



NFRC 102-2017 THERMAL PERFORMANCE TEST REPORT

Series/Model: FW 2500
Type: Glazed Wall System (Curtain Wall)

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

QCT Project No.:
QCT-TH-11279.01

Report Date:
2/26/2019



Report No.: QCT-TH-11279.01

Page 1 of 8
Report Date: 02/26/2019

**NFRC 102-2017 THERMAL PERFORMANCE
TEST REPORT**

Rendered To:

FreMarq Innovations, Inc.
8300 Highland Drive
Wausau, WI 54401

Test Sample Identification:

Series/Model: FW 2500

Product Type: Glazed Wall System (Curtain Wall)

Thermal Break: Thermally broken

Thermal Break Material: Other - Baydur PUL-2500

Overall Size: 2005mm x 2005mm (79" x 79")

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

Test Sample Submitted by: FreMarq Innovations, Inc.

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 102-2017, *Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems*.

Test Results Summary:

Standardized U-factor (U_{st}):	0.31	Btu/(hr·ft ² ·F)	CTS Method
-------------------------------------	------	-----------------------------	------------



Report No.: QCT-TH-11279.01

Page 2 of 8

Report Date: 02/26/2019

Test Sample Description:

Size Specification:	Frame	Exterior Sash	Interior Sash
Size (inches)	79" x 79"	N.A.	N.A.
Daylight Opening (inches)	35-3/4" x 74"(2 lites)	N.A.	N.A.

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

Properties:	Frame	Exterior Sash	Interior Sash
Material	Aluminum	N.A.	N.A.
Exterior Color	Gray	N.A.	N.A.
Exterior Finish	Paint	N.A.	N.A.
Interior Color	Gray	N.A.	N.A.
Interior Finish	Paint	N.A.	N.A.

Spacer:

Code	Spacer Type	Primary Sealant	Secondary Sealant	Desiccant
A1-D	Aluminum	PIB	Silicone	Yes

Reinforcement Description:

Location	Material
None	N.A.

Grid:

Size	Type	Pattern
None	N.A.	N.A.

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

Glazing Information:

Layer 1	LowE 366 (#2) - 0.225"
Gap 1	Argon 90% - 0.5"
Layer 2	Clear - 0.393"
Gap 2	N.A.
Layer 3	N.A.
Gas Fill Method	Single-Probe*

*Stated per Client/Manufacturer

Not Applicable (N.A.)



Report No.: QCT-TH-11279.01

Page 3 of 8
Report Date: 02/26/2019

Weatherstrip:

Type	Quantity	Location
None	N.A.	N.A.

Hardware:

Type	Quantity	Location
None	N.A.	N.A.

Drainage:

Type	Quantity	Location
None	N.A.	N.A.

Insulation:

Type	Location
None	N.A.



Report No.: QCT-TH-11279.01

Page 4 of 8

Report Date: 02/26/2019

Measured Test Data:

Heat Flows	Quantity	Units
1. Total Measured Metering Box Input (Q_{total})	1043.42	Btu/hr
2. Surround Panel Thickness	7	inches
3. Surround Panel Conductivity (C_{sp})	0.0271	Btu/(hr·ft ² ·F)
4. Surround Panel Heat Flow (Q_{sp})	37.65	Btu/hr
5. Metering Box Wall Plus Flanking Loss (Q_{mb+fl})	0.04	Btu/hr
6. EMF vs. Heat Flow Equation (Equivalent Information)	7098.1(EMF)+25.611	
7. Test Specimen Heat Flow (Q_s)	1005.73	Btu/hr

Areas	Quantity	Units
8 Specimen Projected Area (A_s)	43.34	ft ²
9. Specimen Interior Total (3-D) Surface Area (A_h)	54.23	ft ²
10. Specimen Exterior Total (3-D) Surface Area (A_c)	46.47	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)	73.80	deg F
18. Metering Room Average Relative Humidity	13.63	%
18-5. Metering Room Maximum Relative Humidity	14.13	%
18-6. Metering Room Minimum Relative Humidity	13.39	%
19. Climate Room Wind Speed (Perpendicular Flow)	15.56	mph
20. Total Pressure Differential Across Test Specimen	0.00	psf
23. Surround Panel Warm Side Surface Temperature (t_{sp1})	68.29	deg F
24. Surround Panel Cold Side Surface Temperature (t_{sp2})	1.03	deg F

Thermal Transmittance	Quantity	Units
25. Specimen Thermal Transmittance (U_s)	0.33	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 Emittance (ϵ_1)	0.84	N.A.
28. Metering Box Baffle Emittance (ϵ_{b1})	0.95	N.A.
29. Equivalent Room Side Surface Temperature (t_1)	53.87	deg F
30. Equivalent Climate Side Surface Temperature (t_2)	3.73	deg F
31. Room Side Baffle Temperature (t_{b1})	68.51	deg F
32. Climate Side Baffle Temperature (t_{b2})	0.49	deg F
33. Room Side Surface Heat Transfer Coefficient (h_h)	1.46	Btu/(hr·ft ² ·F)
34. Climate Side Surface Heat Transfer Coefficient (h_c)	5.62	Btu/(hr·ft ² ·F)
35. Test Specimen Conductance (C_s)	0.4628	Btu/(hr·ft ² ·F)
36. Convection Coefficient (K_c)	0.37	Btu/(hr·ft ² ·F)
37. Room Side Radiative Heat Flow (Q_{r1})	493.72	Btu/hr
38. Room Side Convective Heat Flow (Q_{c1})	512.01	Btu/hr
39. Room Side Radiative Heat Flux (q_{r1})	11.39	Btu/(hr·ft ²)
40. Room Side Convective Heat Flux (q_{c1})	11.81	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
1/3/19 9:05 AM
- The test parameters were considered stable for two consecutive four hour test periods from
1/3/19 11:30 PM to 1/4/19 7:30 AM
- The thermal performance test results were derived from
1/4/19 3:30 AM to 1/4/19 7:30 AM

Glazing Deflection (inches)*:

D.L.O. 1	D.L.O. 2	
1.138	1.110	Overall IG thickness at edge
1.119	1.073	Overall IG thickness of center upon receipt of specimen (after stabilization)
0.529	0.487	Gap thickness upon receipt of specimen in laboratory (after stabilization)
1.119	1.073	Overall IG thickness of center at laboratory ambient conditions before testing
1.109	1.062	Overall IG thickness of center 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 10/31/2018 in accordance with Quast Consulting and Testing, Inc. calibration procedure. A calibration check was performed in 09/16/2018.

"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 (Ust) 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-11279.01

Page 7 of 8

Report Date: 02/26/2019

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 five 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 (16 pages).

A handwritten signature in black ink, appearing to read "Jeff Zibton", is positioned above a horizontal line.

