

MOCK-UP TEST REPORT

Rendered to:

TUBELITE, INC.

PROJECT: 200 Series Curtain Wall Mock-Up



Report No: 85616.01-120-32
Test Completion Date: 01/15/09
Report Date: 02/11/09
Record Retention End Date: 01/15/13



Architectural Testing

MOCK-UP TEST REPORT

Rendered to:

TUBELITE, INC.
3056 Walker Ridge Drive NW
Walker, Michigan 49544

Report No: 85616.01-120-32
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Project: 200 Series Curtain Wall Mock-Up

Project Summary: Architectural Testing, Inc. was contracted by Tubelite, Inc. to conduct performance testing on a mock-up for the referenced project. All testing was performed in accordance with the attached "Curtain Wall Mock-Up Test Procedure" dated October 28, 2008 and revised January 28, 2009. This report includes written and photographic documentation of testing performed and a copy of "As-Built" mock-up drawings.

Drawing Reference: Reference Tubelite Inc. 200 Series Curtain Wall Installation instructions Pages 4 through 11. Also reference Tubelite Inc. As-built drawings T954-1 through T954-5, dated June 1, 2008. Copies attached to this report.

General Mock-up Description:

Project Type: The mock-up was comprised of an aluminum and glass curtain wall system. Reference should be made to the attached set of "As-Built" drawings for complete assembly, anchorage, and sealant details.

Glazing: The mock-up was exterior glazed using a pressure bar system. The pressure bar is used to capture the glass units to the framing members.

Drainage: The curtain wall mock-up is designed to weep out through three (3) 1/4" holes in the horizontal pressure plates of each light.

Sealant: All exterior seals were of Dow Corning 795. All critical seals and frame joinery were of PTI 707 Butyl sealant.

Anchorage: Each vertical mullion was anchored to the adjacent substrate at each floor simulation.

General Mock-up Description: (Continued)

Installation: The mock-up was erected into a steel test rig. The sill simulation was designed to move horizontally for use in evaluating the system for inter-story movement. The perimeter seals were designed to allow for the movement and remain air and water tight.

Overall Size:

Front Elevation: 16' 5" wide by 27' 1/2" high.

Test Methods:

Air Infiltration: ASTM E 283-04, *Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen*. Testing was conducted at 6.24 psf positive static air pressure difference.

Static Pressure Water Resistance: ASTM E 331-00, *Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference*. Testing was conducted at 15.0 psf positive static air pressure difference for a 15 minute duration. Water was applied to the mock-up at a minimum rate of 5 gal/ft²/hr.

Dynamic Pressure Water Resistance: AAMA 501.1-05, *Standard Test Method for Exterior Windows, Curtain Walls, and Doors for Water Penetration Using Dynamic Pressure*. Testing was conducted with a dynamic pressure equivalent of 15.0 psf for a 15 minute duration. Water was applied to the mock-up at a minimum rate of 5 gal/ft²/hr.

Structural Performance: ASTM E 330-02, *Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference*. Testing was conducted at positive and negative loads as described in the test procedure and listed in the test results.

Interstory Differential Horizontal Movement: AAMA 501.4-01, *Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Interstory Drifts*. Three complete cycles shall be performed in the horizontal direction at the floor simulation. Testing was conducted at design displacement as described in the test procedure and listed in the test results.

Thermal Cycling: Reference should be made to Test No. 8 in the attached test procedure and to the test results.

Test Witnesses: The following representatives witnessed all or part of the testing:

<u>Name</u>	<u>Company</u>
Jack Johnson	Tubelite, Inc.
Darryl Sample	Tubelite, Inc.
Steve Deyoung	Tubelite, Inc.
Rick Smith	Hutt's Glass Co.
Scott Kramer	Architectural Testing, Inc.
Shane Haring	Architectural Testing, Inc.
Joe Enriquez	Architectural Testing, Inc.

FINAL TEST RESULTS
December 15, 2008

General Note: Unless otherwise stated, all comments relative to location are as viewed from the interior.

<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Preload @ +30.0 psf	---	---
Static Pressure Air Infiltration @ 6.24 psf	PASSED $\leq 0.01 \text{ cfm/ft}^2$	0.06 cfm/ft ² max.
Static Pressure Water Resistance @ 15.0 psf	PASSED No uncontrolled leakage	No uncontrolled leakage
Dynamic Pressure Water Resistance @ 15.0 psf	PASSED No uncontrolled leakage	No uncontrolled leakage
Uniform Load Deflection @ +30.0 psf (Preload) @ +60.0 psf (Design Load) @ -30.0 psf (Preload) @ -60.0 psf (Design Load)	PASSED See Table #1 and Sketch #1	See Table #1 and Sketch 1
Repeat Static Pressure Air Infiltration @ 6.24 psf	PASSED $\leq 0.01 \text{ cfm/ft}^2$	0.06 cfm/ft ² max.

FINAL TEST RESULTS
December 15, 2008
(Continued)

<u>Title of Test</u>	<u>Measured</u>	<u>Allowed</u>
Repeat Static Pressure Water Resistance @ 15.0 psf	PASSED No uncontrolled leakage	No uncontrolled leakage

December 29, 2008 through January 1, 2008

Thermal Cycling	PASSED	No visible damage
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January 15, 2008

Repeat Static Pressure Air Infiltration @ 6.24 psf	PASSED ≤ 0.01 cfm/ft ²	0.06 cfm/ft ² max.
Repeat Static Pressure Water Resistance @ 15.0 psf	PASSED No uncontrolled leakage	No uncontrolled leakage
Interstory Horizontal Displacement @ .750"	PASSED No visible damage	No visible damage
Uniform Structural Overloads @ +45.0 psf (Preload) @ +90.0 psf (Overload) @ -45.0 psf (Preload) @ -90.0 psf (Overload)	PASSED See Table #2 and Sketch #1	See Table #2 and Sketch #1

END OF TESTING

"As-Built" Mock-up drawings, data sheets, a copy of this report, or other pertinent project documentation will be retained by Architectural 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 by Architectural Testing, Inc. will expire. Results obtained are tested values and were secured by using the designated test methods. This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. It is the exclusive property of the client so named herein and relates only to the specimen(s) tested. This report may not be reproduced, except in full, without the written approval of Architectural Testing, Inc.

For ARCHITECTURAL TESTING, INC.:

Joe Enriquez
Senior Project Technician

Joseph W. Wise
Director - Project/Curtain Wall Testing

JE:jld

Attachments (pages): This report is complete only when all attachments listed are included.

Appendix-A: Test Procedure (4)

Appendix-B: Sketch (1)

Appendix-C: Tables (2)

Appendix-D: Photographs (2)

Appendix-E: Drawings (12)

Revision Log

<u>Rev. #</u>	<u>Date</u>	<u>Page(s)</u>	<u>Revision(s)</u>
0	02/11/09	N/A	Original report issue

Appendix A
Test Procedure

Mock-Up Test Procedure

Rendered to:

TUBELITE, INC.

Project: 200 Series Curtain Wall Mock-up

Mock-up testing for *200 Series Curtain Wall Project* shall be performed in accordance with referenced test methods as specified in the bid documents. Mock-up testing shall be observed by the Engineer and/or the Owner, Architect and their consultants during construction and testing. No pretesting shall be conducted without the architect or consultant present.

The final test procedure shall be as follows:

1. **PRELOAD (ASTM E330)**

To set the specimen for testing, a positive differential (inward acting) of **30.0 psf** (50% design load), will be applied to the specimen and held for a minimum of ten (10) seconds, then released. The wall and anchoring will be inspected for any failure.

Allowable

No visible signs of failure shall be allowed.

2. **STATIC AIR INFILTRATION TEST (ASTM E283)**

The mock-up exterior face will be covered with polyethylene (plastic sheeting). The mock-up will then be subjected to a positive static pressure differential of **6.24 psf**. The air infiltration required to maintain the air pressure differential is measured. This air infiltration reading represents the chamber tare. The polyethylene will be removed and the mock-up specimen will again be subjected to a positive static pressure differential of **6.24 psf**. Air infiltration will be measured. This total air infiltration reading represents the amount of air through the specimen and the chamber tare. Subtracting the chamber tare from the latter total reading yields the net amount of air infiltration through the mock-up. Dividing the mock-up air leakage by the mock-up area yields the air infiltration rate.

Allowable

Air infiltration shall not exceed **0.06 cfm** per square foot of fixed wall area.

3. STATIC WATER PENETRATION TEST (ASTM E331)

A fifteen (15) minute water penetration test will be conducted on the wall system with a water application rate of 5 gal/hr/ft² at a pressure differential of **15.0 psf**. No uncontrolled water penetration is allowed.

Allowable

No uncontrolled water leakage.

4. DYNAMIC WATER PENETRATION (AAMA 501.1)

A fifteen (15) minute water penetration test will be conducted on the system with a water application rate of 5 gal/hr/ft² and dynamic air stream equivalent to static pressure of **15.0 psf**.

Allowable

No uncontrolled water leakage.

5. UNIFORM STRUCTURAL DESIGN LOAD TEST (ASTM E330)

Deflection of the system shall be measured and recorded at design pressure when held for sixty (60) seconds and evaluated using the following allowable criteria:

Each load shall be held as follows:

- +**30.0 psf** - 50% Positive Design Load
- +**60.0 psf** - 100% Positive Design Load
- 30.0 psf** - 50% Negative Design Load
- 60.0 psf** - 100% Negative Design Load

Allowable Criteria

Deflection of framing member's perpendicular to the plane of the wall shall not exceed L/175 for clear spans up to 13' 6".

