

ASTM F1642-12/GSA TS01 TEST REPORT

Report No.: D0345.03-119-12

Rendered to:

3M Company
St. Paul, Minnesota

PRODUCT TYPE: Fragment Retention Film on Single Pane Annealed Glass with 3M™
Impact Protection Profile

SERIES/MODEL: 3M™ Ultra S600, Safety and Security Film

SPECIFICATION: ASTM F1642-12, *Standard Test Method for Glazing and
Glazing Systems Subject to Airblast Loadings*

AND

GSA-TS01-2003, *US General Services Administration Standard Test Method for
Glazing and Window Systems Subject to Dynamic Overpressure Loadings*

This report contains in its entirety:

Cover Page: 1 page
Summary of Results: 1 page
Report Body: 8 pages
Test Facility: 1 page
Pressure-Time Plots: pages
Drawings: 6 pages

Test Completion Date: 09/04/2013
Report Date: 12/04/2013
Test Record Retention Date: 12/04/2017

Summary of Results

ASTM F2912-11 System Rating: Very Low Hazard (H3)

| Title | Summary of Results | | |
|---------------------------------|---------------------------|----------------|-----------------|
| | #1 | #2 | #3 |
| Test Specimen | | | |
| ASTM Hazard Rating | Very Low Hazard | Minimal Hazard | Very Low Hazard |
| GSA Performance Condition | 3a | 2 | 3a |
| Average Peak Reflected Pressure | 3.75 psi | 4.75 psi | 4.00 psi |
| Average Positive Phase Impulse | 26 psi-msec | 26 psi-msec | 28 psi-msec |
| Average Positive Phase Duration | 11.21 msec | 12.79 msec | 8.24 msec |

Reference must be made to Report No. D0345.03-119-12, dated 12/04/13 for complete test specimen description and detailed test results.

Report Issued To: 3M Renewable Energy Division
3M Center, Building 235, E-330-3D-02
St. Paul, Minnesota 55144

Test Laboratory: Architectural Testing, Inc.
130 Derry Court
York, Pennsylvania 17406
717-764-7700

1.0 Project Summary:

- 1.1 Product Type:** Fragment Retention Film on Single Pane Annealed Glass with 3M™ Impact Protection Profile
- 1.2 Series/Model:** 3M™ Ultra S600, Safety and Security Window Film
- 1.3 Compliance Statement:** 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 specimens tested. This report may not be reproduced, except in full, without the written approval of Architectural Testing, Inc.
- 1.4 Test Dates:** 09/03/2013 and 09/04/2013
- 1.5 Test Facility:** Architectural Testing, Inc.'s shock tube is housed in a 10,000 square foot state-of-the-art test facility located in York, Pennsylvania. Blast loadings are produced on the specimen to simulate the effects of a high explosive charge at a specified standoff distance. Shock waves are generated by the sudden rupturing of a thin aluminum membrane. The shock wave expands as it travels down the tube, and impacts the target with a specific positive pressure and impulse. A photograph of the shock tube is provided in Figure #1 of Appendix A.
- 1.6 Test Sample Source:** The test specimens were provided by the client. Representative samples of the test specimens will be retained by Architectural Testing for a minimum of four years from the test completion date.
- 1.7 Drawing Reference:** The test specimen drawings have been reviewed by Architectural Testing and are representative of the test specimens reported herein. Test specimen construction was verified by Architectural Testing per the drawings located in Appendix D. Any deviations are documented herein or on the drawings.

1.8 Data Acquisition: In accordance with ASTM F 1642-04 and GSA TS01, four reflective pressure transducers are utilized to record data at a 1MHz sample rate. Two reflective pressure transducers are located on the specimen holder at the top and right side (when viewed from the interior). A third pressure transducer is located on the shell to the exterior of the specimen, and a fourth is located in the witness chamber, directly to the interior of the specimen holder. A sketch of the specimen holder and corresponding reflective pressure sensor locations are provided in Figure #2 of Appendix A.

1.9 List of Official Observers:

| <u>Name</u> | <u>Company</u> |
|-------------------|------------------------------|
| Paul Neumann | 3M Renewable Energy Division |
| Joshua I. Scott | Architectural Testing, Inc. |
| Steven A. Neff | Architectural Testing, Inc. |
| Travis A. Hoover | Architectural Testing, Inc. |
| Joseph Reed, P.E. | Architectural Testing, Inc. |
| Emily C. Riley | 3M Renewable Energy Division |

2.0 Test Specifications:

ASTM F 1642-12, *Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loadings*

ASTM F 2912-11, *Standard Specification for Glazing and Glazing Systems Subject to Airblast Loadings*

GSA-TS01-2003, *US General Services Administration Standard Test Method for Glazing and Window Systems Subject to Dynamic Overpressure Loadings*

3.0 Test Specimen Description: The following descriptions apply to all specimens.

3.1 Product Sizes:

| Measured Dimensions | Width (inches) | Height (inches) |
|----------------------------|-----------------------|------------------------|
| Overall Size | 57 | 45 |
| Fixed Day Lite Opening | 53-1/2 | 41-1/2 |

3.0 Test Specimen Description: (Continued)

3.2 Frame Construction:

| Frame Member | Material | Description |
|----------------------|----------|--|
| Head, sill and jambs | Aluminum | Extruded |
| Glass Stop | Aluminum | Extruded. Snaps into place on sill frame member to secure the glazing. |

| | Joinery Type | Detail |
|-------------|--------------|---|
| All corners | Square Cut | Butted and secured using extruded aluminum shear blocks (Reference Drawing 3M window test fixture with IPA drawing detail D, P/N 45-101). |
| Jambs | N/A | The jambs were secured to each sill shear block using one #10 x 5/8" long Phillips flat head screw |
| Head | N/A | The head was secured to the each jamb shear block using one #10 x 5/8" long Phillips flat head screw |

3.3 Glazing Method: All specimens utilized 1/4" thick clear annealed glass with a 6 mil micro-layered, tear resistant safety and security film adhered to the interior surface of the glass. The glass was channel glazed and secured at the exterior sill using extruded aluminum glazing stops. The glass was set against a kerf-mounted rubber gasket with a 1/2" glazing bite. The glass was secured in place from the interior using a 3M™ Impact Protection Profile, flexible-mechanical rubber gasket (IPP) (Reference Drawing 3M Window Test Fixture, Detail J).

3.4 Hardware: No hardware was utilized.

3.5 Reinforcement: No reinforcement was utilized.

4.0 Installation: The specimens utilized steel "J" shaped anchor plates. Each anchor plate secured to the window frame using four M6 x 1.75 by 38mm long self-drilling TEK screws, extending through the anchor plate into the window frame. Each plate utilized two M12 x 1.75 by 45mm long bolts with flat plate washers, lock washers and nuts securing the anchor plate to the steel buck. Anchor plate bolts were located 2" from each side of the plate and 4" on center. The anchor plates at the sill and head were located 8" and 24" from the jambs. The anchor plates on the jambs were located 16" in from the head and sill.