Individual-In-Responsible-Charge

Jeff Zibton



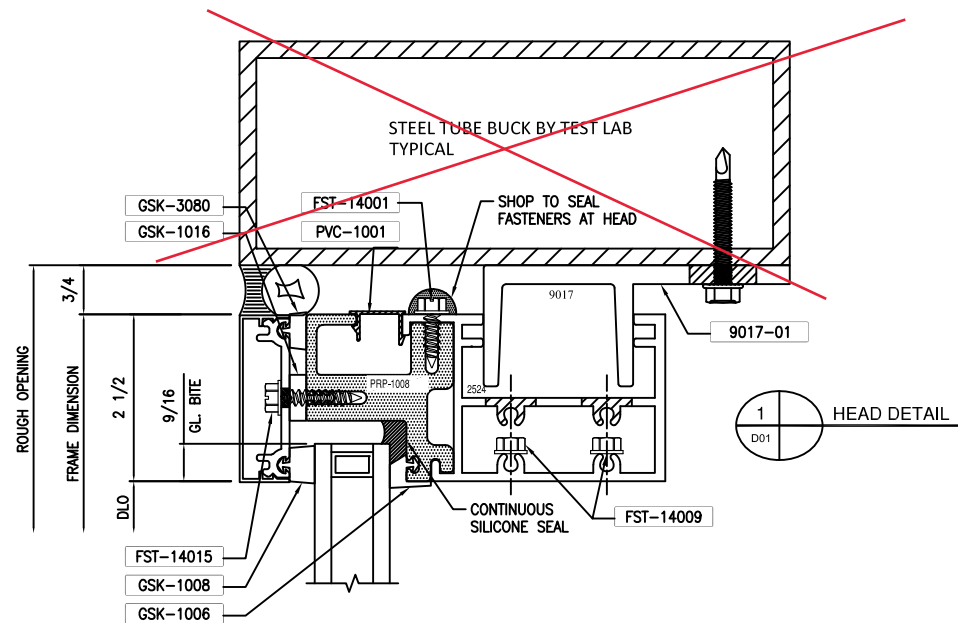
Report No.: QCT-TH-11279.01

Page 8 of 8
Report Date: 02/26/2019

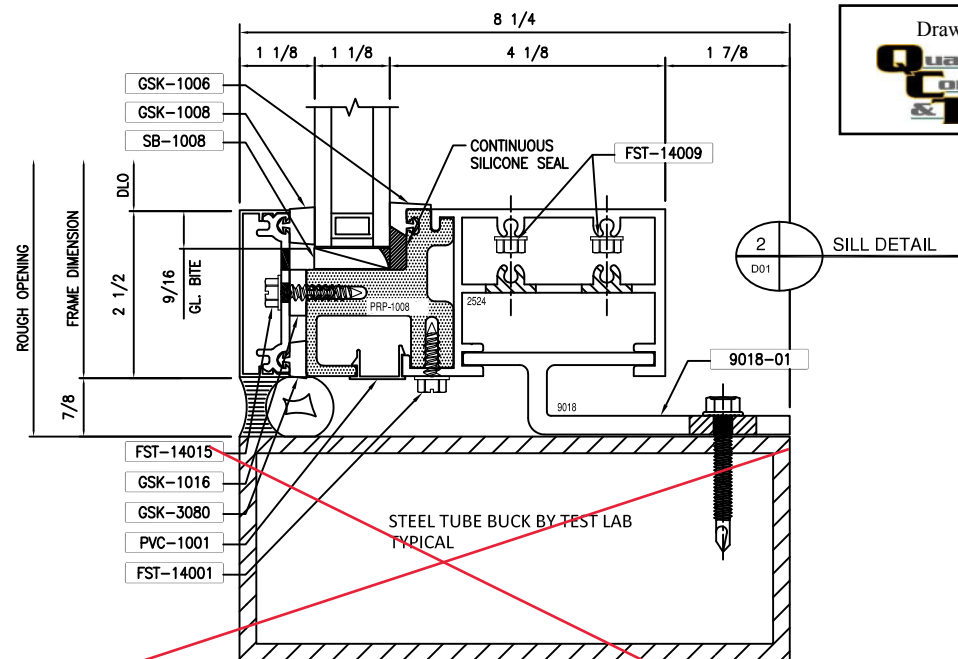
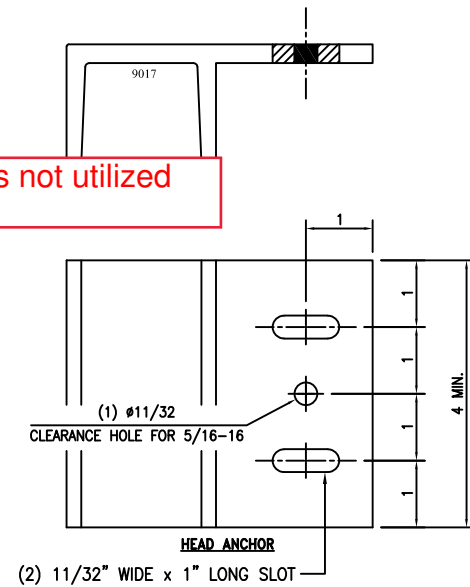
Revision No.	Date	Description
.01	02/26/19	Original report issued.



Appendix A: Drawings



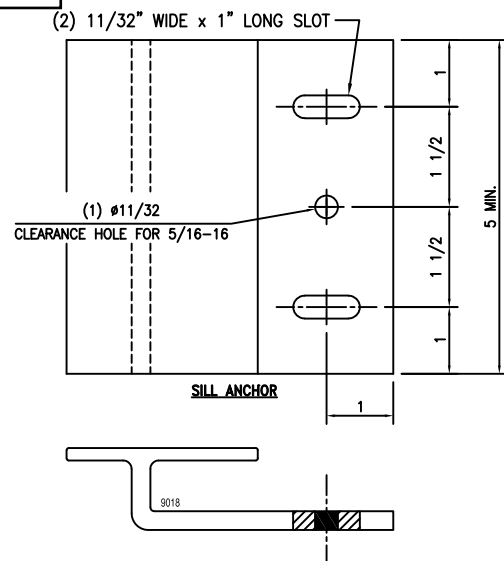
Anchors not utilized



Drawings represent specimen as tested



QCT-TH-11279
02/26/2019
JMZ



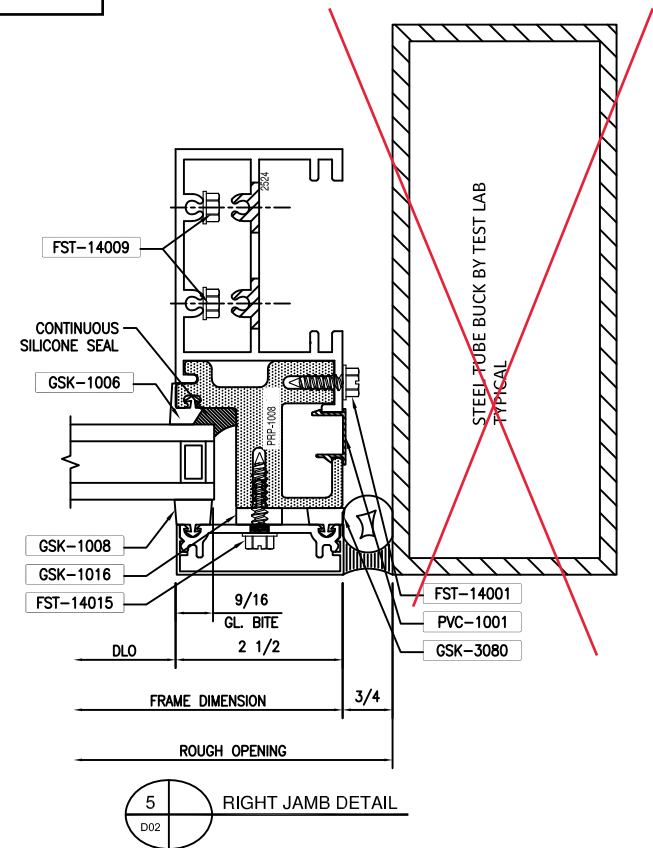
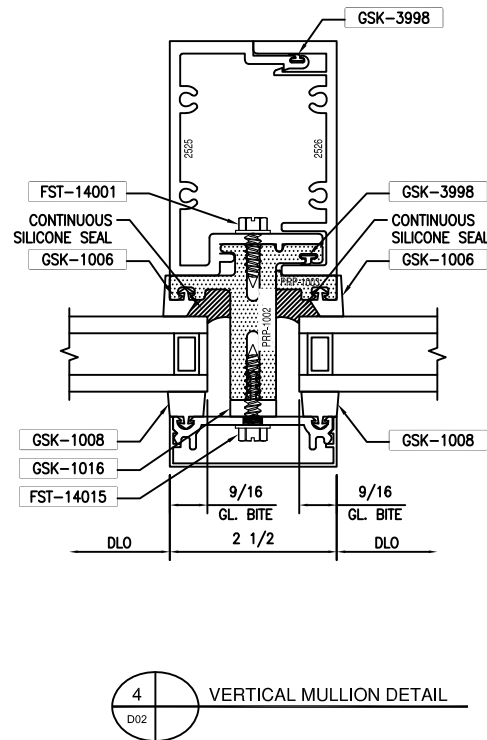
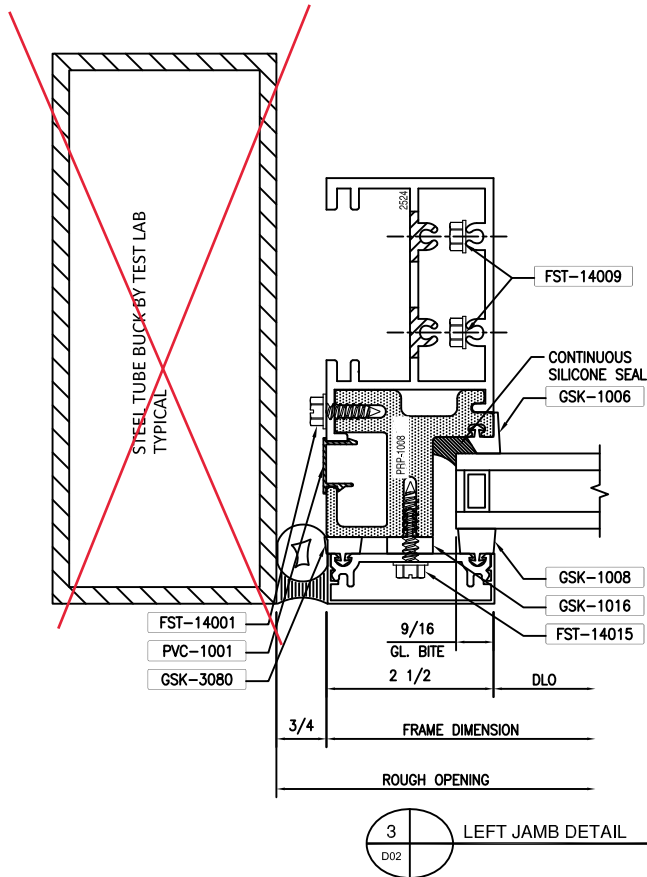