6. REPEAT STATIC AIR INFILTRATION TEST (ASTM E283)

Repeat Test No. 2 as stated above.

7. REPEAT STATIC WATER PENETRATION TEST (ASTM E331)

Repeat Test No. 3 as stated above.

8. THERMAL CYCLES (AAMA 501.5)

The entire mock-up shall be subjected to three (3) thermal cycles. Each cycle shall be maintained for two hours after establishing equilibrium and consist of:

1. Thermal Cycle Requirements (AAMA 501.5)
 - a. Low exterior temperature of 0°F for two hours after establishing equilibrium.
 - b. High exterior ambient temperature of 150°F for two hours after establishing equilibrium.
 - c. Components used within the system shall withstand noiselessly thermal movements without buckling, distortion, cracking, failure of glass, and failure of joint seals or undue stress on the finished surfaces, materials, or fixing assemblies.

9. REPEAT STATIC AIR INFILTRATION TEST (ASTM E283)

Repeat Test No. 2 as stated above.

10. REPEAT STATIC WATER PENETRATION TEST (ASTM E331)

Repeat Test No. 3 as stated above.

11. INTERSTORY DIFFERENTIAL HORIZONTAL MOVEMENT TEST (AAMA 501.4)

Three (3) complete cycles shall be performed in the horizontal direction at the mid-height floor simulation. Horizontal movement will be .750" to the left, then back to zero, .750" to the right, and then back to zero (one cycle).

Allowable

There shall be no failure or gross permanent distortion of anchors, frame, glass, or panels. Structural silicone shall not experience adhesive or cohesive failure along any glass, frame or panel edge. Glazing gaskets may not disengage and weather seals may not fail.

12. UNIFORM STRUCTURAL OVER LOAD TEST (ASTM E330)

Permanent deformation of the system shall be measured and recorded at 1.5 x design pressure when held for ten (10) seconds and evaluated using the following allowable criteria:

Each load shall be held as follows:

- +**45.0 psf** - 75% Positive Design Load
- +**90.0 psf** - 150% Positive Design Load
- 45.0 psf** - 75% Negative Design Load
- 90.0 psf** - 150% Negative Design Load

Allowable

The net permanent set shall not exceed 0.2% of the clear span.

END OF TESTING

This Revised Test Procedure dated January 28, 2009 for the *200 Series Curtain Wall Project* is approved as written.

JE:jld

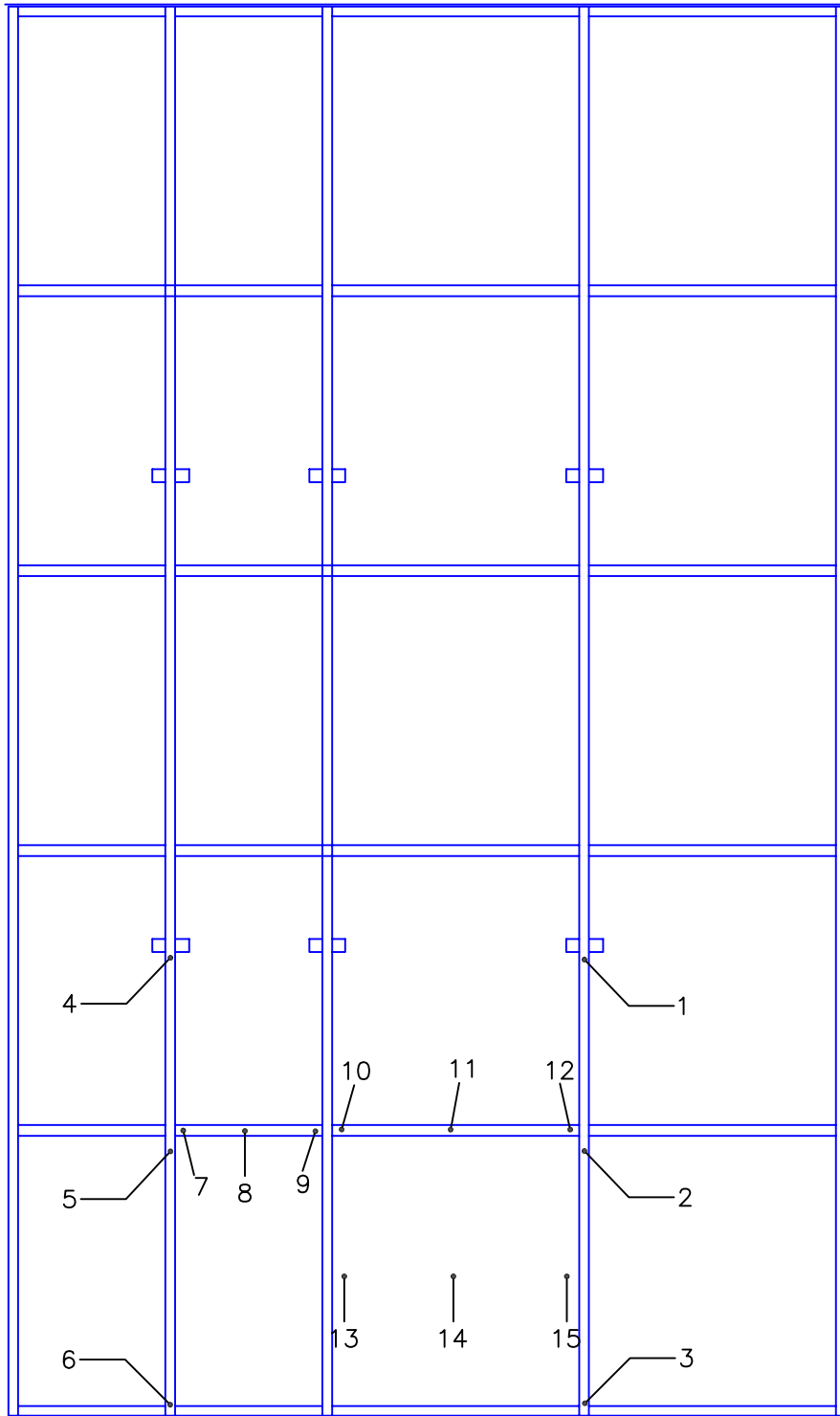
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Appendix B

Sketch

REV:	DATE:	DESCRIPTION:	BY:
X	X/XX/XX	XXXXX	XXX

INTERIOR VIEW



Appendix C

Tables

TABLE #1
Uniform Load Deflection
 (Deflection in inches)

Indicator Location	Positive 60.0 psf	Net Deflection	Negative 60.0 psf	Net Deflection	Allowed*
1	0.020	---	0.010	---	---
2	0.250	0.230	0.300	0.270	0.588
3	0.020	---	0.050	---	---
4	0.040	---	0.010	---	---
5	0.210	0.185	0.200	0.190	0.588
6	0.010	---	0.010	---	---
7	0.200	---	0.160	---	---
8	0.200	0.005	0.190	0.020	0.192
9	0.190	---	0.180	---	---
10	0.190	---	0.200	---	---
11	0.230	0.010	0.200	0.005	0.328
12	0.250	---	0.210	---	---
13	0.250	---	0.280	---	---
14	1.000	0.725	0.700	0.435	N/A
15	0.300	---	0.250	---	---

**General Note: Refer to Sketch #1 for dial indicator locations and to the test procedure for information regarding allowable deflections.*

TABLE #2
Uniform Structural Overloads
 (Permanent Set in inches)

Indicator Location	Positive 90.0 psf	Net Deflection	Negative 90.0 psf	Net Deflection	Allowed*
1	0.010	---	0.010	---	---
2	0.040	0.000	0.015	0.005	0.206
3	0.070	---	0.010	---	---
4	0.010	---	0.020	---	---
5	0.010	0.000	0.020	0.005	0.206
6	0.010	---	0.010	---	---
7	0.020	---	0.020	---	---
8	0.030	0.005	0.020	0.000	0.067
9	0.030	---	0.020	---	---
10	0.030	---	0.020	---	---
11	0.030	0.000	0.020	0.000	0.115
12	0.030	---	0.020	---	---

**General Note: Allowable amounts are based on 0.2% of clear span. Refer to Sketch #1 for dial indicator locations and to the test procedure for additional information regarding allowable deflections.*