5.0 Test Results: The results are tabulated as follows.

Test Specimen #1:

| Description | Results |
|-------------------------------------|------------------------|
| Ambient Temperature | 78 °F |
| Glazing Temperature | 78 °F |
| ASTM Hazard Rating | Very Low Hazard |
| GSA Performance Condition | 3a |
| Peak Positive Pressure | |
| Top Pressure | 3.81 psi |
| Right Pressure | 3.64 psi |
| Shell Pressure | 3.80 psi |
| Average Pressure | 3.75 psi |
| Witness Chamber Pressure | 0.22 psi |
| Peak Positive Phase Duration | |
| Top Duration | 13.09 msec |
| Right Duration | 12.36 msec |
| Shell Duration | 8.18 msec |
| Average Duration | 11.21 msec |
| Peak Positive Phase Impulse | |
| Top Impulse | 27 psi*msec |
| Right Impulse | 26 psi*msec |
| Shell Impulse | 26 psi*msec |
| Average Impulse | 26 psi*msec |
| Glazing Response | |
| Glazing Breakage | Fractured |
| Glazing Pullout Length and Location | None |
| Glazing Tearing | None |

| Witness Chamber Results |
|--|
| The glazing fractured but was fully retained in the frame. There was a small amount of glazing dust and shards found on the witness chamber floor. There were two fragment indents located at a height of 14" and 19" as well as a sliver perforation at a height of 10 in on the witness panel. |

Pressure-time plots are presented in Appendix B. Pre-test and post-test photographs are provided in Appendix C.

6.0 Test Results: (Continued)

Test Specimen #2:

| Description | Results |
|-------------------------------------|-----------------------------------|
| Ambient Temperature | 82 °F |
| Glazing Temperature | 82 °F |
| ASTM Hazard Rating | Minimal Hazard |
| GSA Performance Condition | 2 |
| Peak Positive Pressure | |
| Top Pressure | 4.74 psi |
| Right Pressure | 5.11 psi |
| Shell Pressure | 4.40 psi |
| Average Pressure | 4.75 psi |
| Witness Chamber Pressure | 0.22 psi |
| Peak Positive Phase Duration | |
| Top Duration | 12.14 msec |
| Right Duration | 13.39 msec |
| Shell Duration | 12.84 msec |
| Average Duration | 12.79 msec |
| Peak Positive Phase Impulse | |
| Top Impulse | 26 psi*msec |
| Right Impulse | 27 psi*msec |
| Shell Impulse | 26 psi*msec |
| Average Impulse | 26 psi*msec |
| Glazing Response | |
| Glazing Breakage | Fractured |
| Glazing Pullout Length and Location | 20 in total between head and sill |
| Glazing Tearing | 1 in on lower left corner |

| Witness Chamber Results |
|---|
| The glazing fractured but was fully retained in the frame. There were no fragments found on the witness chamber floor or the witness panel. |

Pressure time plots are presented in Appendix B. Pre-test and post-test photographs are provided in Appendix C.

7.0 Test Results: (Continued)

Test Specimen #3:

| Description | Results |
|-------------------------------------|------------------------------------|
| Ambient Temperature | 83 °F |
| Glazing Temperature | 84 °F |
| ASTM Hazard Rating | Very Low Hazard |
| GSA Performance Condition | 3a |
| Peak Positive Pressure | |
| Top Pressure | 4.09 psi |
| Right Pressure | 4.11 psi |
| Shell Pressure | 3.80 psi |
| Average Pressure | 4.00 psi |
| Witness Chamber Pressure | 0.28 psi |
| Peak Positive Phase Duration | |
| Top Duration | 7.13 msec |
| Right Duration | 7.17 msec |
| Shell Duration | 10.43 msec |
| Average Duration | 8.24 msec |
| Peak Positive Phase Impulse | |
| Top Impulse | 28 psi*msec |
| Right Impulse | 29 psi*msec |
| Shell Impulse | 28 psi*msec |
| Average Impulse | 28 psi*msec |
| Glazing Response | |
| Glazing Breakage | Fractured |
| Glazing Pullout Length and Location | 31 in along head, 36 in along sill |
| Glazing Tearing | 10 in at head |

| Witness Chamber Results |
|--|
| The glazing fractured but was retained in the frame. There were seven fragments found on the floor at 11-1/2, 14, 18, 56, 58, 68 and 74 in inside the witness chamber with no markings on the witness panel. |

Pressure time plots are presented in Appendix B. Pre-test and post-test photographs are provided in Appendix C.

The service life of this report will expire on the stated Test Record Retention End Date, at which time such materials as drawings, data sheets, samples of test specimens, copies of this report, and any other pertinent project documentation, shall be discarded without notice.

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.:

Emily C. Riley - Project Manager
Structural Systems Testing

Joseph A. Reed, P.E. - Director
Engineering

ECR:ecr/tah/jas

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

- Appendix A: Test Facility (1)
- Appendix B: Pressure Time Plots (6)
- Appendix C: Photographs (5)
- Appendix D: Drawings (6)

Revision Log

| <u>Rev. #</u> | <u>Date</u> | <u>Page(s)</u> | <u>Revision(s)</u> |
|---------------|-------------|----------------|-----------------------|
| 0 | 12/04/13 | N/A | Original report issue |



Test Report No.: D0345.03-119-19
Report Date: 12/04/13
Test Record Retention Date: 12/04/17