Drawings represent specimen as tested

QCT-TH-11279

02/26/2019

JMZ



TRIM TAGS KEY

9017-01

HEAD ANCHOR 6063-T6
4" WIDE
LOCATION: 1 CLIP PER VERTICAL
1 CLIP AT JAMBS

9018-01

SILL ANCHOR 6063-T6
5" WIDE
LOCATION: 1 CLIP PER VERTICAL
1 CLIP AT JAMBS

UIF

PVC-1001

CAULK BACKER

UIF

FST-14001

#14 x 3/4" HWH SMS
AT 16" O.C. MAX

UIF

FST-14009

#14 x 2" HWH TEX
FRAMING FASTENER

UIF

FST-14015

#14 x 1" HWH SMS TYPE A
AT 9" O.C. PRESSURE PLATE

UIF

GSK-1006

70 DUROMETER SILICONE GASKET
[LN. FT.]

UIF

GSK-1008

EXTERIOR GLAZING GASKET
60 DUROMETER EPDM GASKET

UIF

GSK-3080

EXTERIOR GLAZING SPACER
60 DUROMETER EPDM GASKET

UIF

GSK-1016

STEM ISOLATOR
70 DUROMETER EPDM GASKET

UIF

GSK-3998

SWEEP GASKET
73 DUROMETER SANTOPRENE/PP GASKET

UIF

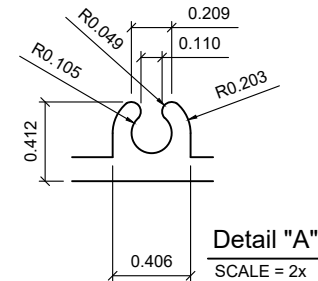
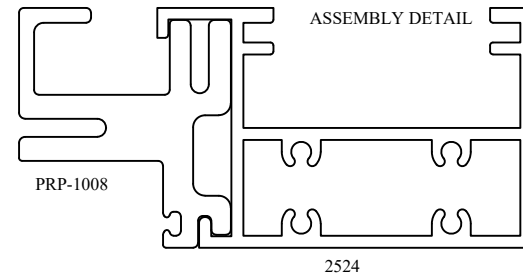
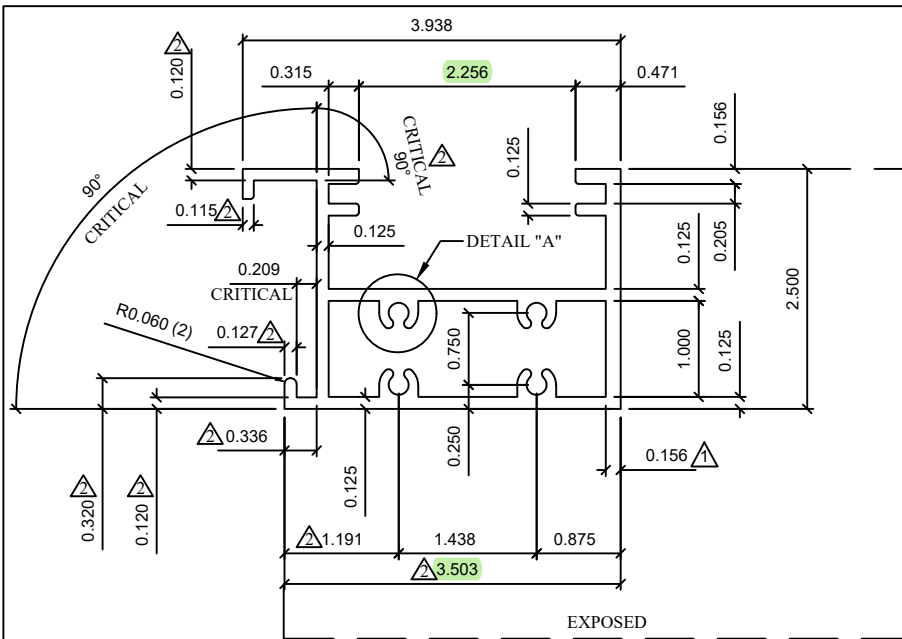
SB-1008

5/16" x 1 1/8" x 4" 85 DUROMETER
BLACK SILICONE SETTING BLOCK (2) PER LITE

Drawings represent specimen as tested

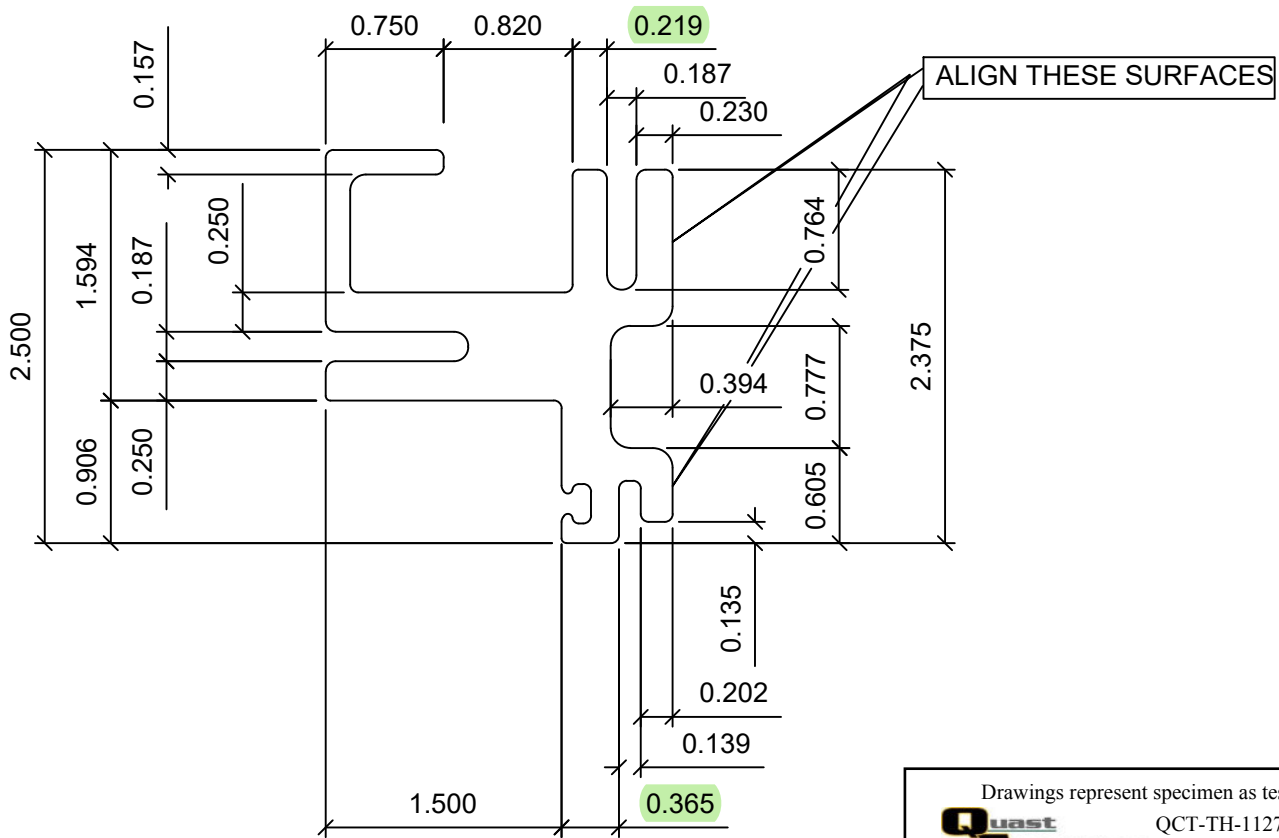


QCT-TH-11279
02/26/2019
JMZ



Drawings represent specimen as tested
Quast Consulting & Testing, Inc.
 QCT-TH-11279
 02/26/2019
 JMZ

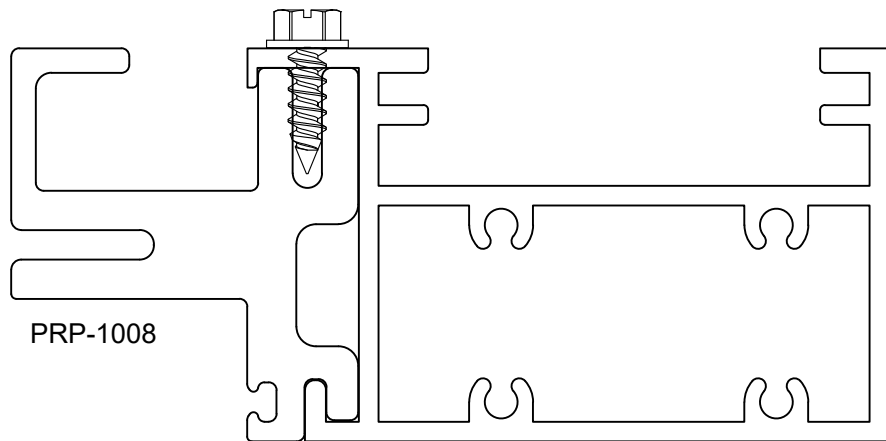
REV. NO.	DATE	BY	DESCRIPTION			FreMarq Innovations 8300 Highland Drive Wausau, WI 54401	TITLE: WINDOW PERIMETER	
△	6/28/18	TAF	THICKENED BACK LEG	MATERIAL: ALUM ALLOY 6063-T6			DRAWN BY: TAF	
△	9/28/18	BDK	120 WAS .125 / .115 WAS .125 / .127 WAS .134 / .336 WAS .343 / 320 WAS .327 / 1.191 WAS 1.108 / 3.503 WAS 3.510 / ADDED 90° CRITICAL	TOLERANCE: INDUSTRY STANDARD			DATE: 6-18-18	
				Perimeter = 19.343	RADIUS: .030" UNO		PART NO.	2524
△				AREA= 1.992	WEIGHT = 2.39 LB/FT			



Drawings represent specimen as tested

Quast Consulting & Testing, Inc.

