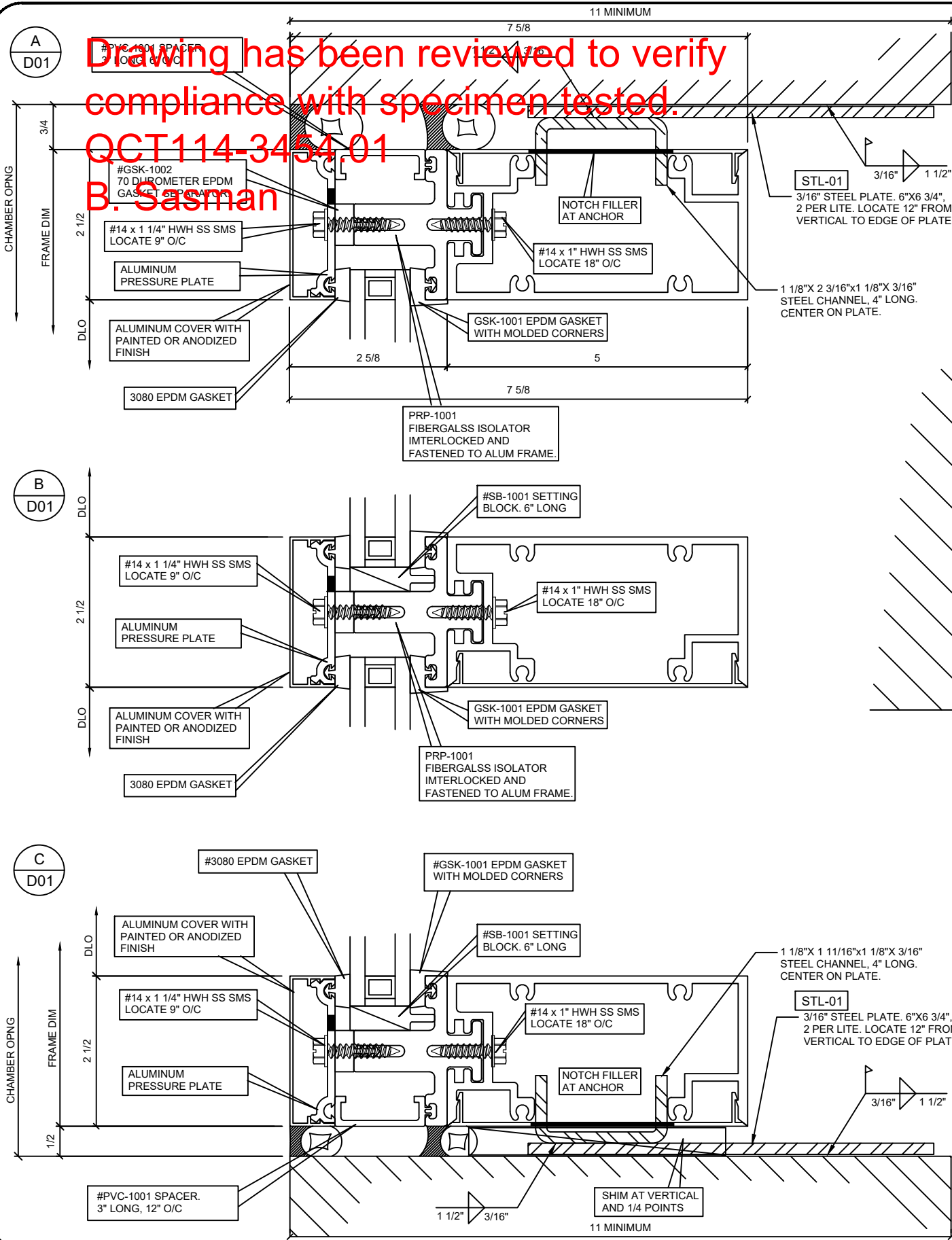


### Revision Log

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.
R4	2-7-2018	Changed values to metric