Appendix A

Test Facility



Figure #1
Shock Tube and Test Facility

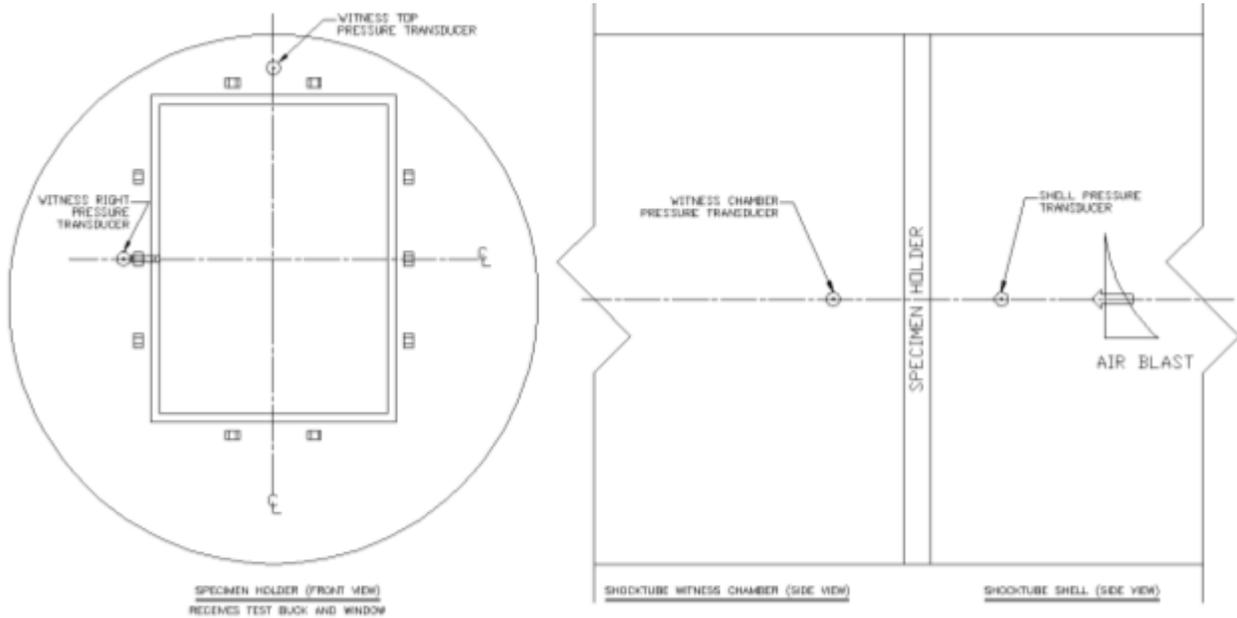
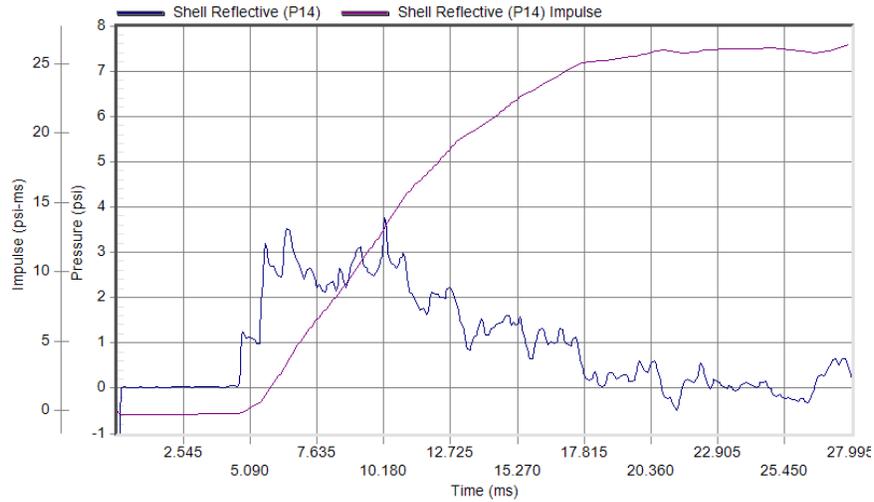


Figure #2
Pressure Sensor Locations

Appendix B

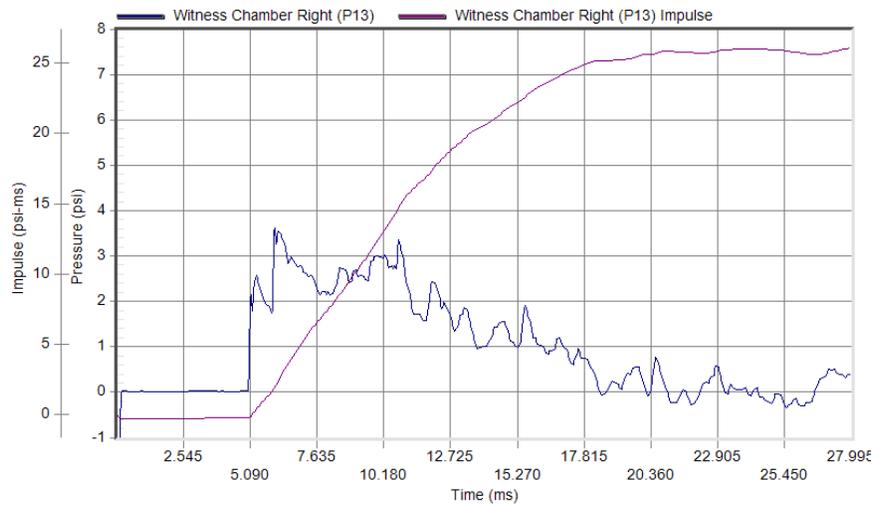
Pressure-Time Plots

Specimen #1



Peak Pressure: 3.80 psi at 10.23 ms
 Duration: 8.18 ms

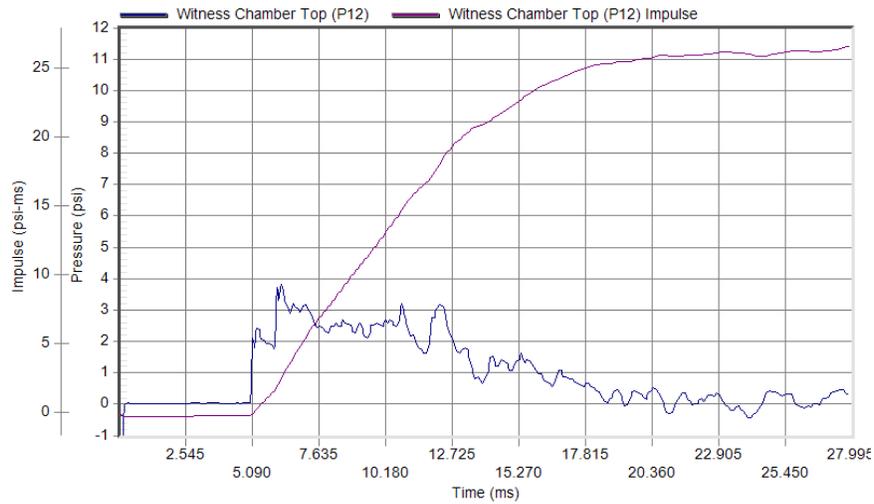
Test Date: 9/4/2013
 Test Time: 11:31 am