QCT-TH-11279
02/26/2019
JMZ



ASSEMBLY DETAIL

Baydur PUL-2500

AREA = 2.153 SQ.IN.

PART NO. PRP-1008



Drawings represent specimen as tested

QCT-TH-11279
02/26/2019
JMZ

CUSTOMER APPROVAL

DATE



MEASURE WITH
CALIPERS

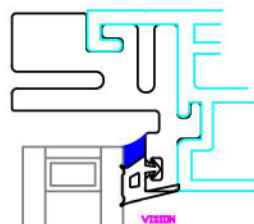
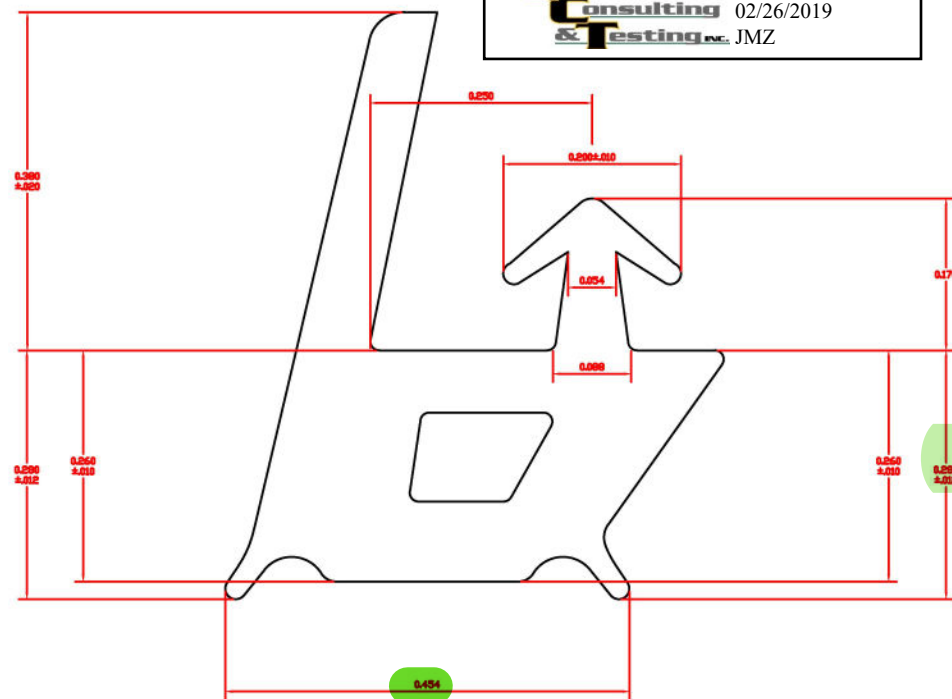
CHECK PART
IN METAL

MUST FIT
LOOSE
IN METAL

MUST FIT
TIGHT
IN METAL

CHECK DART
WITH
CALIPERS

XXXXXX
XXXXXX
XXXXXXXXXX



ACTUAL SIZE



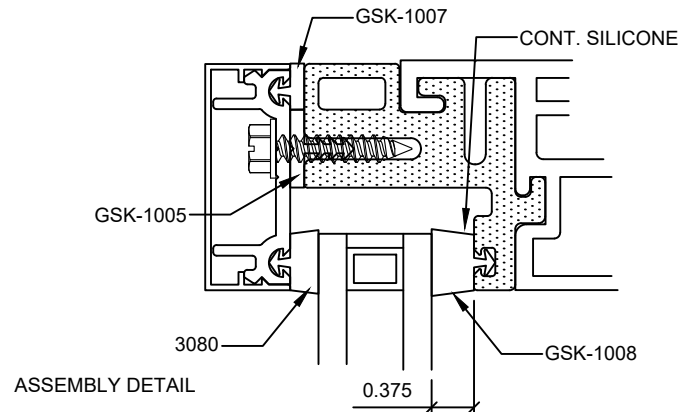
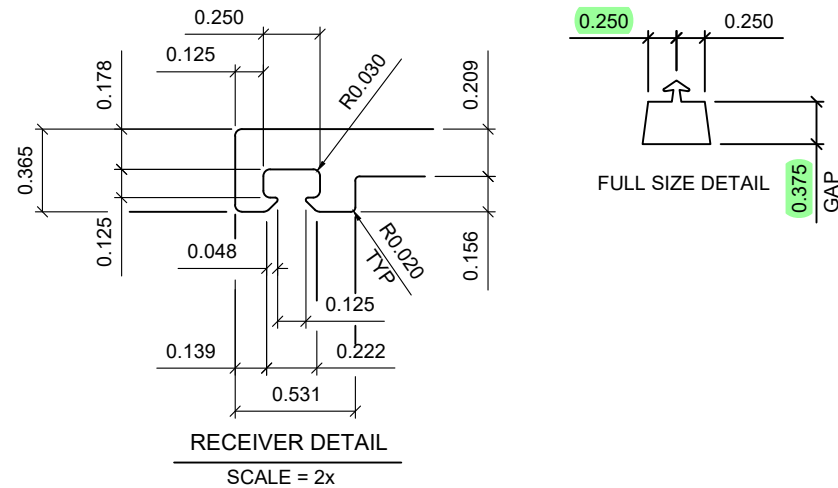
TRELLEBORG PART NUMBER 13541-02-00
CUSTOMER PART NUMBER GSK-1006
COMPOND NUMBER 370555
COMPOND DESCRIPTION 70 DUD BLACK SILICONE

DATE DATE 10-4-17
DRAWN BY MRG
SCALE 10X
AREA .142

Tolerances are per Class II unless otherwise noted.
This drawing sheet and the composite bands are
CONFIDENTIAL and PROPRIETARY information of
Trelleborg. Reproduction or distribution of this
information is forbidden without express written
consent from Trelleborg.

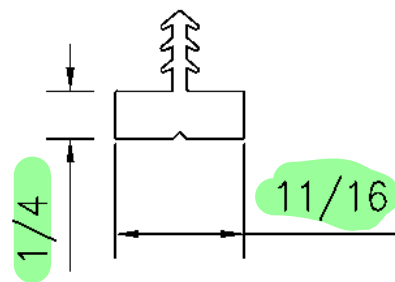
NO VISION SIZE

PART DESCRIPTION: INTERIOR PRESET GASKET
 MATERIAL: 60 DUROMETER EPDM
 DESIGN FOR 0.375" GAP AND WELDED CORNER CAPABILITIES



MATERIAL: .See Note Above		FreMarq Innovations MAILING: PO BOX 512 MERRILL, WI 54452 SHIP TO: 8300 HIGHLAND DR. WAUSAU, WI 54401	TITLE: 3/8" INTERIOR GASKET	
TOLERANCE: INDUSTRY STANDARD			DRAWN BY: TAF	
Perimeter =	RADIUS:		DATE: 8-1-17	
AREA=	WEIGHT=		PART NO.	GSK-1008