Appendix D

Photographs



Photo No. 1
Exterior View during Air Infiltration Test



Photo No. 2
Exterior View during Water Penetration Test



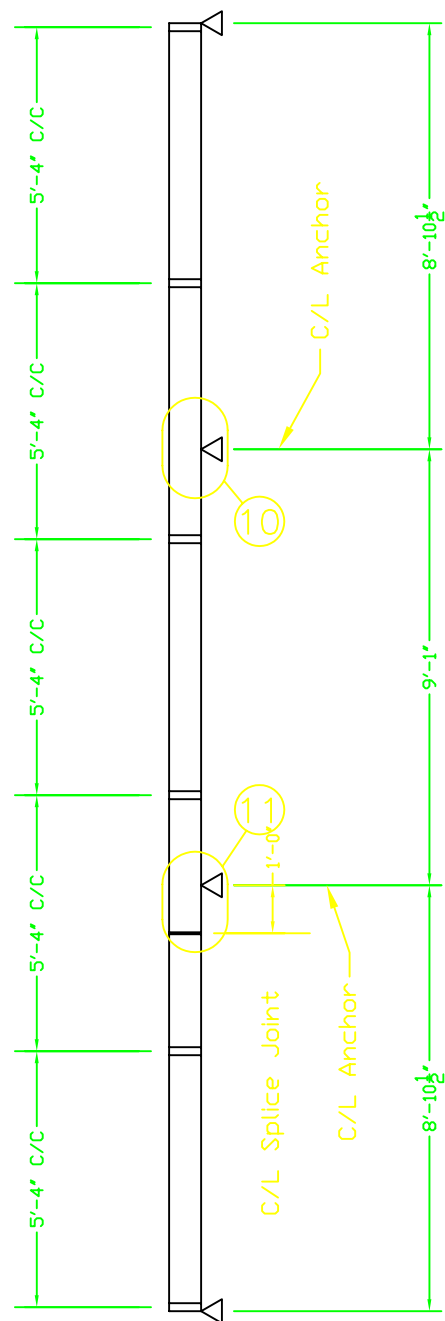
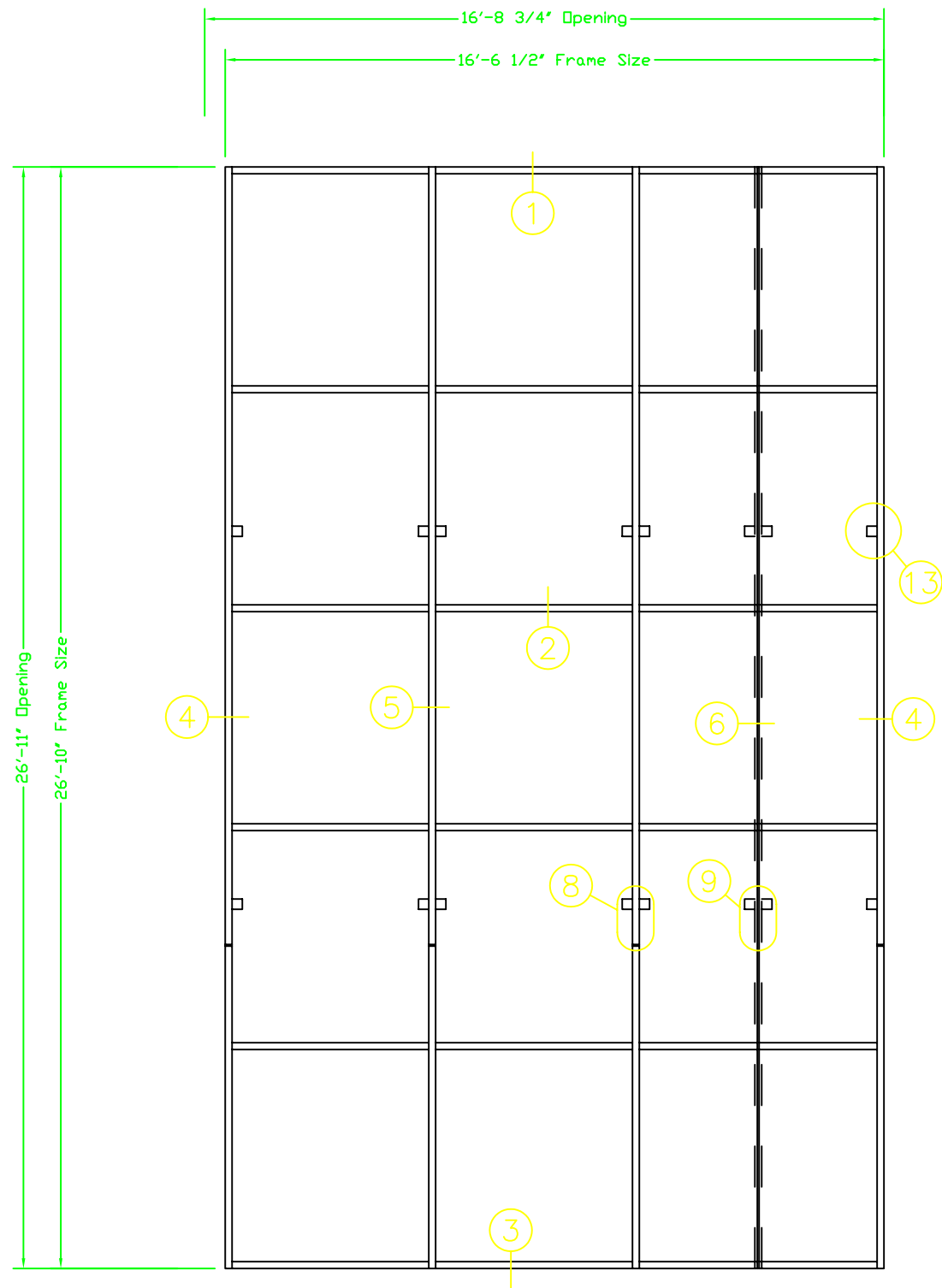
Photo No. 3
Exterior View during Dynamic Water Resistance Test



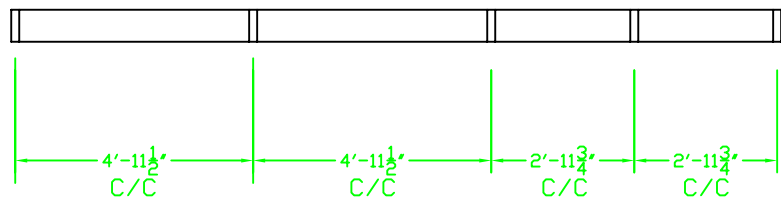
Photo No. 4
Exterior View during Thermal Cycling

Appendix E

Drawings



- Preload @ 50% Design Pressure Per ASTM 330 (30 psf)
- Air Infiltration Per ASTM E283 (6.24 psf)
- Static Water Penetration Per ASTM E331 (15 psf)
- Dynamic Water Penetration Per AAMA 501.1 (15 psf)
- Structural Performance Per ASTM E330 (45 psf)
- Repeat Air Infiltration
- Repeat Static Water Penetration
- Thermal Cycle Per AAMA 501.5
- Repeat Air Infiltration
- Repeat Static Water Penetration
- Preload @ 75% Design Pressure (45 psf)
- Structural Overload Per ASTM E330 (90 psf)

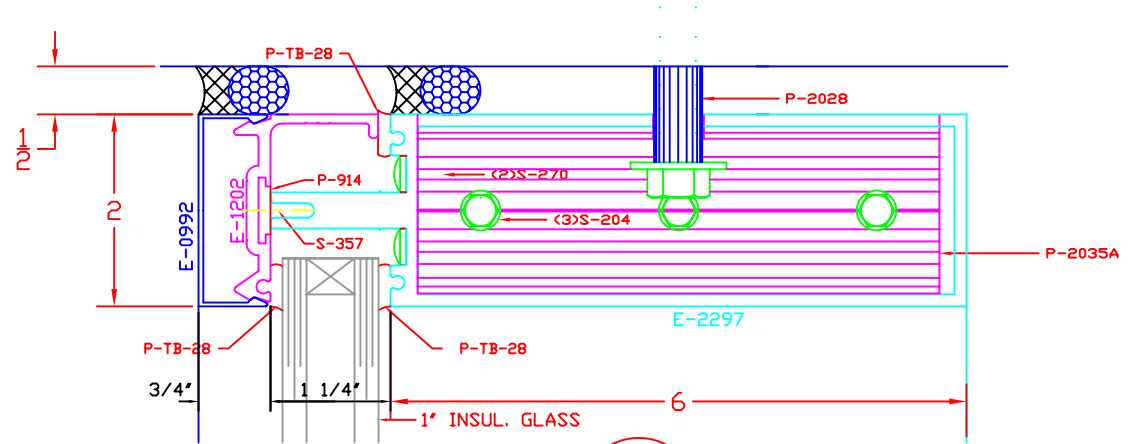


200 Series Mock Up

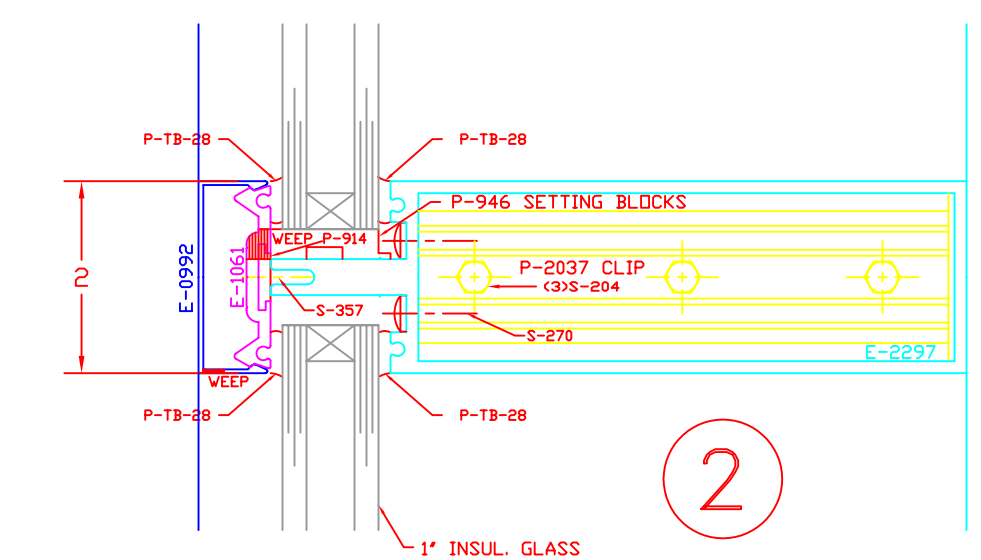
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STOREFRONT, CURTAINWALL & ENTRANCES
DEPENDABLE