Peak Pressure: 3.64 psi at 6.03 ms
 Duration: 12.36 ms

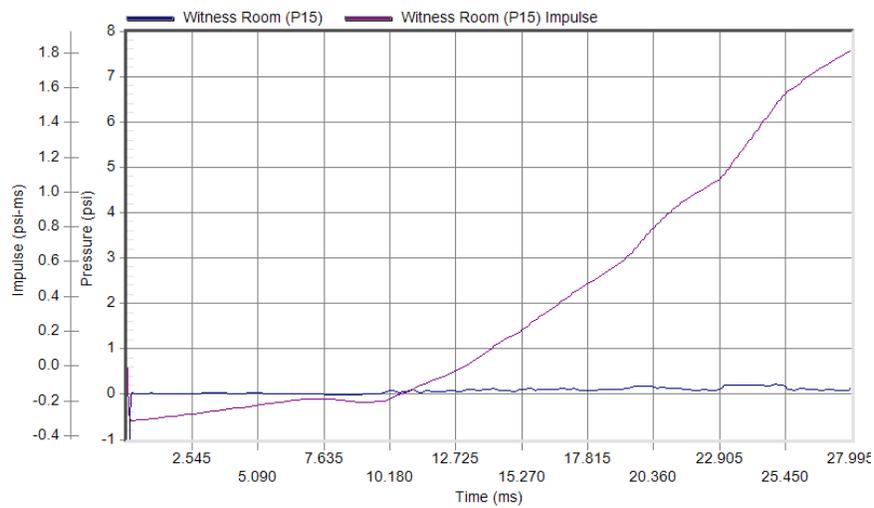
Test Date: 9/4/2013
 Test Time: 11:31 am

Specimen #1: (Continued)