PART DESCRIPTION: STEM ISOLATOR
MATERIAL: 85 DUROMETER EPDM
DESIGN FOR 0.25" GAP

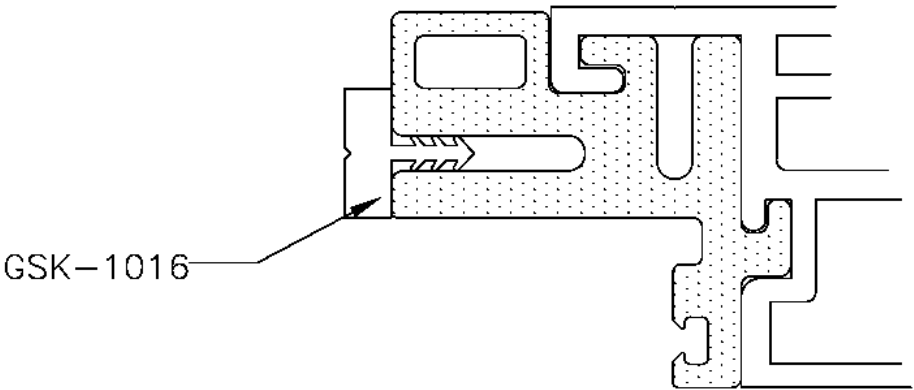


FULL SIZE DETAIL

Drawings represent specimen as tested



QCT-TH-11279
02/26/2019
JMZ



ASSEMBLY DETAIL

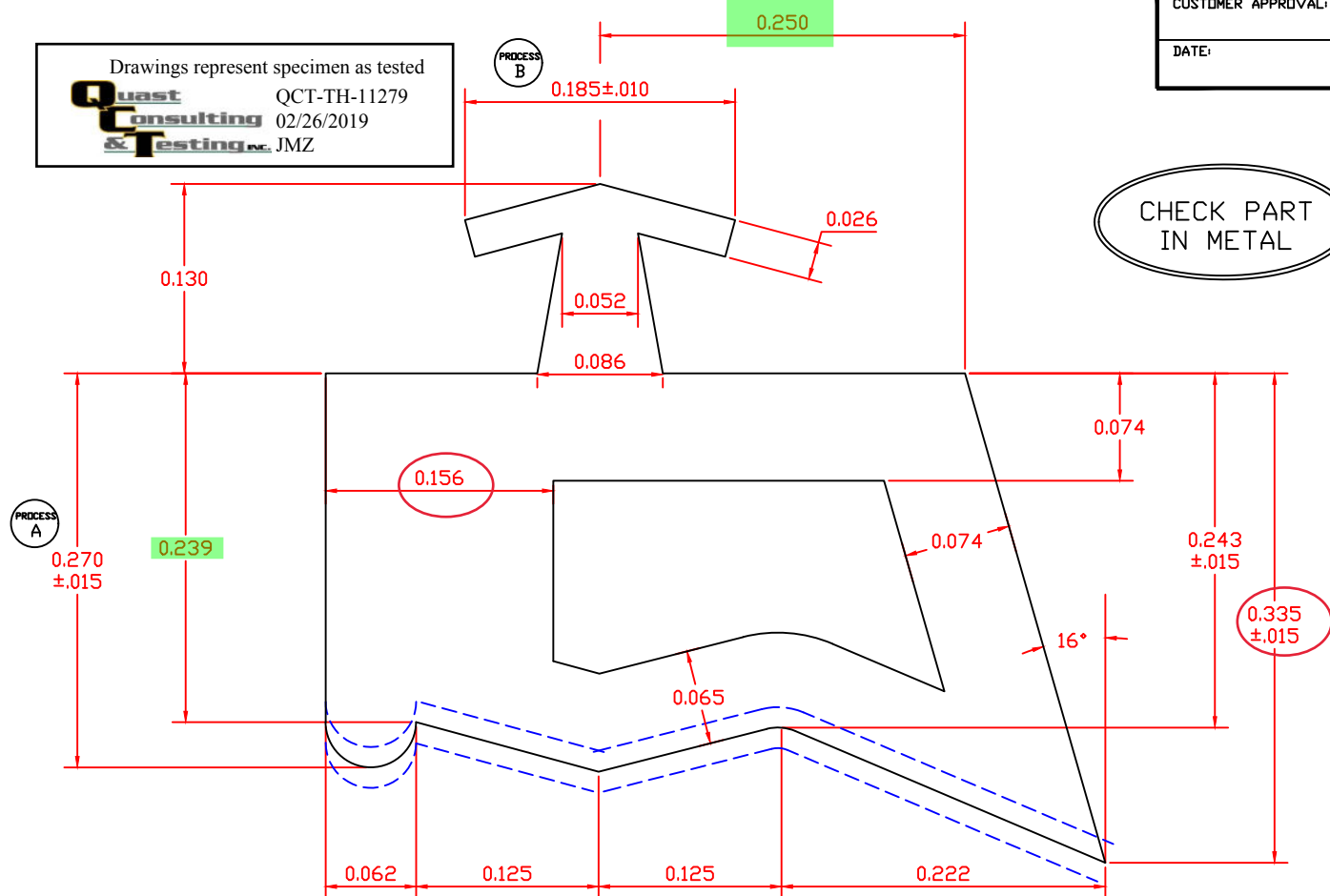
MATERIAL: .See Note Above		FreMaq Innovations SHIP TO: 8300 HIGHLAND DR. WAUSAU, WI 54401	TITLE: 1/4" ISOLATOR	
TOLERANCE: INDUSTRY STANDARD			DRAWN BY: AMB	
Perimeter =	RADIUS:		DATE: 8-8-18	
AREA=	WEIGHT=		PART NO.	GSK-1016

Drawings represent specimen as tested
Quast Consulting & Testing Inc.
 QCT-TH-11279
 02/26/2019
 JMZ

CUSTOMER APPROVAL:

DATE:

CHECK PART
IN METAL



ACTUAL SIZE

3080-04-01 CASCADE LABELS
 3080-04-02 U/M METERS
 3080-04-03 500' / REEL / BOX

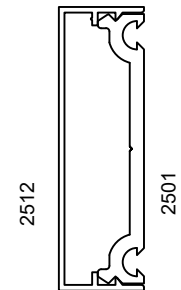
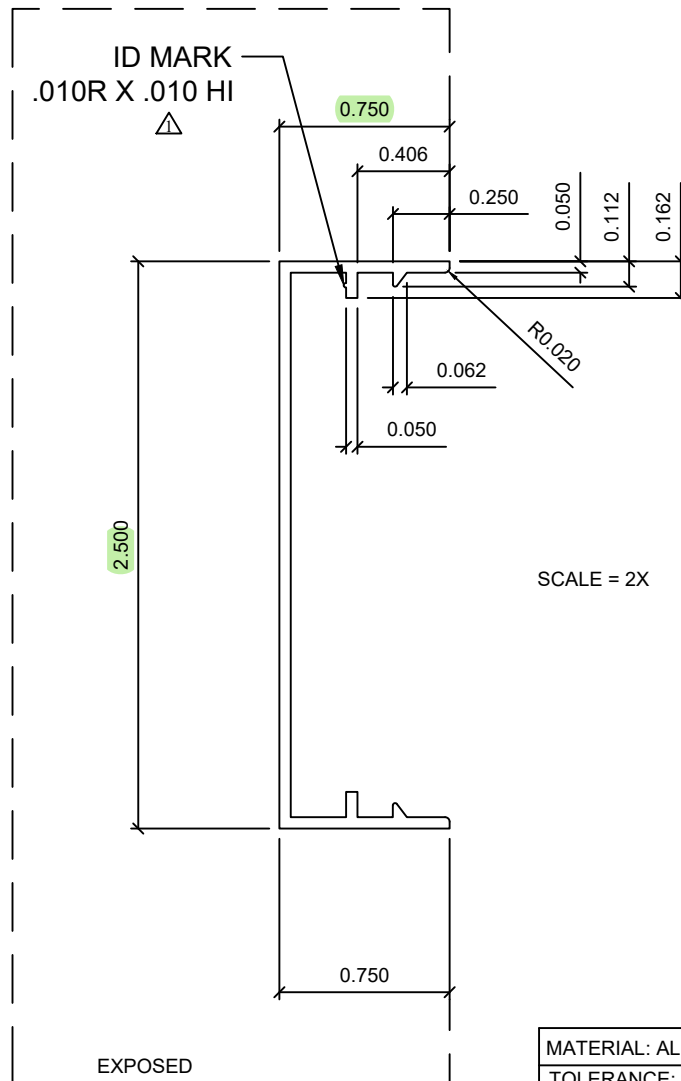
3519-04-00 260863
 3263-02-03 360555



**EXTRUDED POLYMERS
FOR GLAZING, INC.**

1205 Danner Drive
 Aurora, Ohio 44202
 (330) 995-9725 fax (330) 995-9734

EPG PART NUMBER	3080-04-00	DATE	5-24-00
CUSTOMER PART NUMBER	.250FC .250DC .000 TL	SCALE	10X
COMPOUND NUMBER	260555	AREA	.115
DIE NUMBER	3080	FILE	30800400
		DRAWN BY	MRG



ASSEMBLY VIEW
SCALE: 1"=1"