200 SERIES CURTAINWALL SYSTEM
PERFORMANCE TEST MOCK-UP

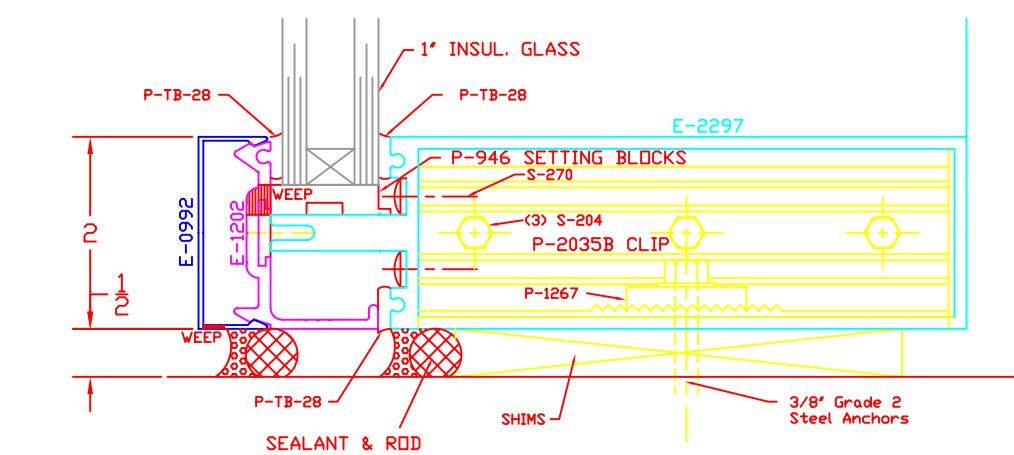
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DRWG SCALE 1/4"=1'	PRODUCT CODE 280	SHEET NO. 1 OF 5	REV



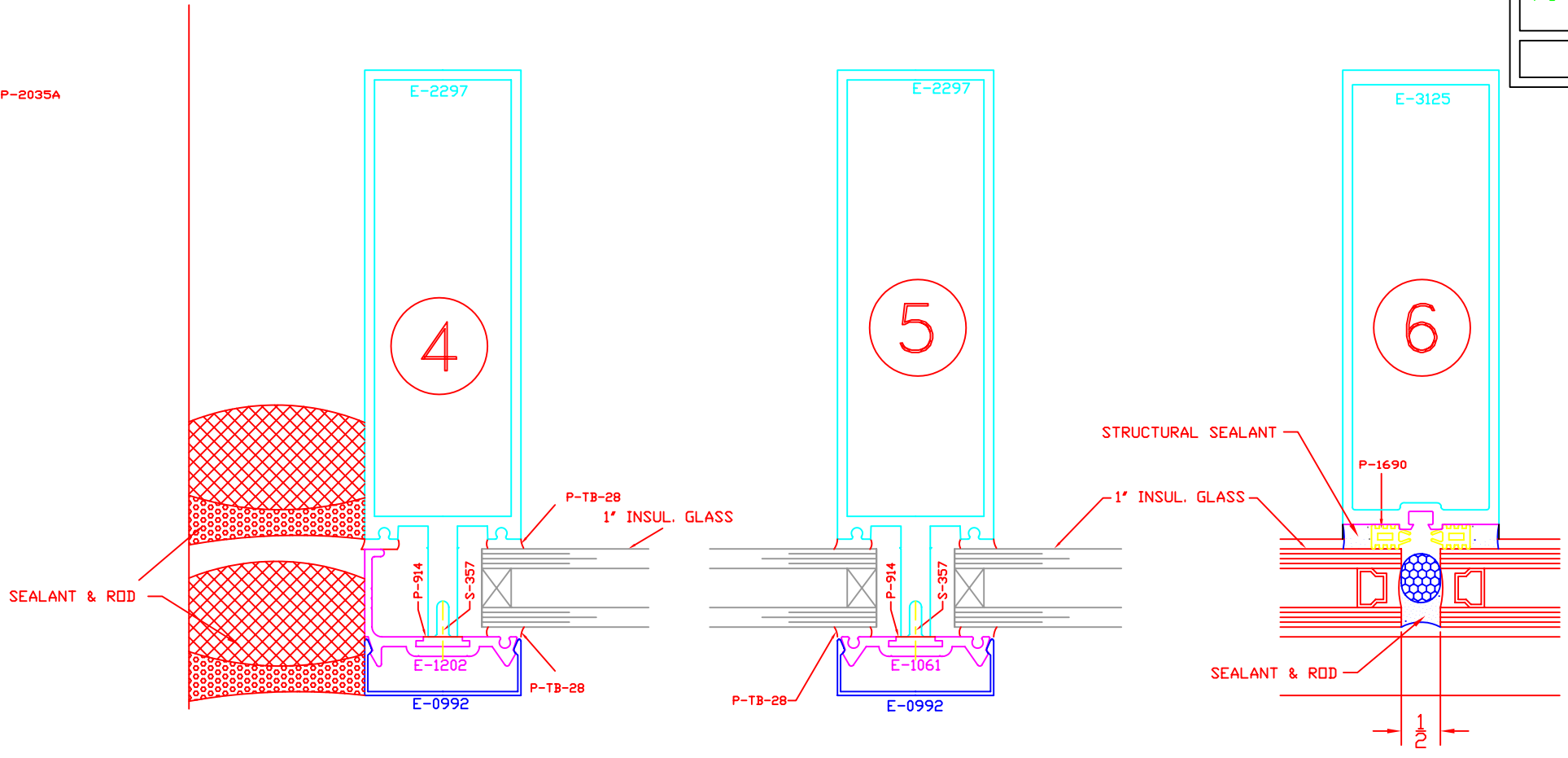
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2



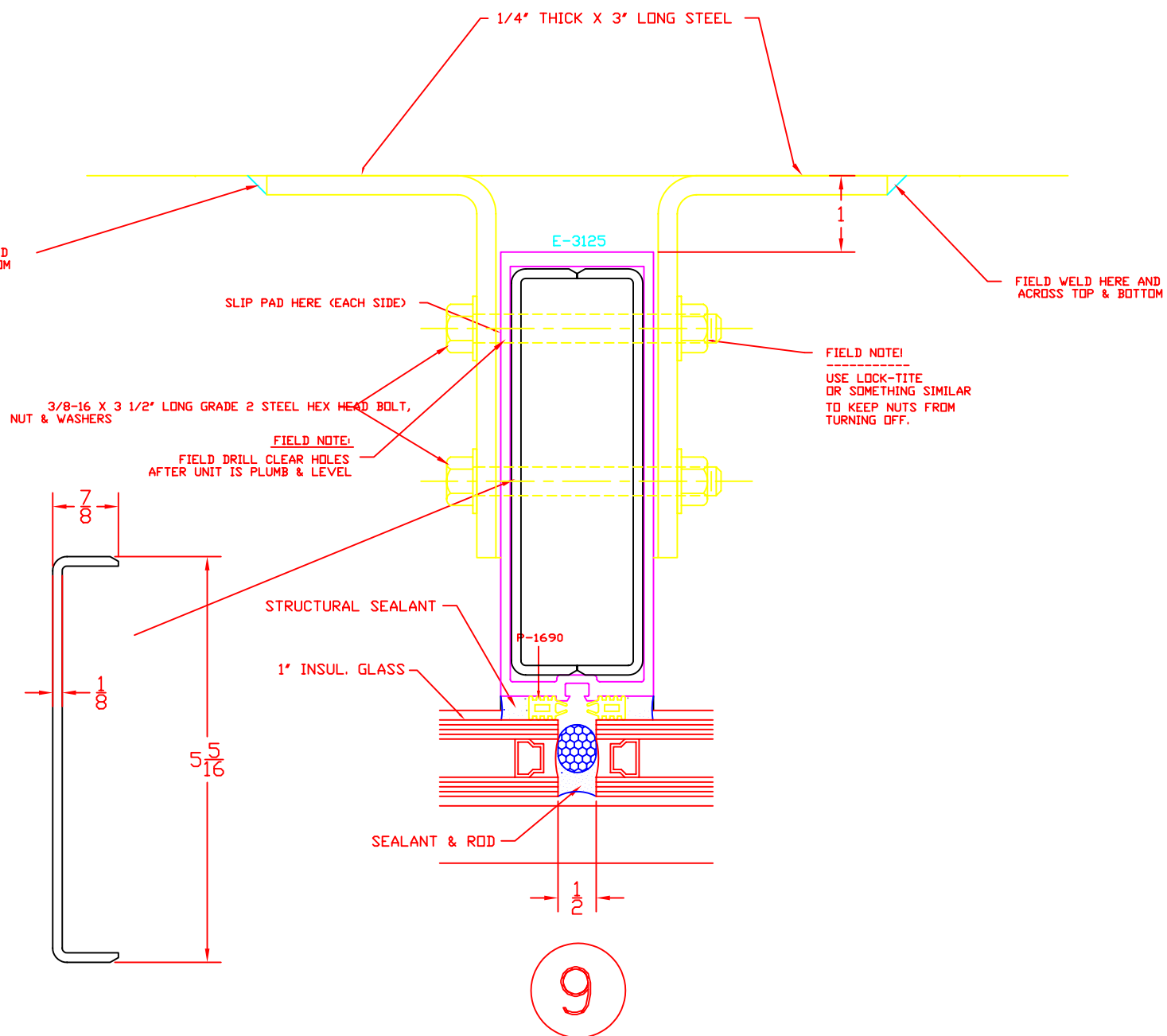
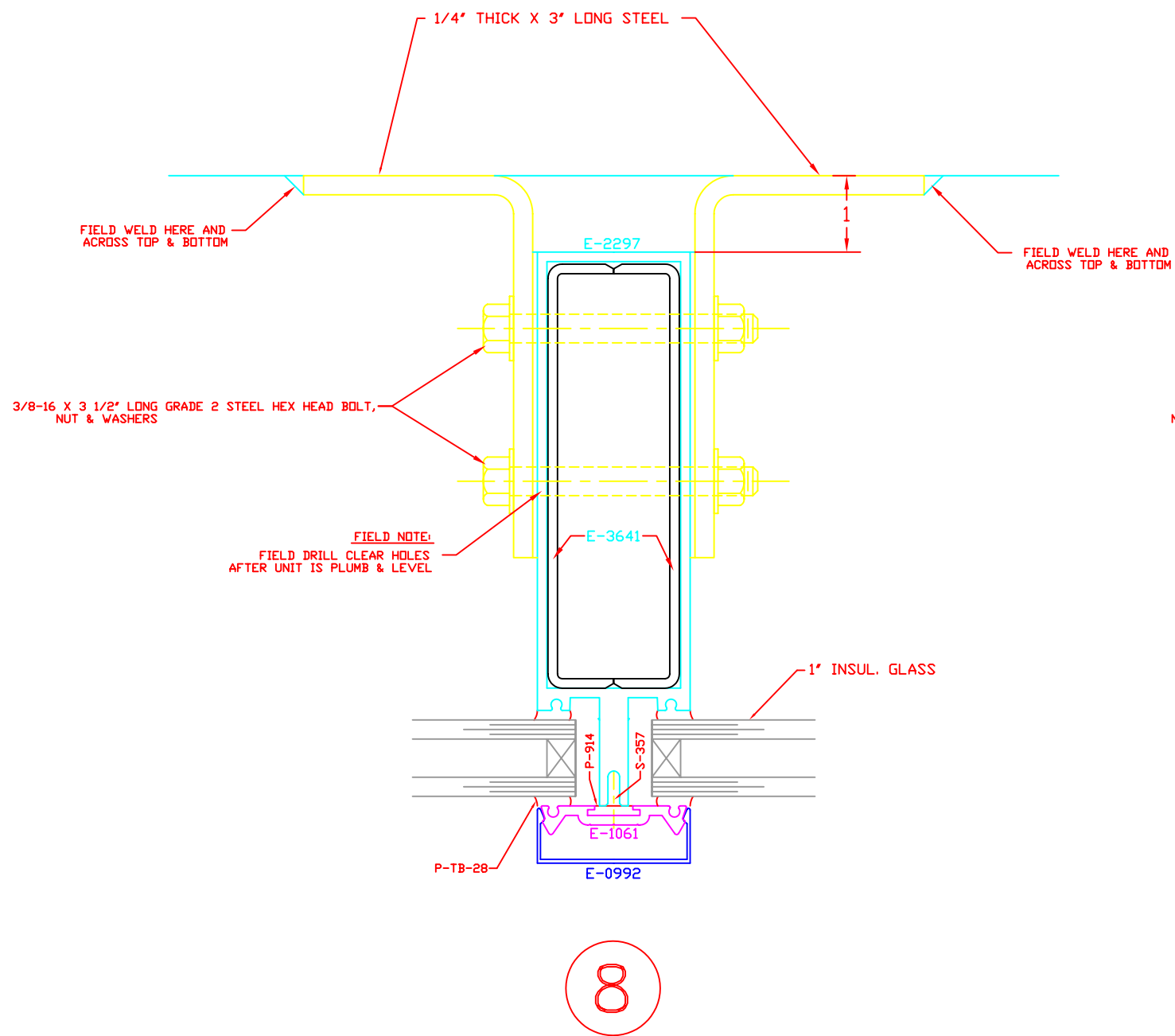
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200 SERIES CURTAINWALL SYSTEM
 PERFORMANCE TEST MOCK-UP