Peak Pressure: 3.81 psi at 6.19 ms
 Duration: 13.09 ms

Test Date: 9/4/2013
 Test Time: 11:31 am

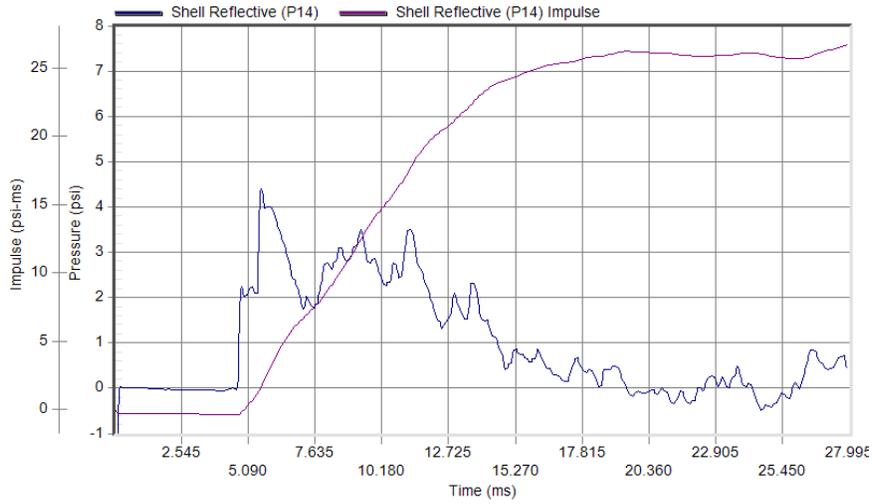


Peak Pressure: 0.22 psi at 25.10 ms
 Duration: 0.00 ms

Test Date: 9/4/2013
 Test Time: 11:31 am

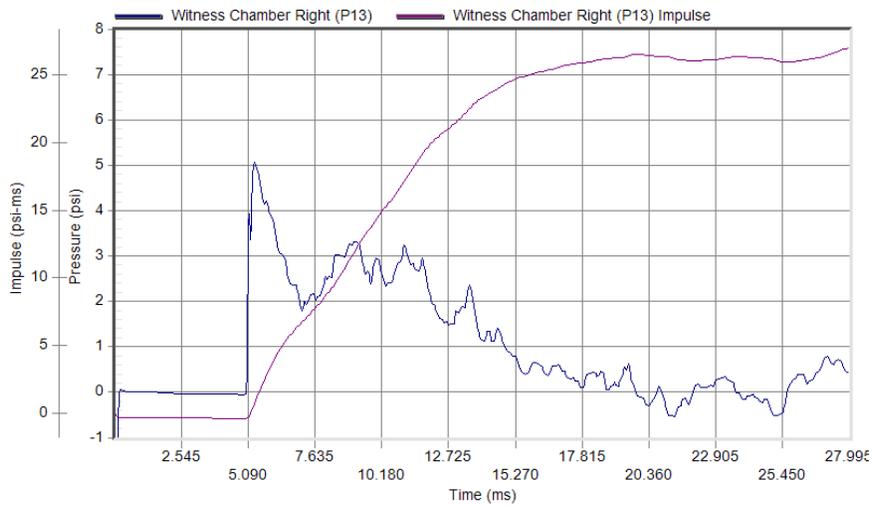


Specimen #2



Peak Pressure: 4.40 psi at 5.60 ms
Duration: 12.84 ms

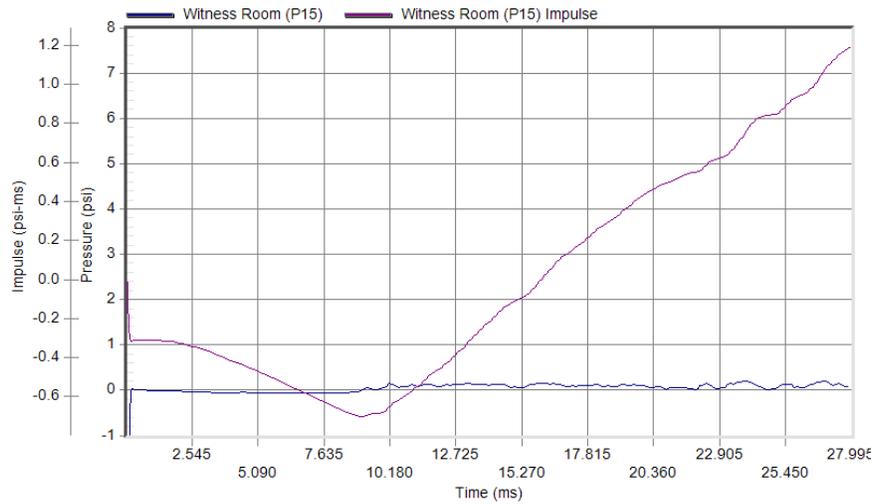
Test Date: 9/4/2013
Test Time: 2:31 pm



Peak Pressure: 5.11 psi at 5.35 ms
Duration: 13.39 ms

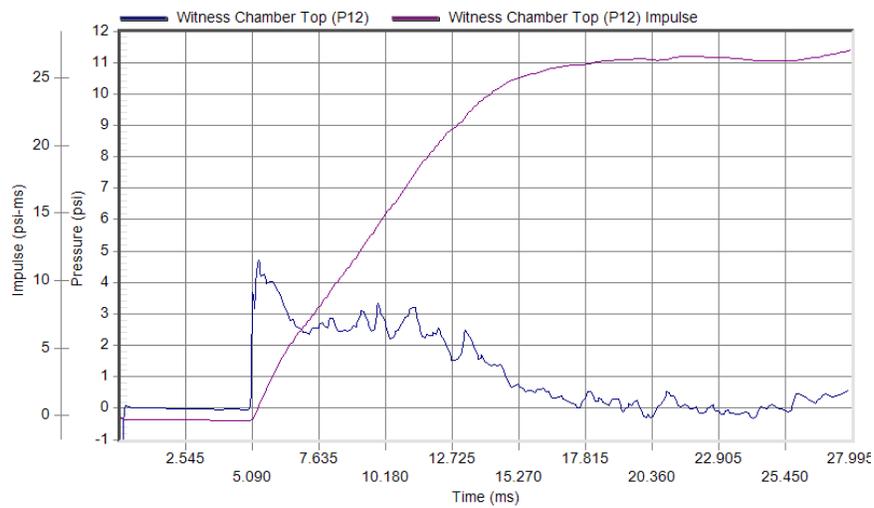
Test Date: 9/4/2013
Test Time: 2:31 pm

Specimen #2: (Continued)



Peak Pressure: 0.22 psi at 26.94 ms
 Duration: 0.00 ms

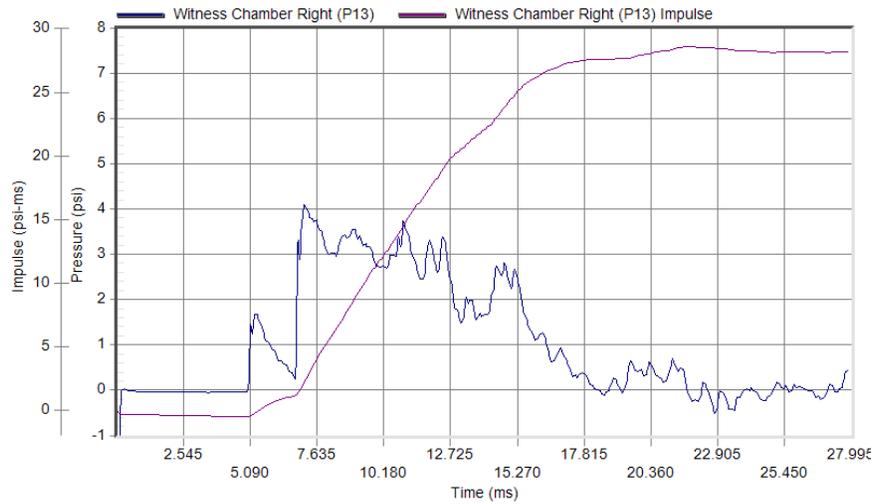
Test Date: 9/4/2013
 Test Time: 2:31 pm



Peak Pressure: 4.74 psi at 5.32 ms
 Duration: 12.14 ms

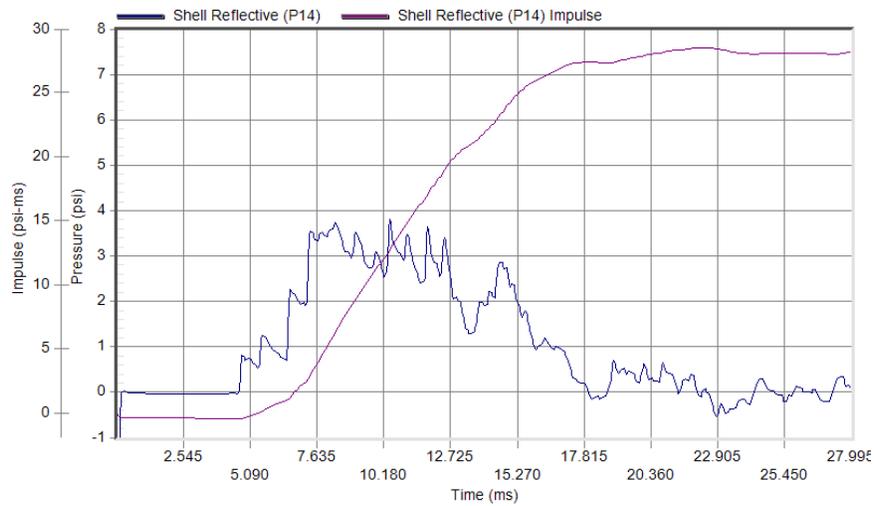
Test Date: 9/4/2013
 Test Time: 2:31 pm

Specimen #3



Peak Pressure: 4.11 psi at 7.17 ms
Duration: 11.05 ms

Test Date: 9/5/2013
Test Time: 4:21 pm

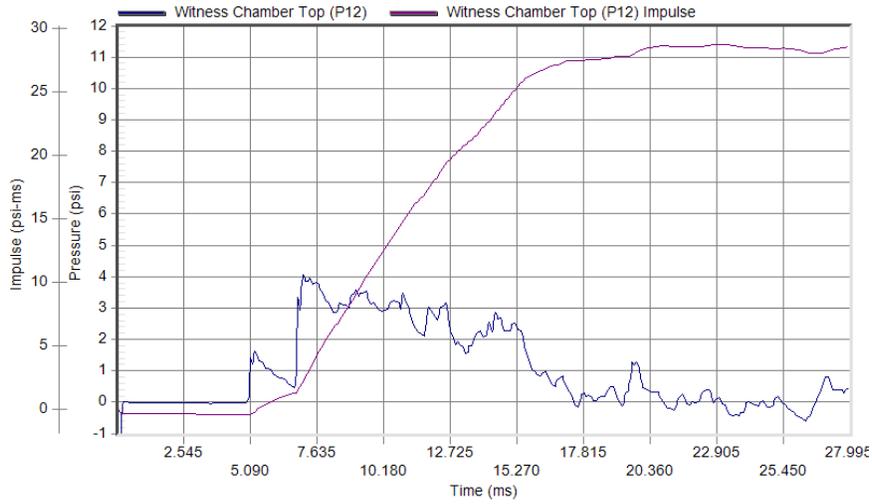


Peak Pressure: 3.80 psi at 10.43 ms
Duration: 7.53 ms

Test Date: 9/5/2013
Test Time: 4:21 pm

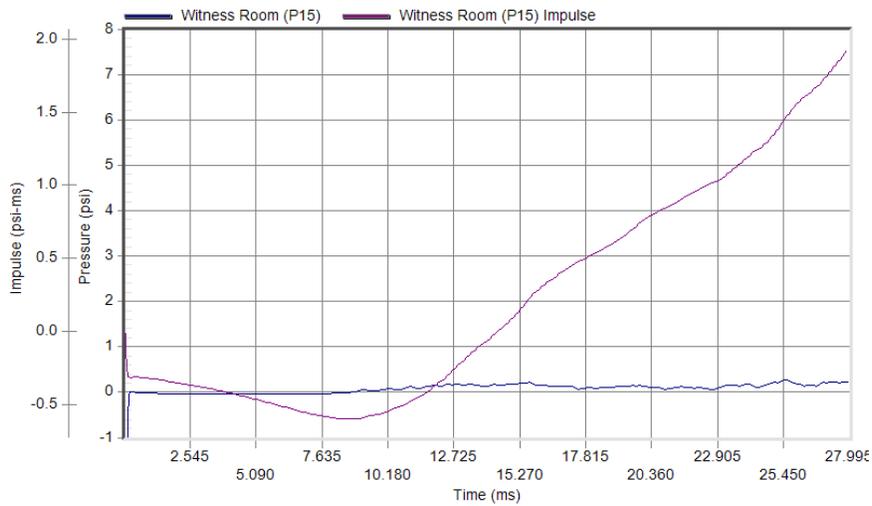


Specimen #3: (Continued)