Drawings represent specimen as tested



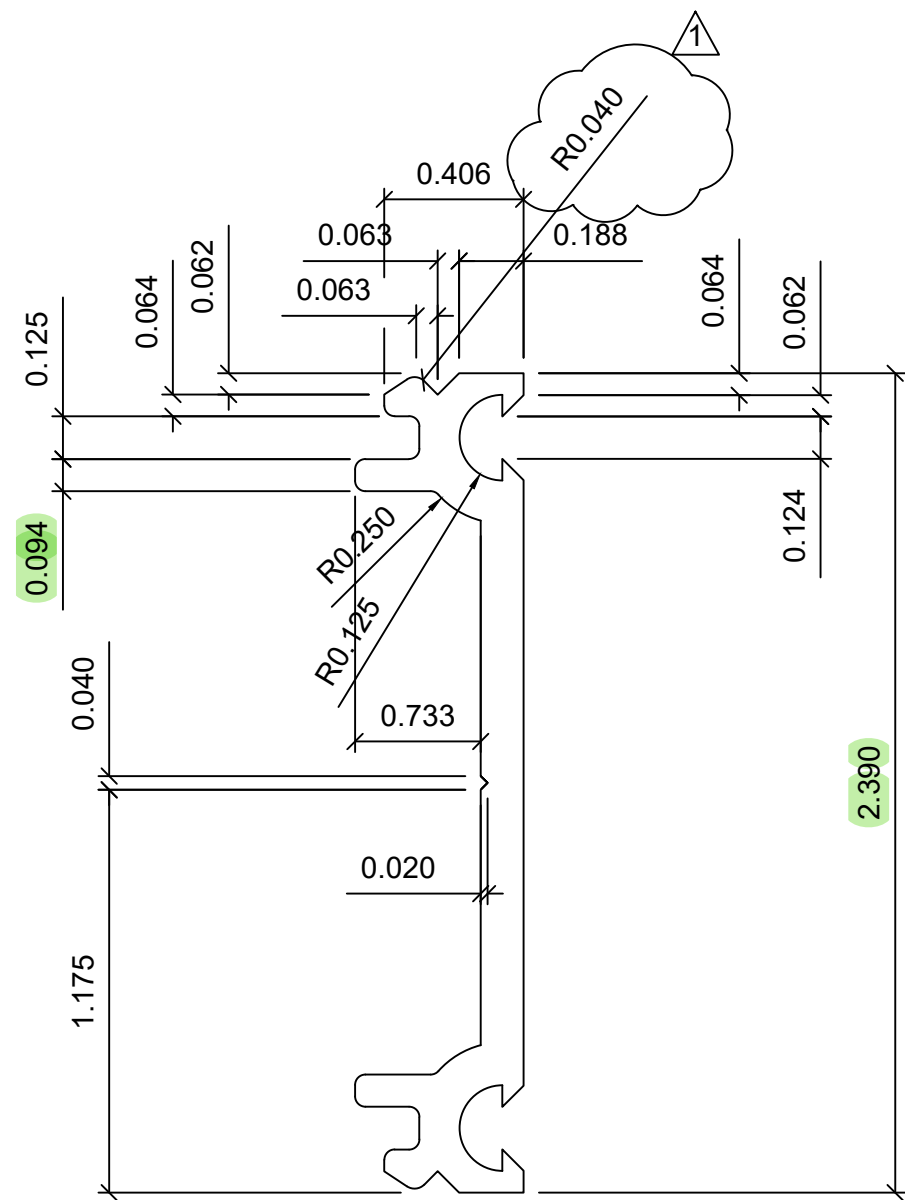
QCT-TH-11279
02/26/2019
JMZ

REV	DATE	BY	DESCRIPTION
△	1/7/19	BDK	ID MARK MOVED TO INTERIOR LEG

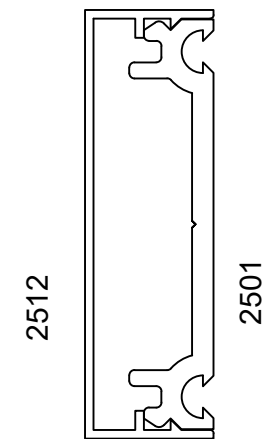
MATERIAL: ALUM ALLOY 6063-T6	
TOLERANCE: INDUSTRY STANDARD	
Perimeter = 8.506	RADIUS: 0.03" UNO
AREA= 0.211	WEIGHT= 0.247 LB/FT

FreMarq Innovations
PO BOX 512
MERRILL, WI 54452

TITLE: 2 1/2" SNAP-ON COVER	
DRAWN BY: TAF	
DATE: 6-24-14	
PART NO.	2512



SCALE = 2X



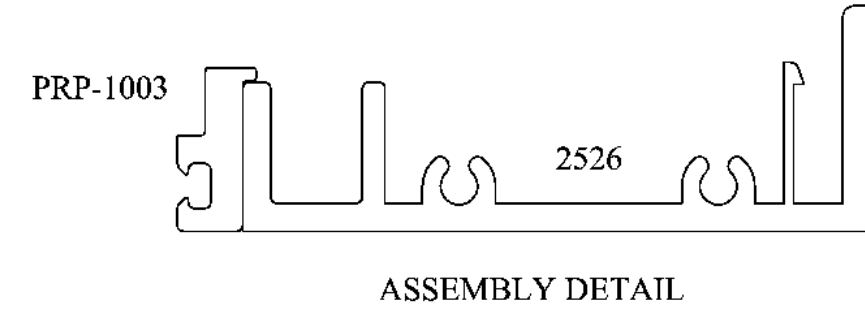
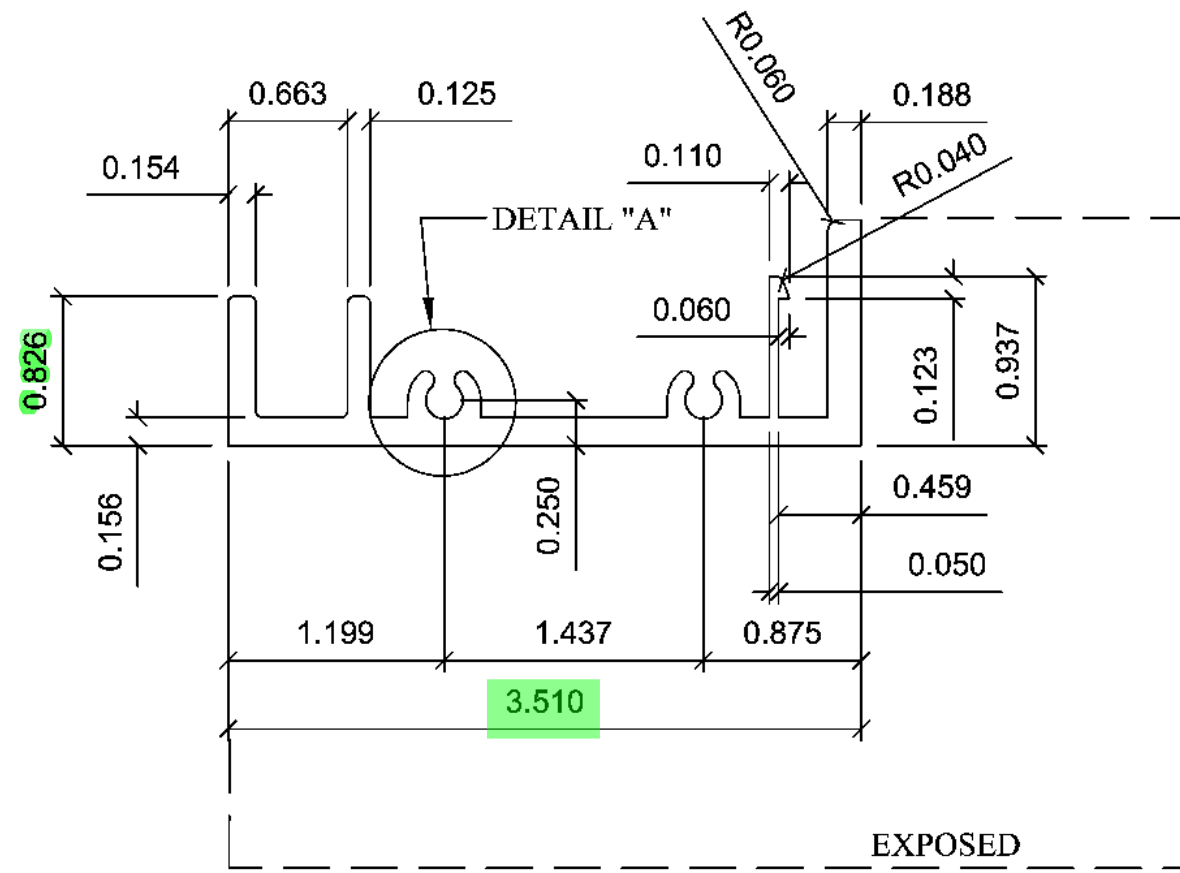
ASSEMBLY VIEW
SCALE: 1"=1"

Drawings represent specimen as tested

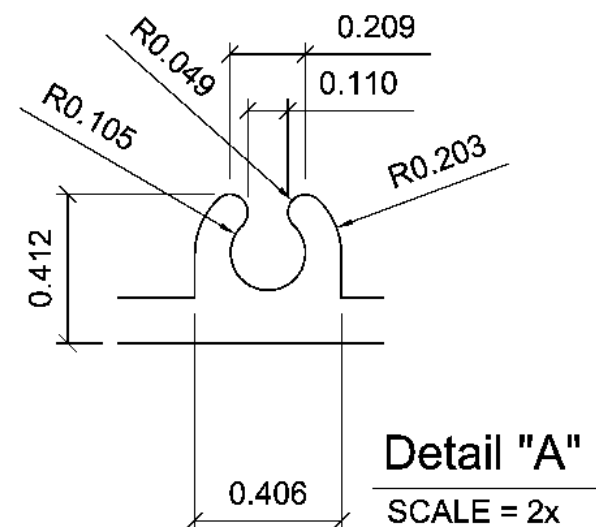
Quast Consulting & Testing Inc. QCT-TH-11279
02/26/2019 JMZ