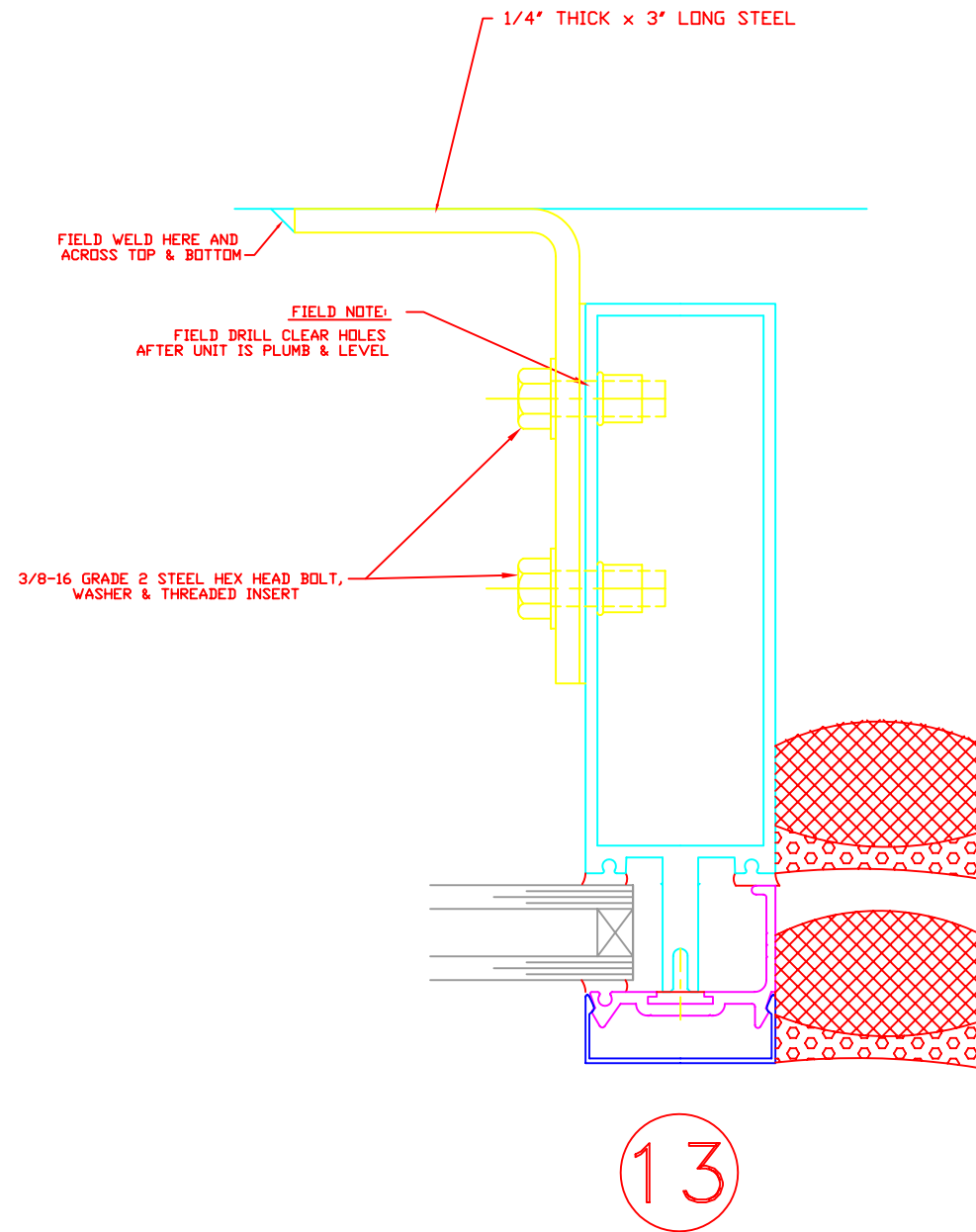
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DRWG SCALE	1/2 SIZE	PRODUCT CODE	280	SHEET NO.	2 OF 5	



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200 SERIES CURTAINWALL SYSTEM
 PERFORMANCE TEST MOCK-UP

DRAWN BY	SRD	DRWG DATE	6/1/08	APPV'D BY	DATE APPV'D
DRWG SCALE	1/2 SIZE	PRODUCT CODE	280	SHEET NO.	3 OF 5
				REV	



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200 SERIES CURTAINWALL SYSTEM
PERFORMANCE TEST MOCK-UP

DRAWN BY	SRD	DRWG DATE	6/1/08	APPV'D BY		DATE APPV'D	
DRWG SCALE	1/2	SIZE	PRODUCT CODE	280	SHEET NO.	4 OF 5	REV

1/4" STEEL ANGLE WINDLOAD CLIP
X 3" LONG EACH SIDE

10

3/8-16 X GRADE 2 STEEL HEX BOLT,
NUT & WASHERS

1" INSUL. SPANDREL GLASS

1/4" STEEL ANGLE DEADLOAD CLIP
X 3" LONG EACH SIDE

3/8-16 X GRADE 2 STEEL HEX
BOLT, NUT & WASHERS

1" INSUL. SPANDREL GLASS

11

12"

OUTLINE OF PRESSURE PLATE

SEALANT N.B.T.