Peak Pressure: 4.09 psi at 7.13 ms
Duration: 10.30 ms

Test Date: 9/5/2013
Test Time: 4:21 pm



Peak Pressure: 0.28 psi at 25.45 ms
Duration: 0.00 ms

Test Date: 9/5/2013
Test Time: 4:21 pm

Appendix C

Photographs



Photo No. 1
Pre-test Specimen #1, Interior



Photo No. 2
Post-test Specimen #1, Interior



Photo No. 3
Post-test Specimen #1, Witness Chamber



Photo No. 4
Pre-test Specimen #2, Interior



Photo No. 5
Post-test Specimen #2, Interior



Photo No. 6
Post-test Specimen #2, Witness Chamber



Photo No. 7
Pre-test Specimen #3, Interior



Photo No. 8
Post-test Specimen #3, Interior

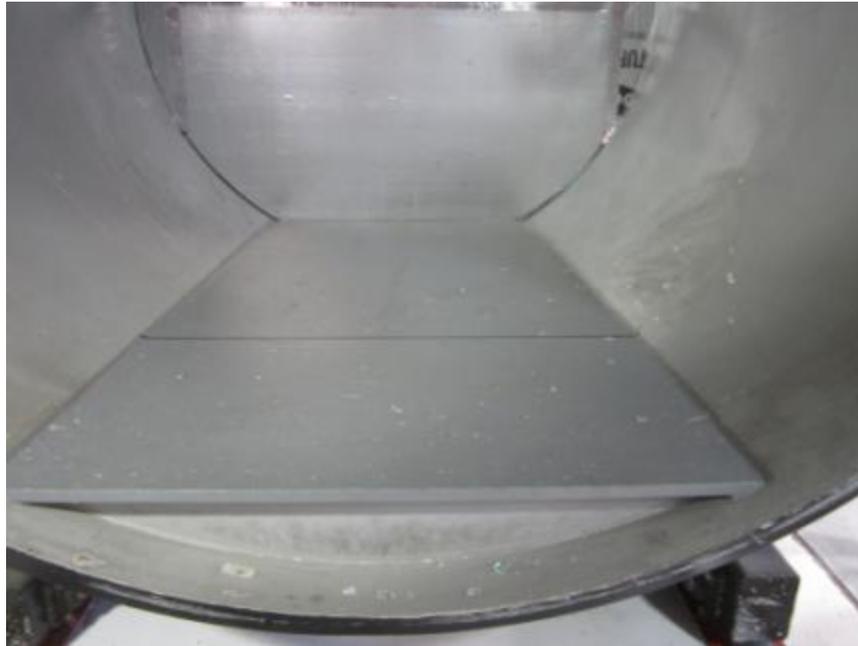


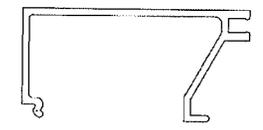
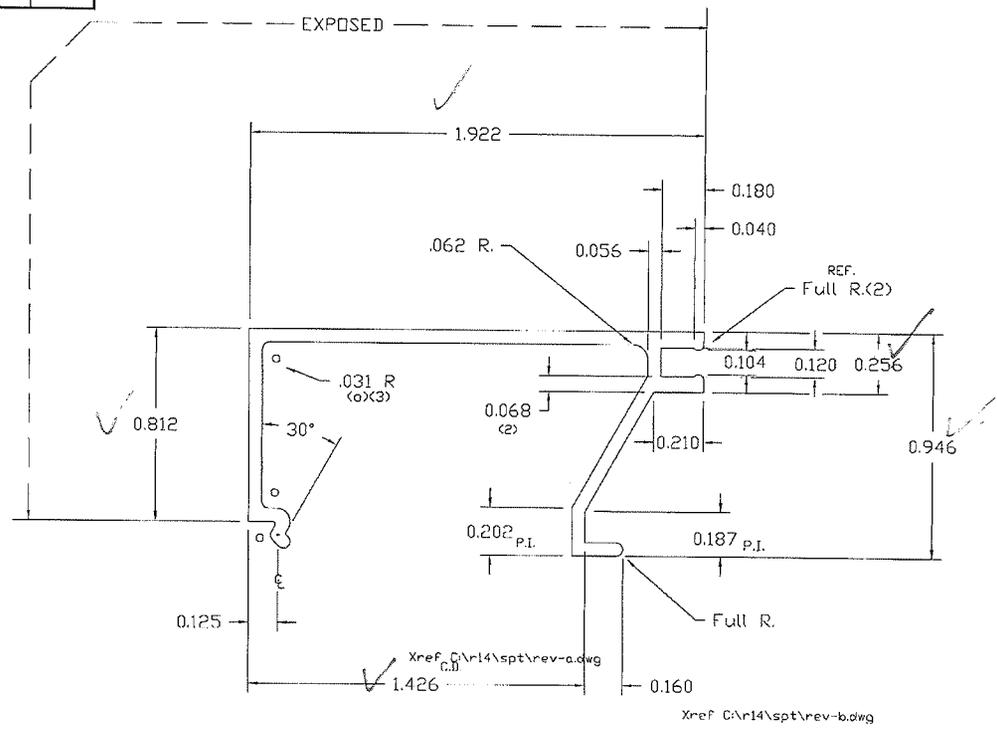
Photo No. 9
Post-test Specimen #3, Witness Chamber

Appendix D

Drawings

| PRINT REVISIONS | DATE |
|-----------------|------|
| | |
| | |
| | |
| | |

| | | |
|--------------------------|--------------------------|--------------------------|
| CRM-49 B | | |
| REL. | | |
| DELHI | TIFTON | BOTH |
| <input type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |



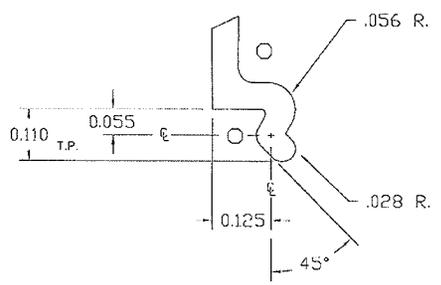
ACTUAL SIZE

Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report # D0345

Date 12/4/13 Tech SCR



DETAIL
4 x Size

BREAK UNSPECIFIED CORNERS .010 R. .056 TYPICAL WALL UNLESS SPECIFIED OTHERWISE.