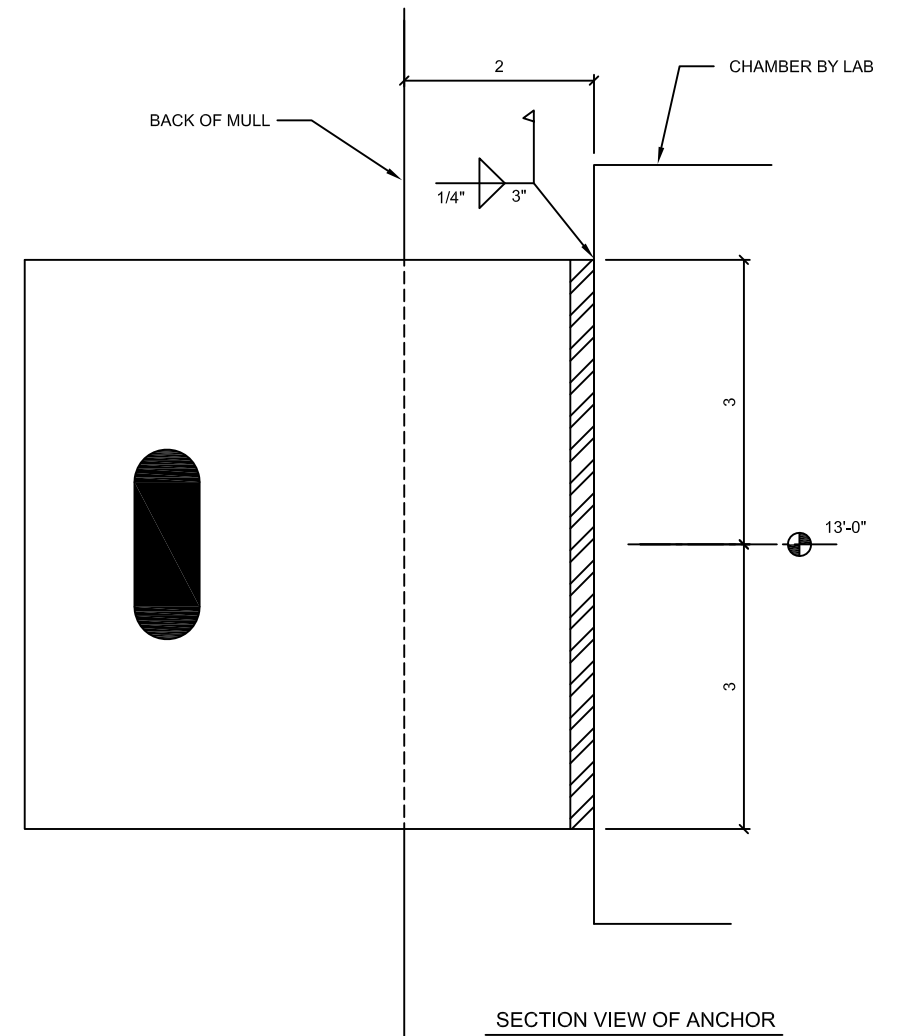
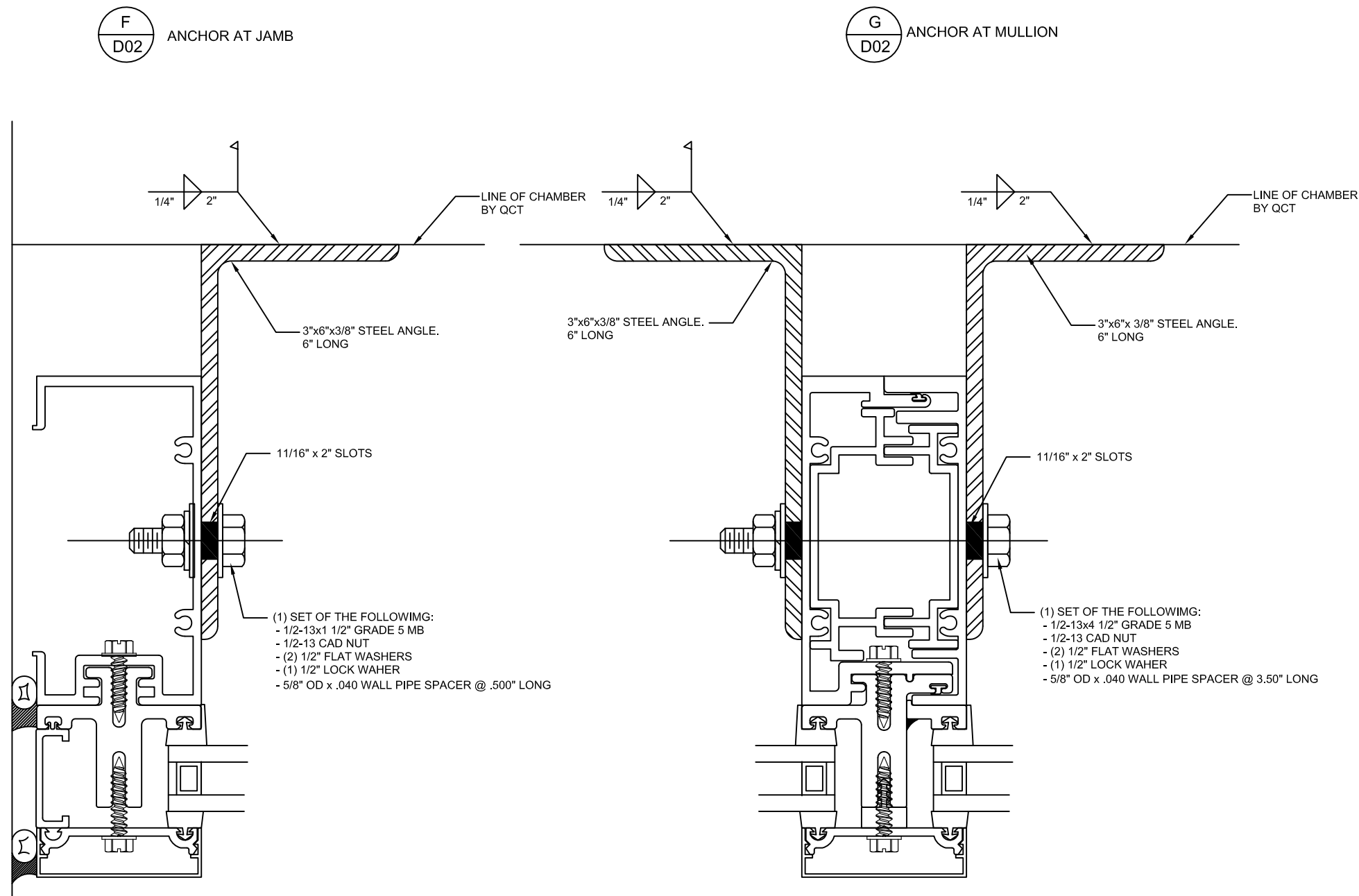