1 REVISED 7-31-17. ADDED .040" RADIUS

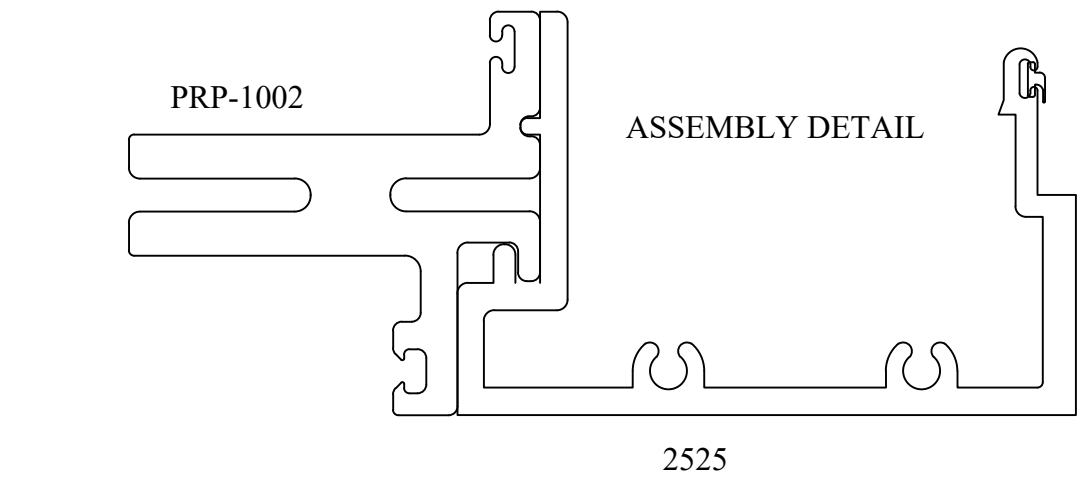
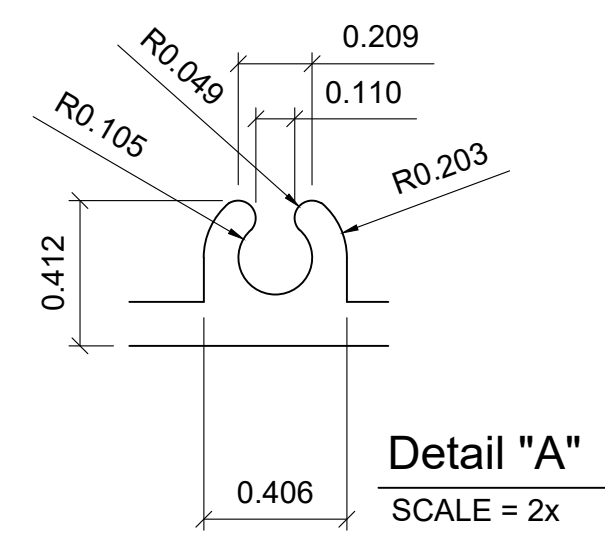
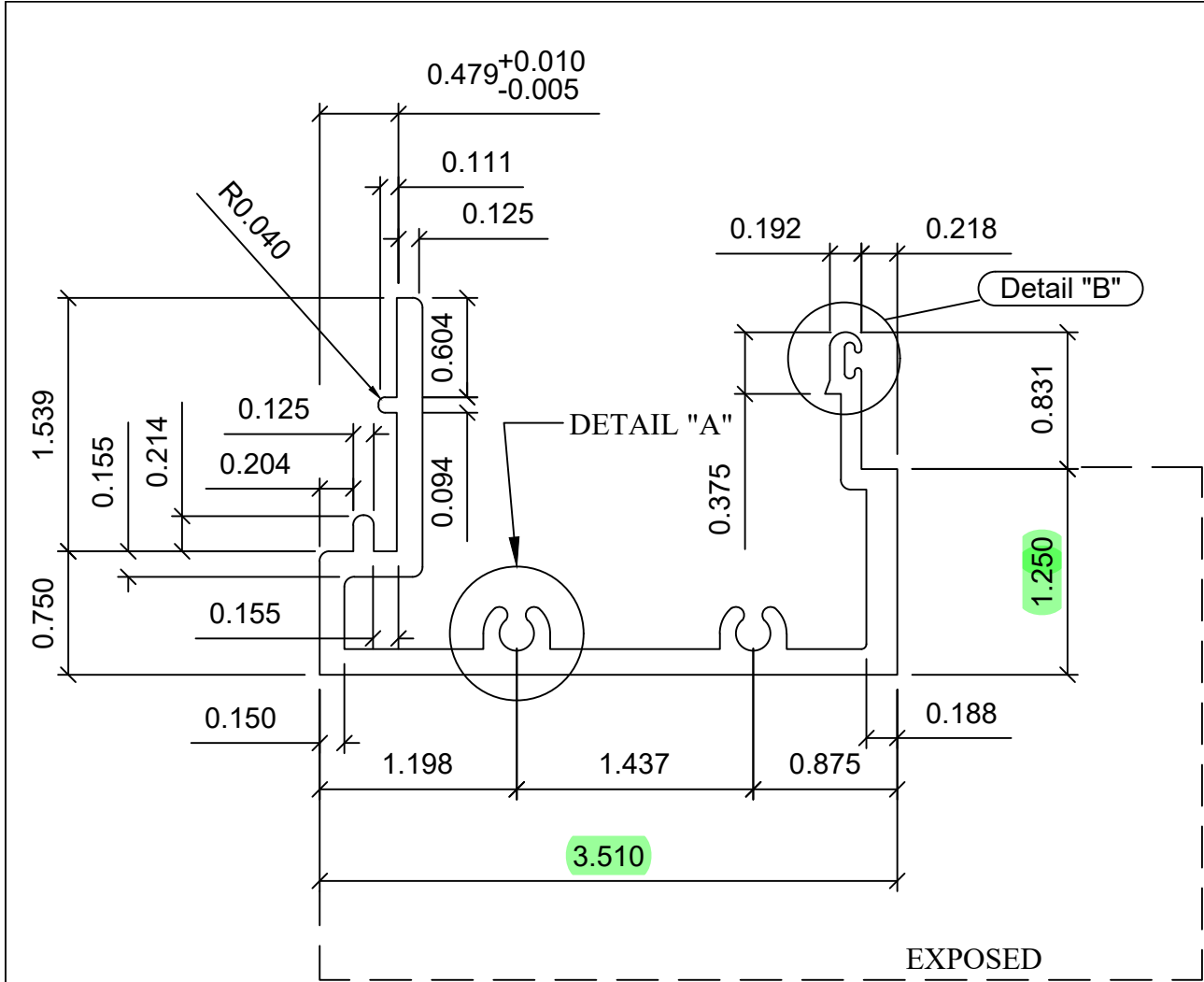
MATERIAL: ALUM ALLOY 6063-T6		FreMarq Innovations PO BOX 512 MERRILL, WI 54452	TITLE: 2 1/2" PRESSURE PLATE	
TOLERANCE: INDUSTRY STANDARD			DRAWN BY: TAF	
Perimeter = 8.390	RADIUS: 0.03" UNO		DATE: 6-24-14	
AREA= 0.446	WEIGHT= 0.535 LB/FT		PART NO.	2501



Drawings represent specimen as tested
 Quast Consulting & Testing, Inc.
 QCT-TH-11279
 02/26/2019
 JMZ



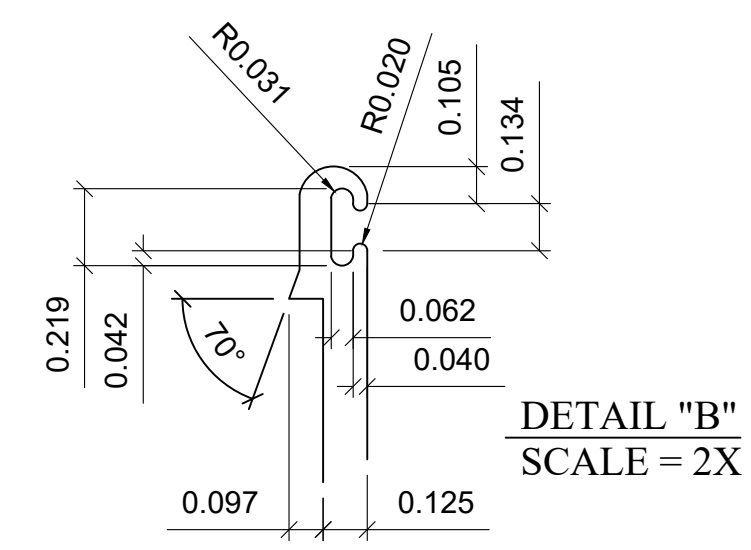
MATERIAL: ALUM ALLOY 6063-T6		FreMarq Innovations 8300 Highland Drive Wausau, WI 54401	TITLE: FEMALE STACK	
TOLERANCE: INDUSTRY STANDARD			DRAWN BY: TAF	
Perimeter = 15.589	RADIUS: .030" UNO		DATE: 6-18-18	
AREA= 1.090	WEIGHT = 1.308 LB/FT		PART NO.	2526