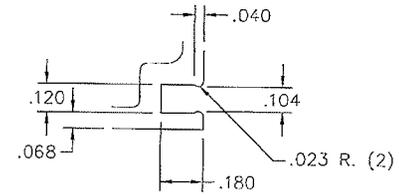
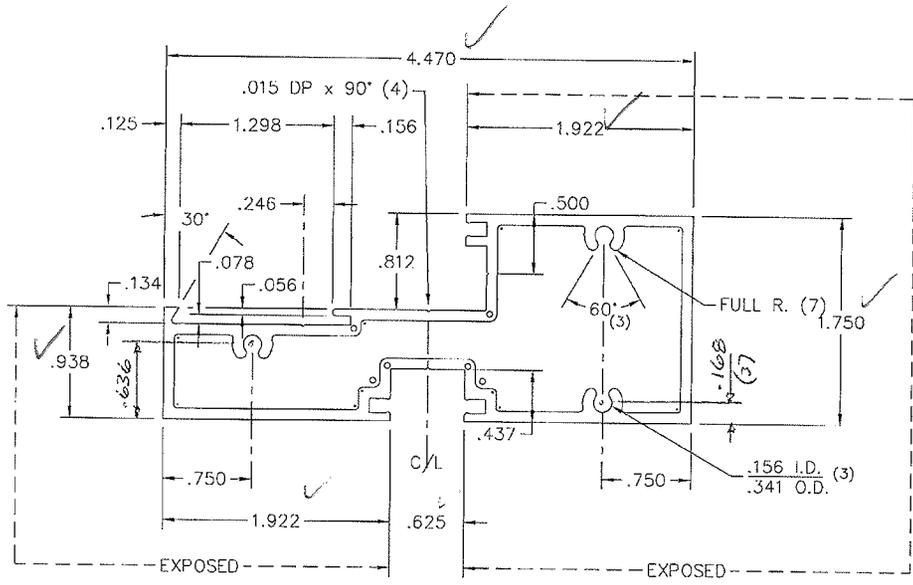
| ESTIMATED DIE DATA | |
|--------------------|---------|
| INTERNAL USE | 6063-T5 |
| AREA | .243 |
| PERIMETER | 8.478 |
| OUTSIDE PERIMETER | 2.734 |
| WT/FT | .291 |
| CIRCLE SIZE | 2-3 |
| FACTOR | .29 |

| | | |
|--------------|--|-----------------|
| sapa: | Sapa Extrusions, Inc. DELHI, LA 71232 | CADD # |
| | CUSTOMER | SCALE |
| | CUSTOMER | DATE |
| APPLICATION | MINNEAPOLIS, MN | LAST REVISION |
| | SILL STOP 1/4" TO 1" | DRAWN |
| | | J. ALBEREZ |
| | | JOB |
| | | CUSTOMER NUMBER |
| | | 45-026 |

| LEGEND | DIE REVISIONS | DATE |
|-------------|-----------------|---------|
| • = .031 R. | A RE-DESIGNED | 1-5-88 |
| o = .062 R. | B SHORTENED LEG | 2-13-89 |
| x = .125 R. | | |
| ⊗ = .250 R. | | |
| * = | | |

| PRINT REVISIONS | | DATE |
|-----------------|-------------------|---------|
| 1 | REDRAWN ON CAD MB | 7-30-98 |
| | | |
| | | |

| | | |
|-------------------------------------|--------------------------|--------------------------|
| CRM-44 | | |
| REV. | | |
| DELHI | TIFTON | BOTH |
| <input checked="" type="checkbox"/> | <input type="checkbox"/> | <input type="checkbox"/> |



DETAIL "A"
2 x SIZE

Architectural Testing
 Test sample complies with these details.
 Deviations are noted.
 Report # D0345
 Date 12/4/13 Tech CBR

BREAK UNSPECIFIED CORNERS .010 R. .090 TYPICAL WALL UNLESS SPECIFIED OTHERWISE.

| ESTIMATED DIE DATA | |
|--------------------|--------------------------|
| INTERNAL USE | 6063-T5 |
| AREA | 1.354 WT/FT 1.624 |
| PERIMETER | 29.721 CIRCLE SIZE 4 - 5 |
| OUTSIDE PERIMETER | 15.421 FACTOR 18 |
| EXPOSED PERIMETER | HOLLOW II |