Drawing has been reviewed to verify compliance with specimen tested. QCT114-3434.01 B. Gasman



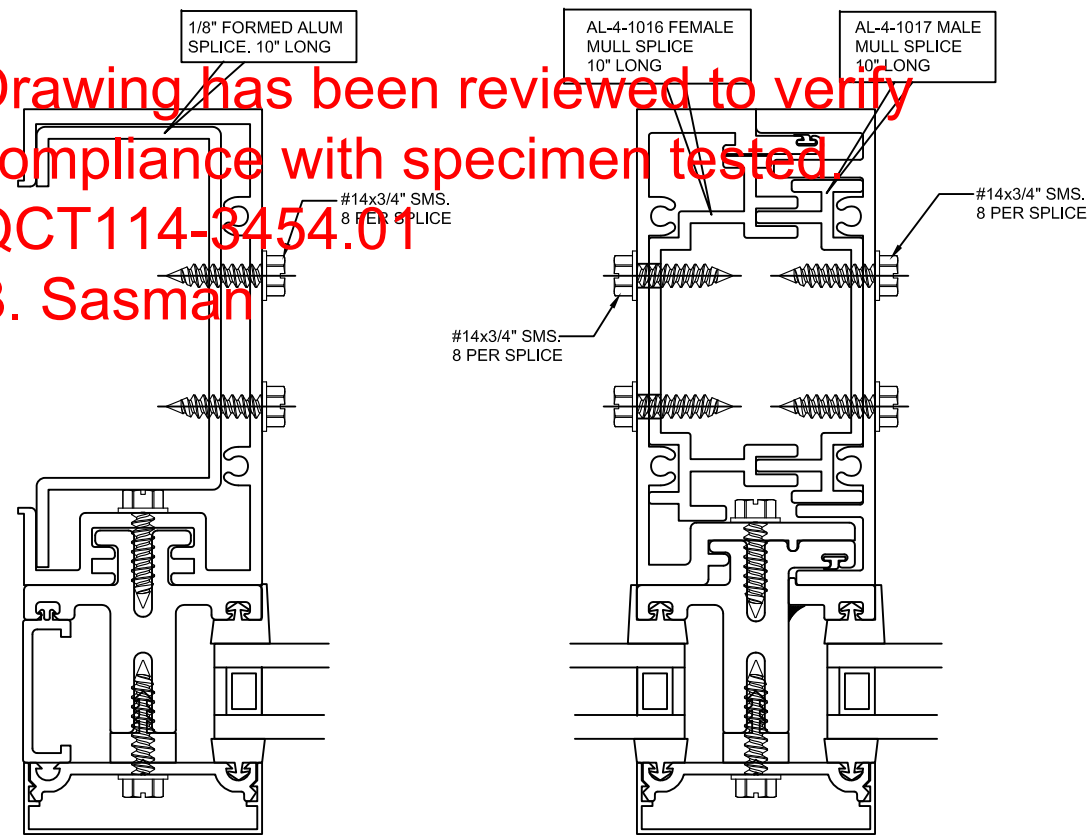
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DRAWN BY: TF	DATE: 10-27-15
SCALE: HALF	
SHEET NO.: D01	