Drawings represent specimen as tested

Quast Consulting & Testing

QCT-TH-11279
02/26/2019
JMZ

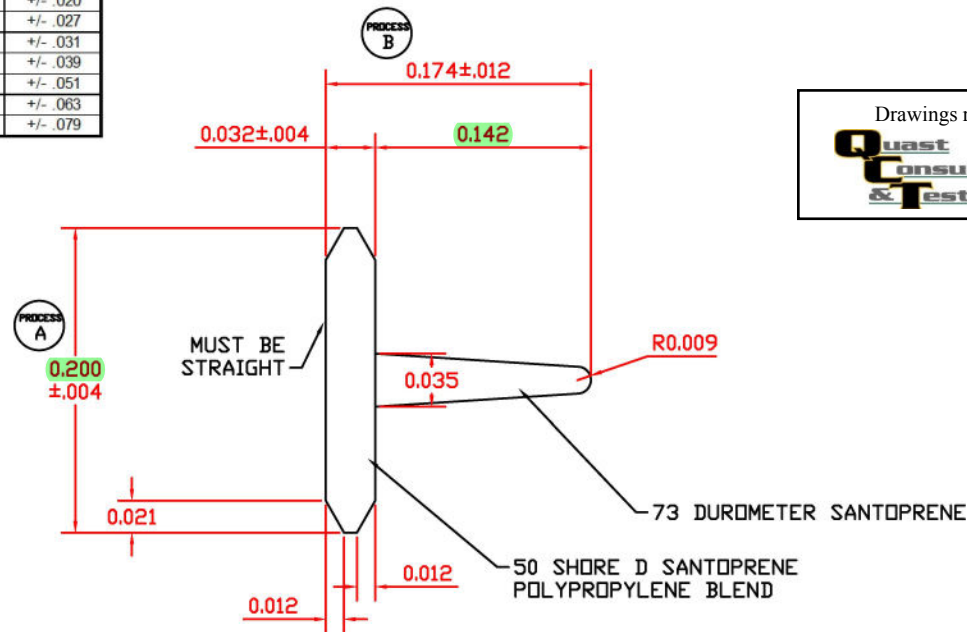


MATERIAL: ALUM ALLOY 6063-T6		FreMarq Innovations 8300 Highland Drive Wausau, WI 54401	TITLE: MALE STACK	
TOLERANCE: INDUSTRY STANDARD			DRAWN BY: TAF	
Perimeter = 19.451	RADIUS: .030" UNO		DATE: 6-18-18	
AREA= 1.426	WEIGHT = 1.711 LB/FT		PART NO.	2525

RMA Class		2
above	up to	Precision
0.000	0.060	+/- .010
0.060	0.100	+/- .014
0.100	0.160	+/- .016
0.160	0.250	+/- .020
0.250	0.390	+/- .027
0.390	0.630	+/- .031
0.630	0.980	+/- .039
0.980	1.570	+/- .051
1.570	2.480	+/- .063
2.480	3.940	+/- .079

CUSTOMER APPROVAL:

DATE:



Drawings represent specimen as tested

QCT-TH-11279

02/26/2019

JMZ

3998-01-02 U/M BOX (3,000 FT)


 ACTUAL SIZE

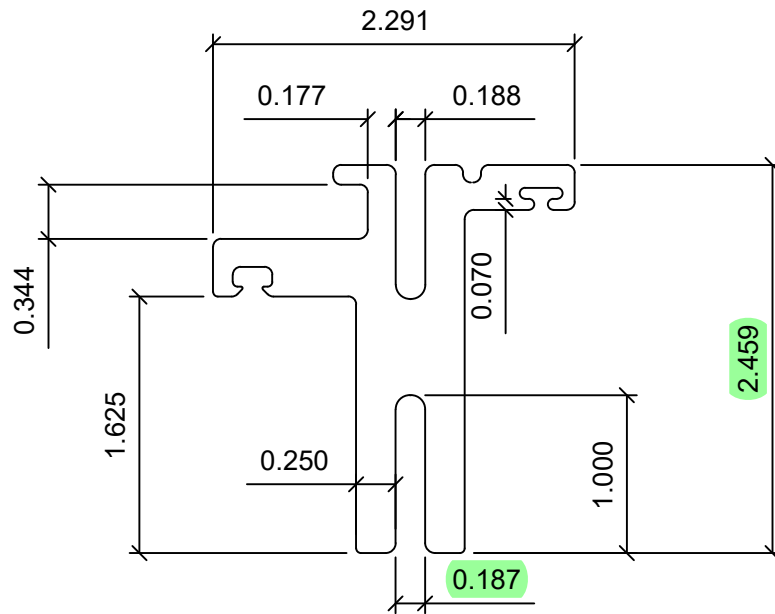
ALL TOLERANCES ARE
RMA CLASS II UNLESS
OTHERWISE NOTED



EXTRUDED POLYMERS
FOR GLAZING, INC.

1780 MILLER PARKWAY
STREETSBORO OHIO 44241
(330) 995-9725 FAX (330) 995-9734

EPG PART NUMBER	3998-01-01	DATE	3-21-05
CUSTOMER PART NUMBER	TOP RAIL SEAL	SCALE	10X
COMPOUND NUMBER		AREA	.007/.004
DIE NUMBER	3998	FILE	39980100
		DRAWN BY	MRG

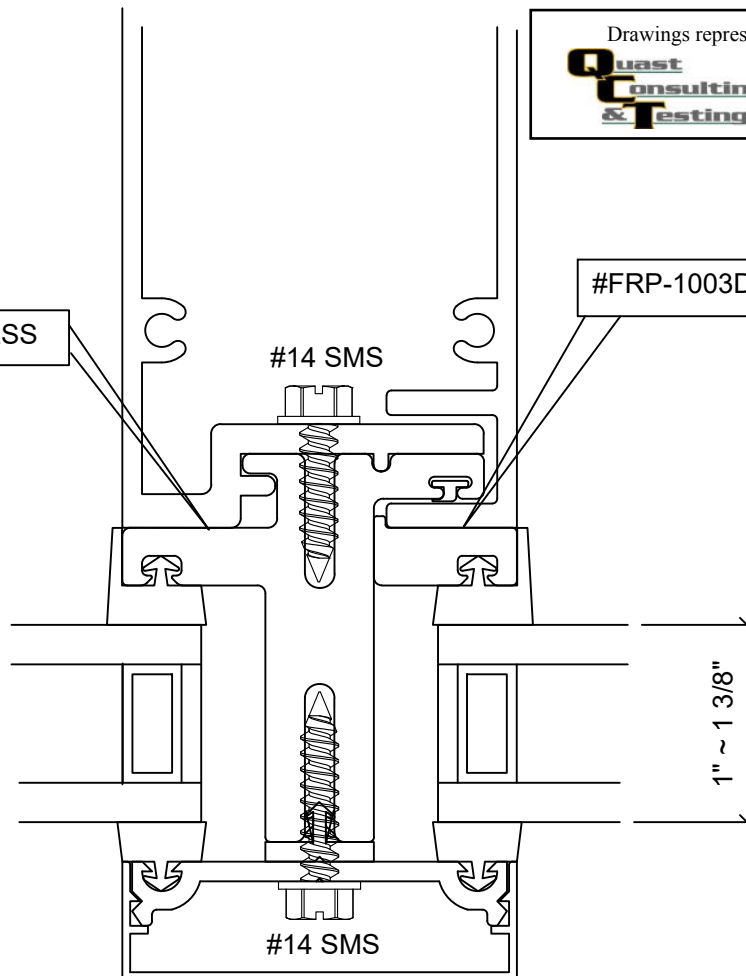


Drawings represent specimen as tested

Quast Consulting & Testing Inc.

QCT-TH-11279
02/26/2019
JMZ

#PRP-1002D FIBERGLASS



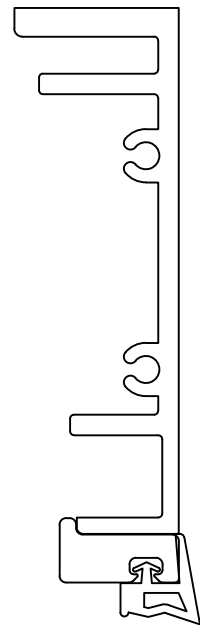
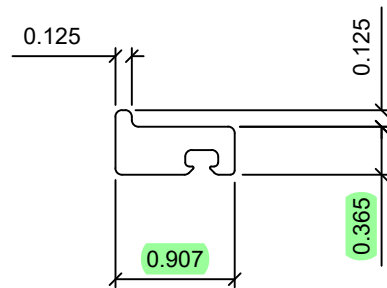
#FRP-1003D FIBERGLASS

ASSEMBLY DETAIL

Baydur PUL-2500

AREA = 1.791 SQ.IN.

PART NO. PRP-1002D



ASSEMBLY DETAIL

AREA = 0.305 SQ.IN.

PART NO. PRP-1003D

Drawings represent specimen as tested



QCT-TH-11279

02/26/2019

JMZ

Baydur PUL-2500