SEALANT

P-903 TWD FACE TAPE

.040 ALUM. SPLICE

4 3/4"

1/4-20 FH SCREWS

E-3641 SPLICE

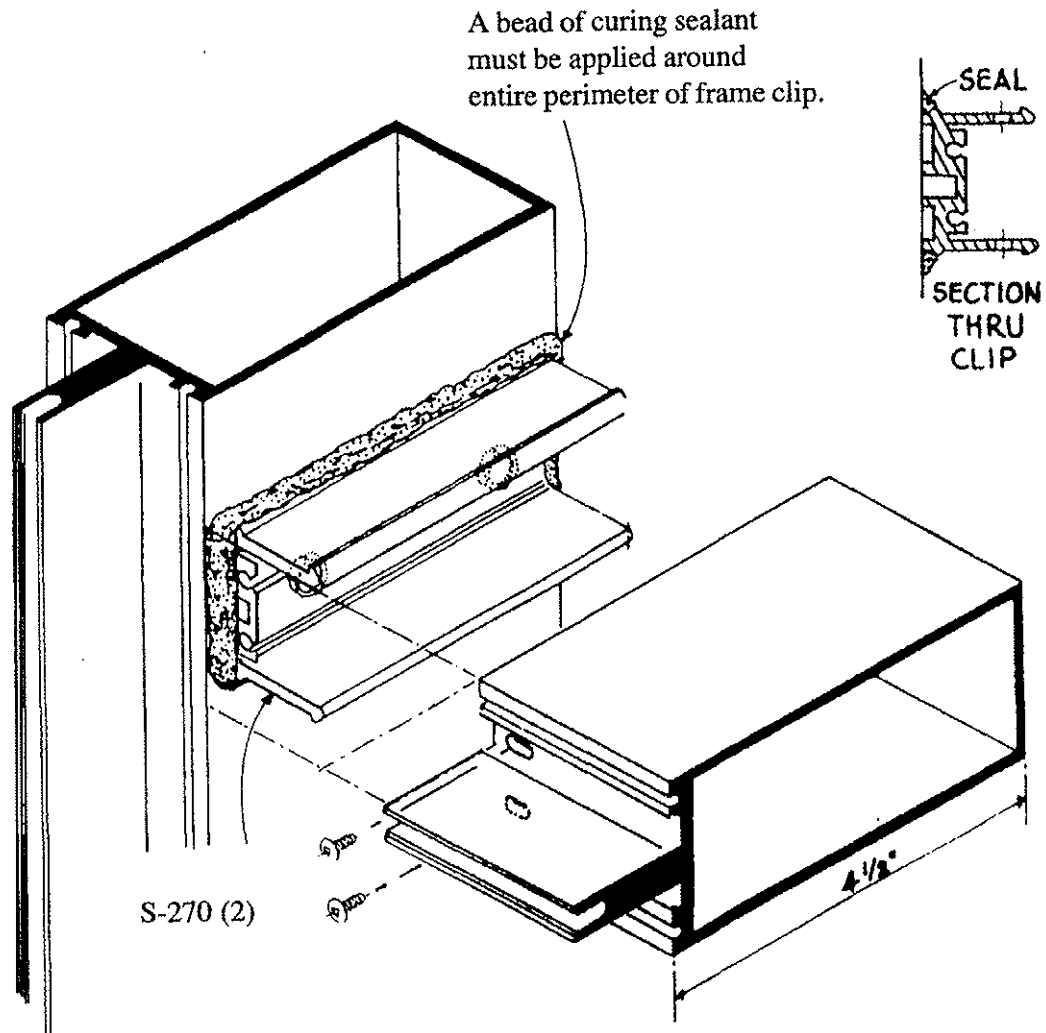
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200 SERIES CURTAINWALL SYSTEM
PERFORMANCE TEST MOCK-UP

DRAWN BY	SRD	DATE	6/1/08	APP'VD BY		DATE	
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1954-5

Step 2- Sealing Clip and Horizontal Joint

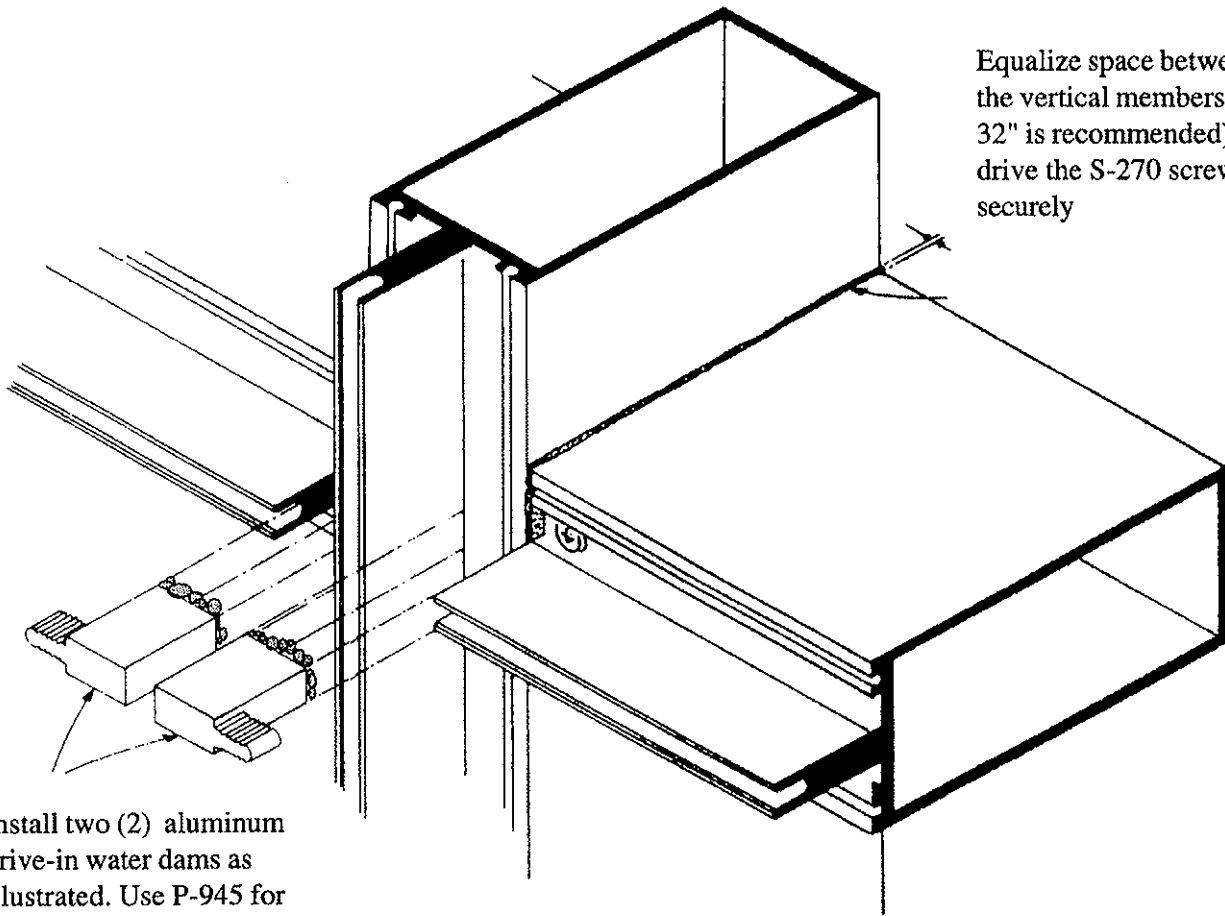


Drill two (2) slotted holes, .201" dia. x .281" long as shown, for S-270 fasteners. Center line of holes is 3/8" from end of tube on "v" groove extruded in member. Seal screw heads.

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STOREFRONTS & ENTRANCES - Page 4

Step 3- Expansion Joints & Water Dams

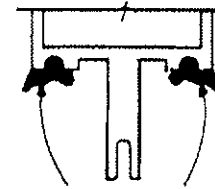


Equalize space between the vertical members (1/32" is recommended) and drive the S-270 screws securely

Install two (2) aluminum drive-in water dams as illustrated. Use P-945 for 1" glass and P-944 for 1/4" glass. Set in bed of sealant.

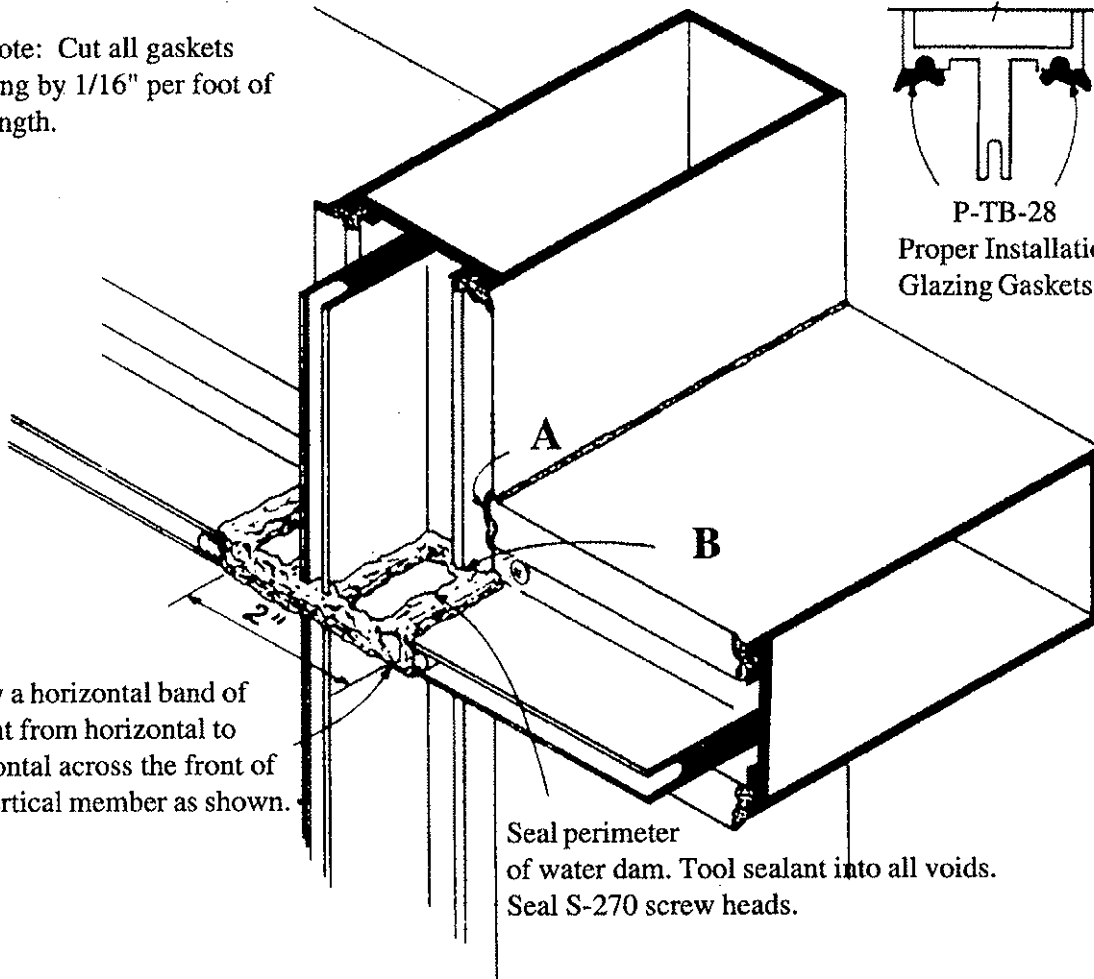
Step 4- Seal Glass Pocket & Install Gaskets