Drawing has been reviewed to verify compliance with specimen tested.  
 QCT114-3454.01  
 B. Sasman



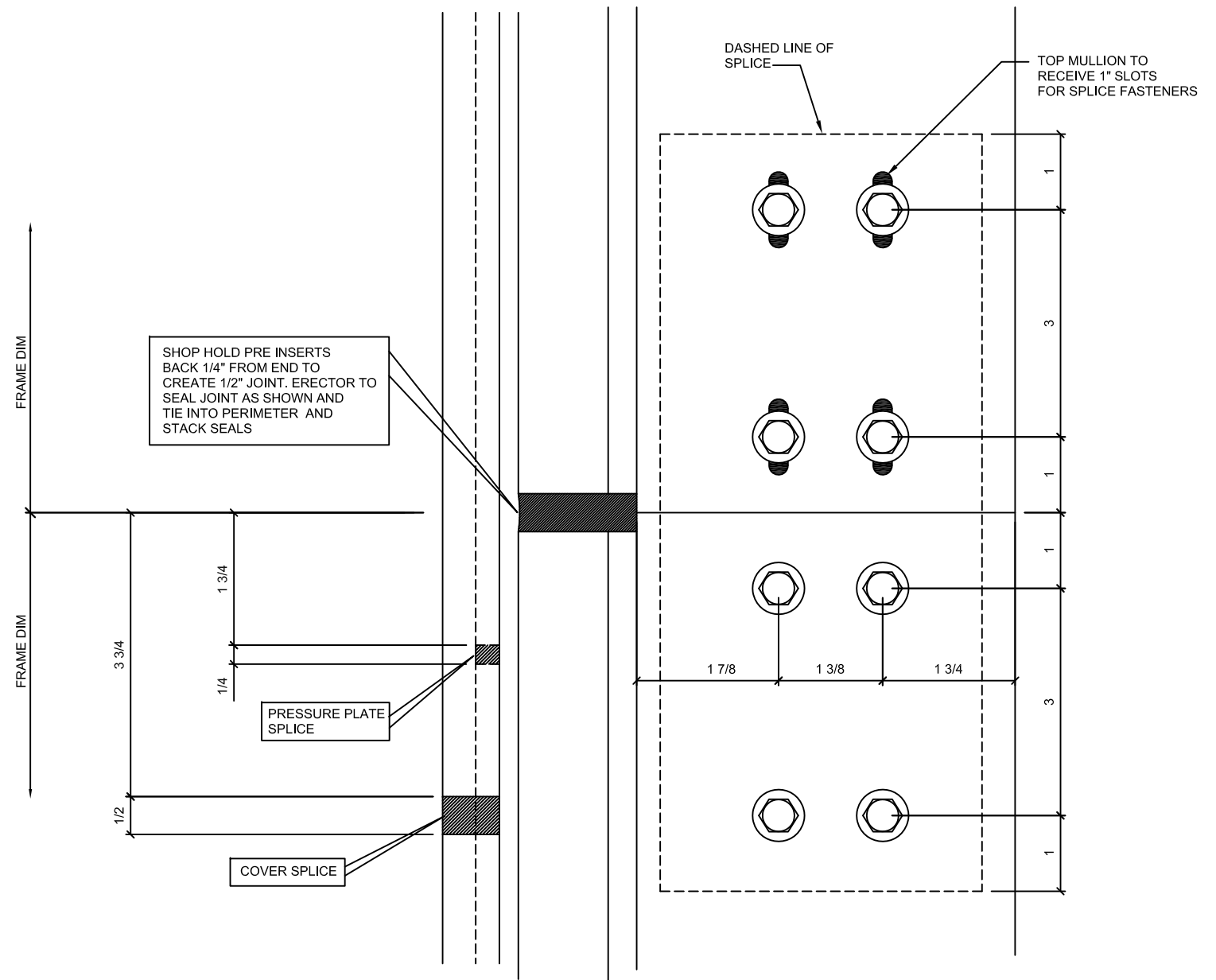
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DRAWN BY: TF	DATE: 10-27-15
SCALE: HALF	
SHEET NO.: D02	21 of 22

Drawing has been reviewed to verify compliance with specimen tested QCT114-3454.01  
 B. Sasman



H  
 D03 ANCHOR AT MULLION

J  
 D03 ANCHOR AT MULLION



SIDE VIEW OF SPLICE

PROJECT: 7" ALUM C.W. PERFORMANCE TEST	
SHEET TITLE: INSTALLATION DETAILS	
STEELGLAZE CORPORATION	
SHIP TO: 8300 HIGHLAND DRIVE WAUSAU, WI 54401 715-297-7674	MAILING ADDRESS: PO BOX 512 MERRILL, WI 54452 715-297-7674
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