Note: Cut all gaskets long by 1/16" per foot of length.



P-TB-28
Proper Installation of
Glazing Gaskets

Apply a horizontal band of sealant from horizontal to horizontal across the front of the vertical member as shown.



Seal perimeter of water dam. Tool sealant into all voids.
Seal S-270 screw heads.

A - Fit horizontal gaskets (P TB 28) to vertical gaskets (P TB 28). To ensure a "crowded" fit, seal the intersection with butyl base sealant.

B - Push vertical gaskets into sealant at water dams.

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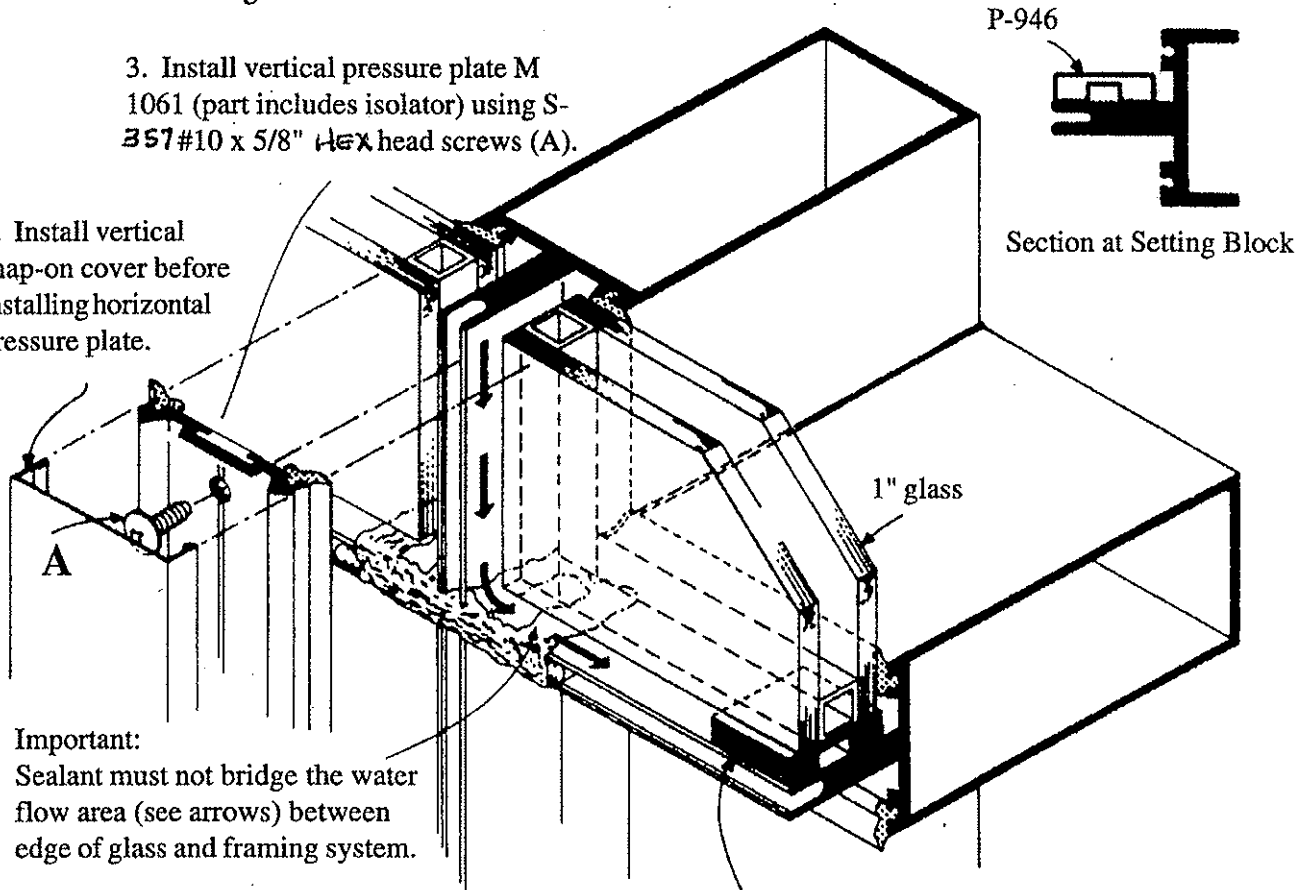
STOREFRONTS & ENTRANCES - Page 6

Step 5- Install Glass & Pressure Plates

2. Install glass.

3. Install vertical pressure plate M 1061 (part includes isolator) using S-357 #10 x 5/8" HEX head screws (A).

4. Install vertical snap-on cover before installing horizontal pressure plate.

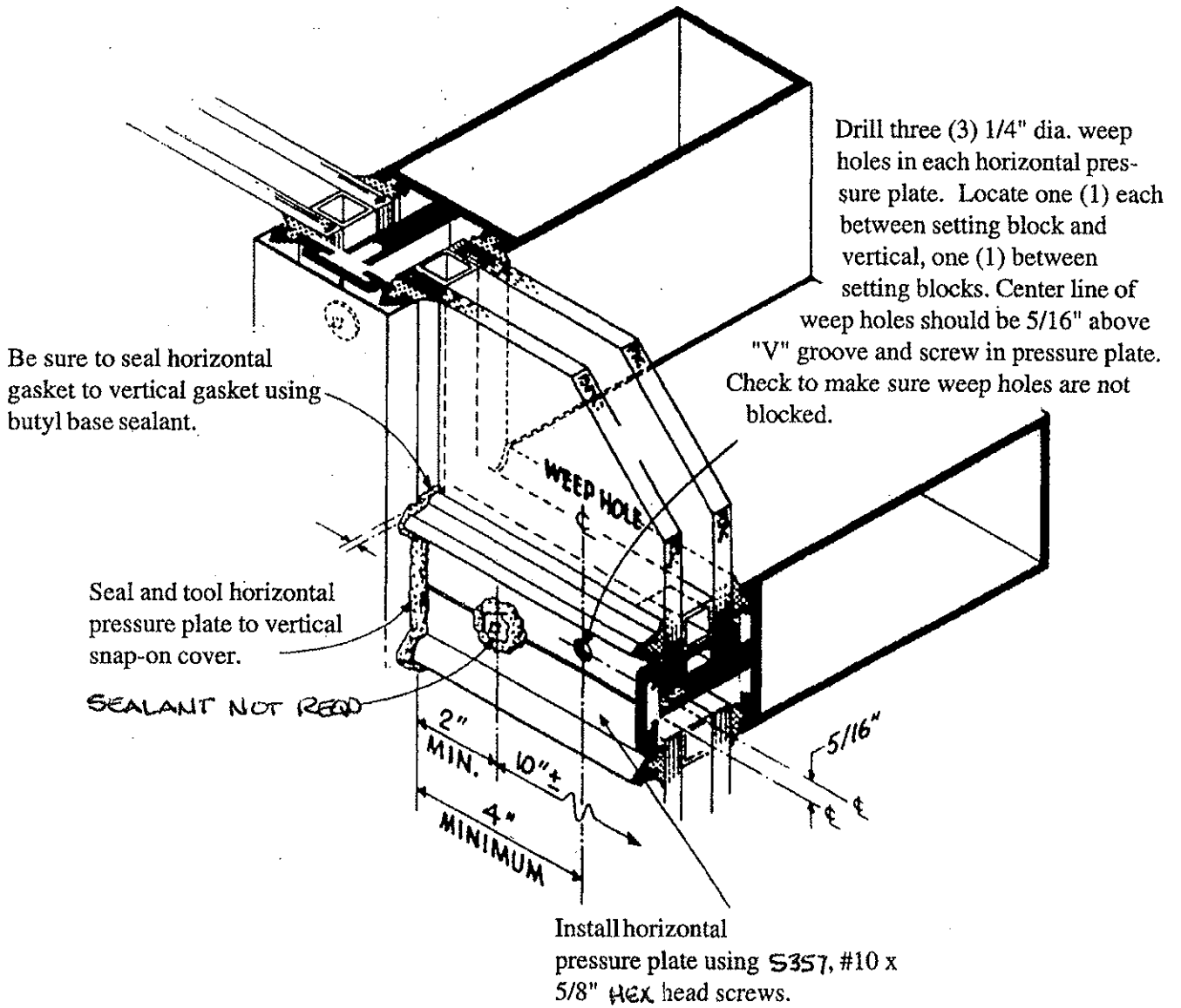


1. Install standard 4" long setting blocks at 1/4 points, or as indicated on approved shop drawings. Use P-946 for 1" glass and P-948 for 1/4" glass.

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STOREFRONTS & ENTRANCES - Page 7

Step 7- Install Pressure Plates

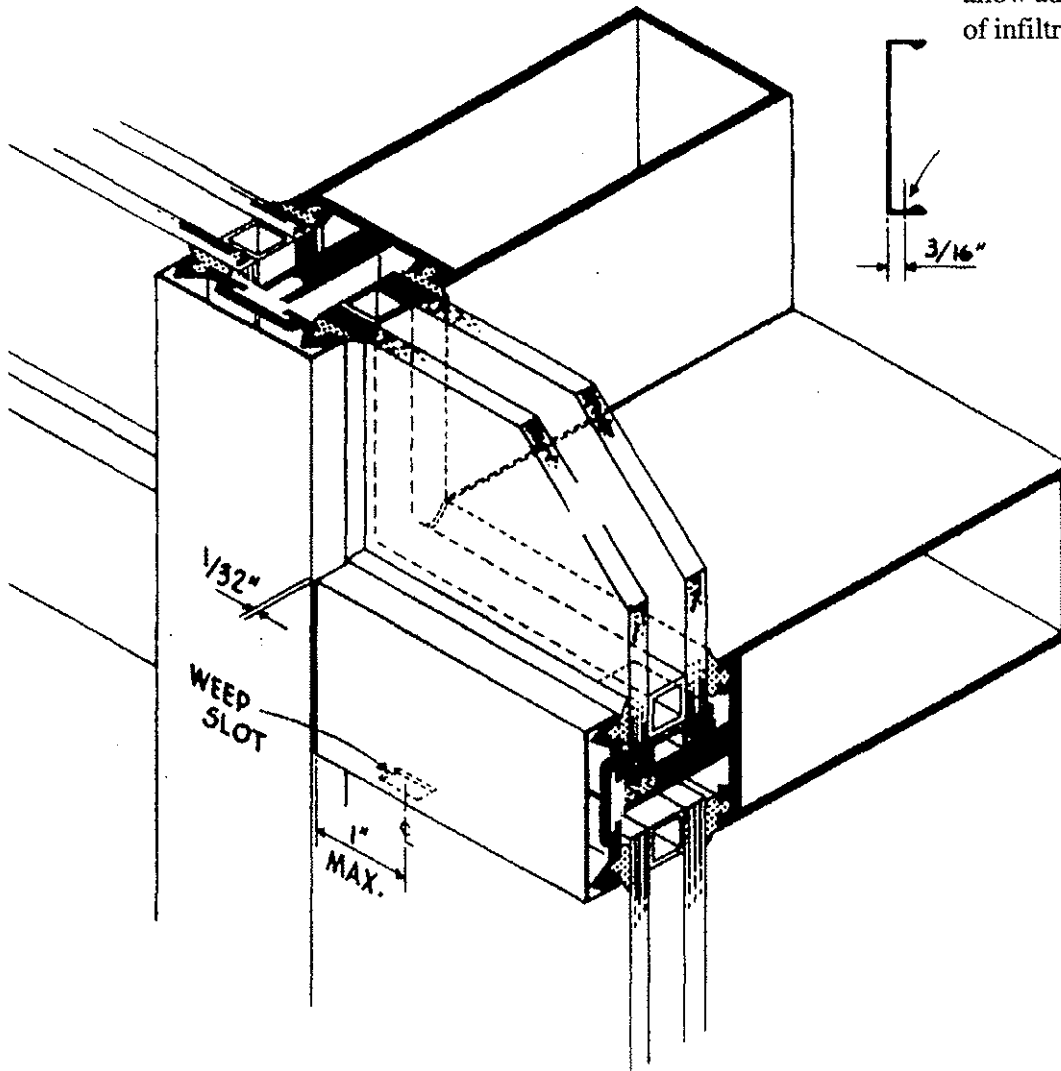


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STOREFRONTS & ENTRANCES - Page 9

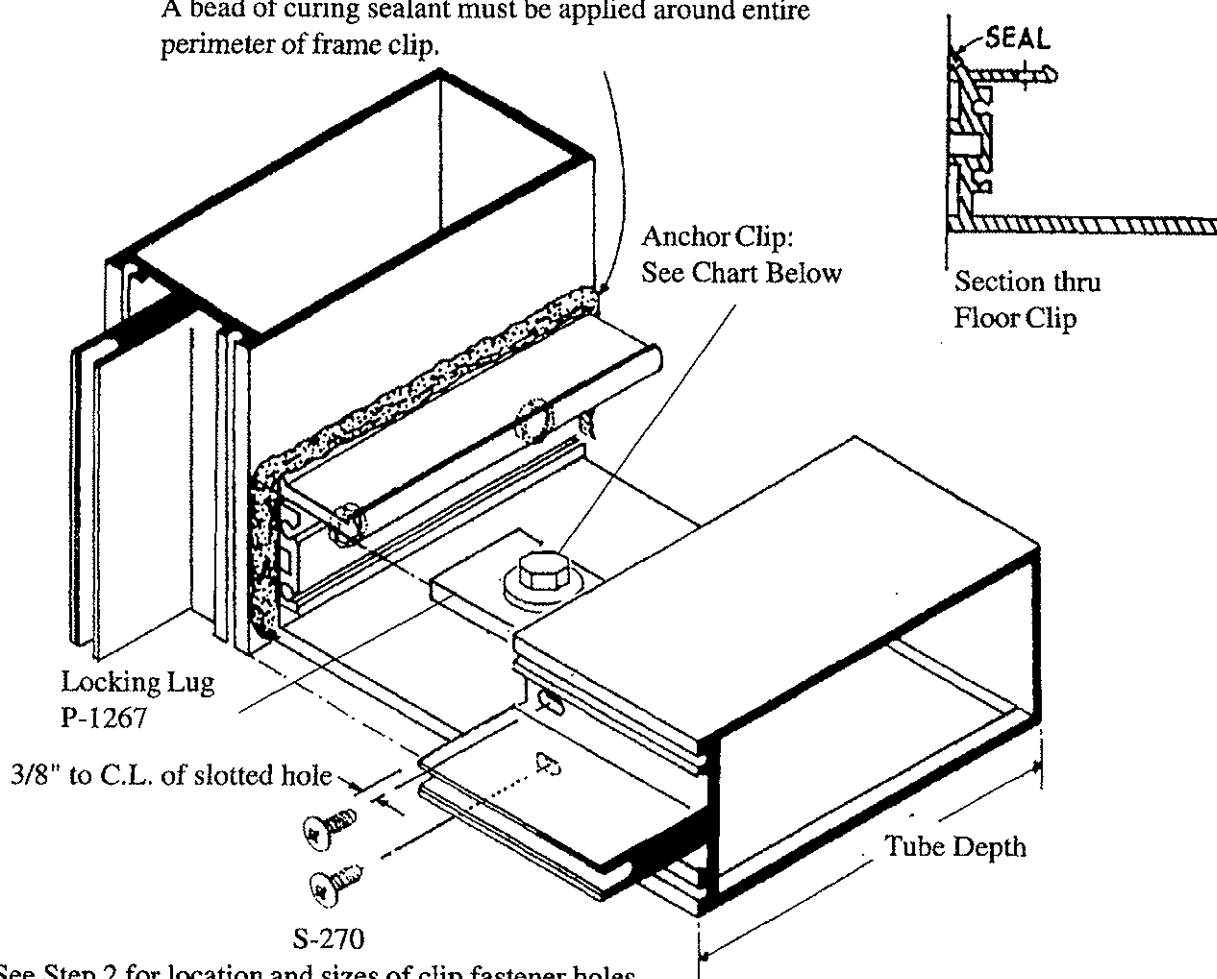
Step 8- Install Horizontal Snap Cover.

Make 1/4" x 1/2" weep slot in bottom edge of snap cover adjacent to each vertical member to allow adequate drainage of infiltrated water.



Optional Sill Anchor Clip.

A bead of curing sealant must be applied around entire perimeter of frame clip.



See Step 2 for location and sizes of clip fastener holes.

Clip C	Dim. A	Dim. B	Use With Extrusions	Glass	Tube Depth
P 1318 B	4.218"	.897"	E 1584. E 2297	1/4", 1"	6"
P 1318 C	2.250"	1.136"	E 0977. E 1025. E 2687	1/4", 1"	4 1/2"
P 1318	2.250"	.938"	E 2194	1/2"	4 1/8"
P 1318 A	2.250"	.886"	E 1199. E 1495. E 2639	1", 1/4", 1"	4"
P 1318 E	2.000"	.886"	E 1148	1"	3 3/4"
P 1318 F	1.875"	.886"	E 2053	1"	3 5/8"
P 1318 D	.750"	.886"	E 1046. E 1180	1"	2 1/2"
P 1318 G	1.125"	.574"	E 1216	1/4", 1"	2 1/4"
P 1318 H	.875"	.574"	E 1215	1"	2"

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