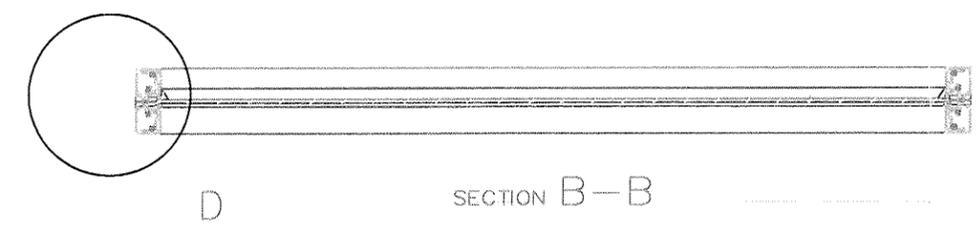
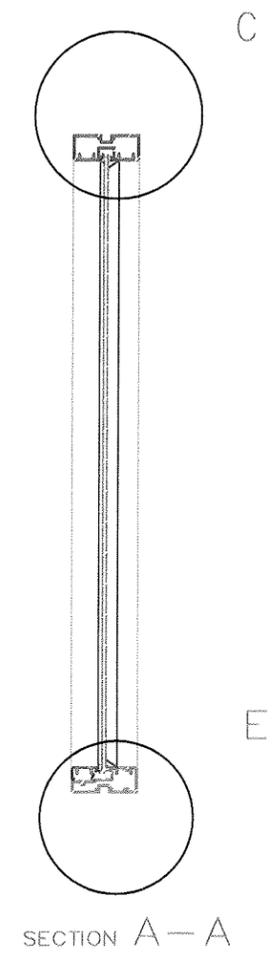
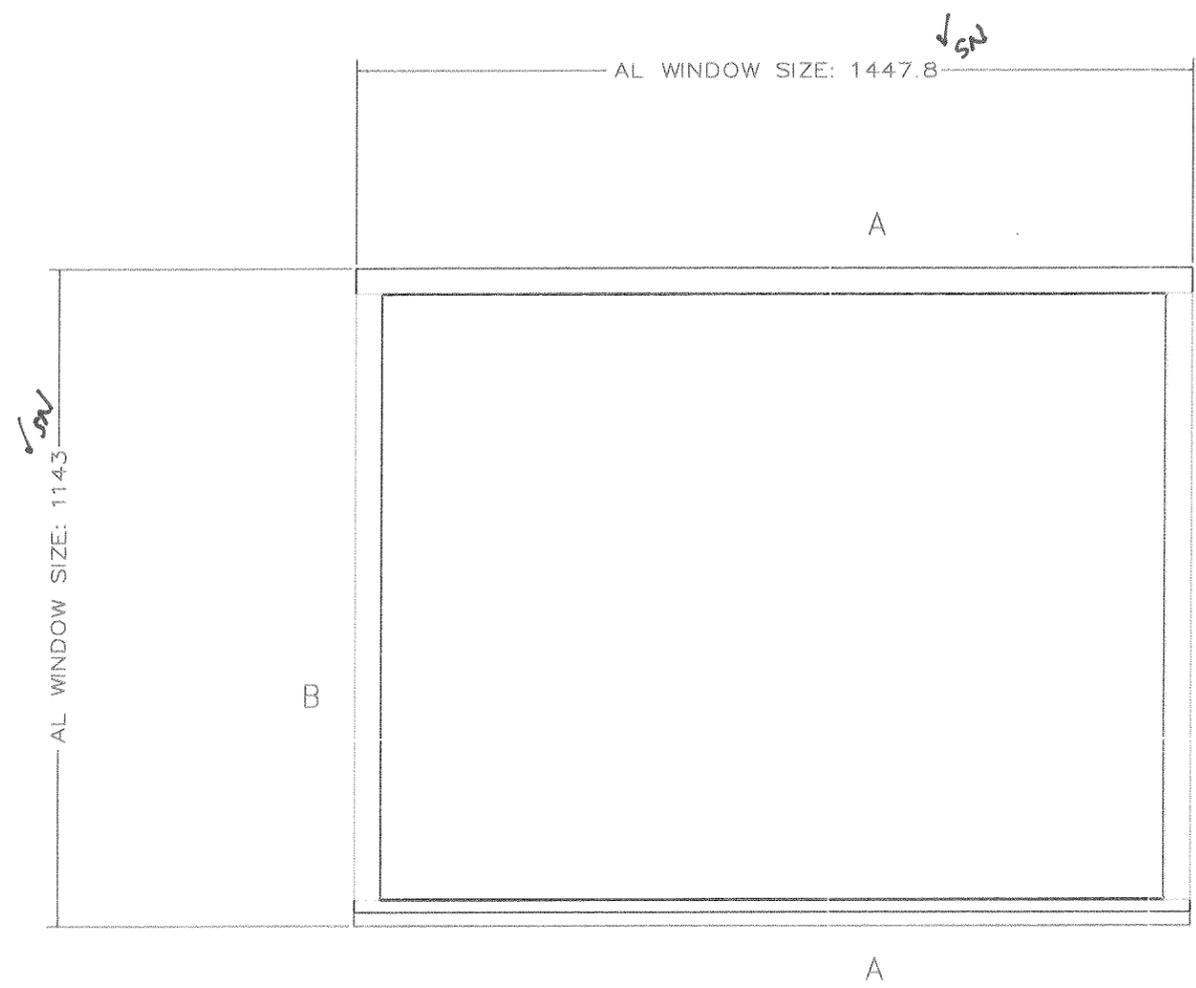
| PRESS SIZE | LEGEND |
|------------|-------------|
| | • = .031 R. |
| | ◦ = .062 R. |
| | x = .125 R. |
| | ⊗ = .250 R. |
| | * = |

| DIE REVISIONS | DATE |
|---------------|------|
| | |
| | |
| | |

sapa: Sapa Extrusions, Inc.
 DELHI, LA 71232
 CUSTOMER
CMI ARCHITECTURAL PRODUCTS
 2800 FREEWAY BOULEVARD
 SUITE 205
 MINNEAPOLIS, MN 55430

| | |
|-----------------|---------------|
| CADD # | CRM-44 350 |
| SCALE | FULL & NOTED |
| DATE | 7-29-98 |
| LAST REVISION | |
| DRAWN JOB | Michael Bryan |
| CUSTOMER NUMBER | 45-018 |

APPLICATION F.G. SILL 1/4"



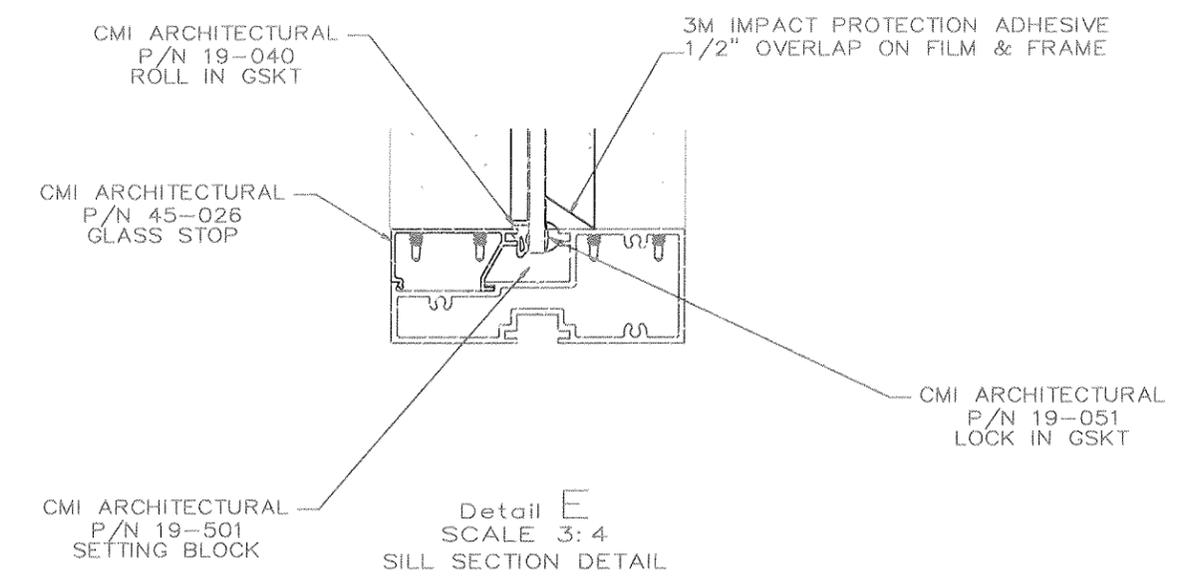
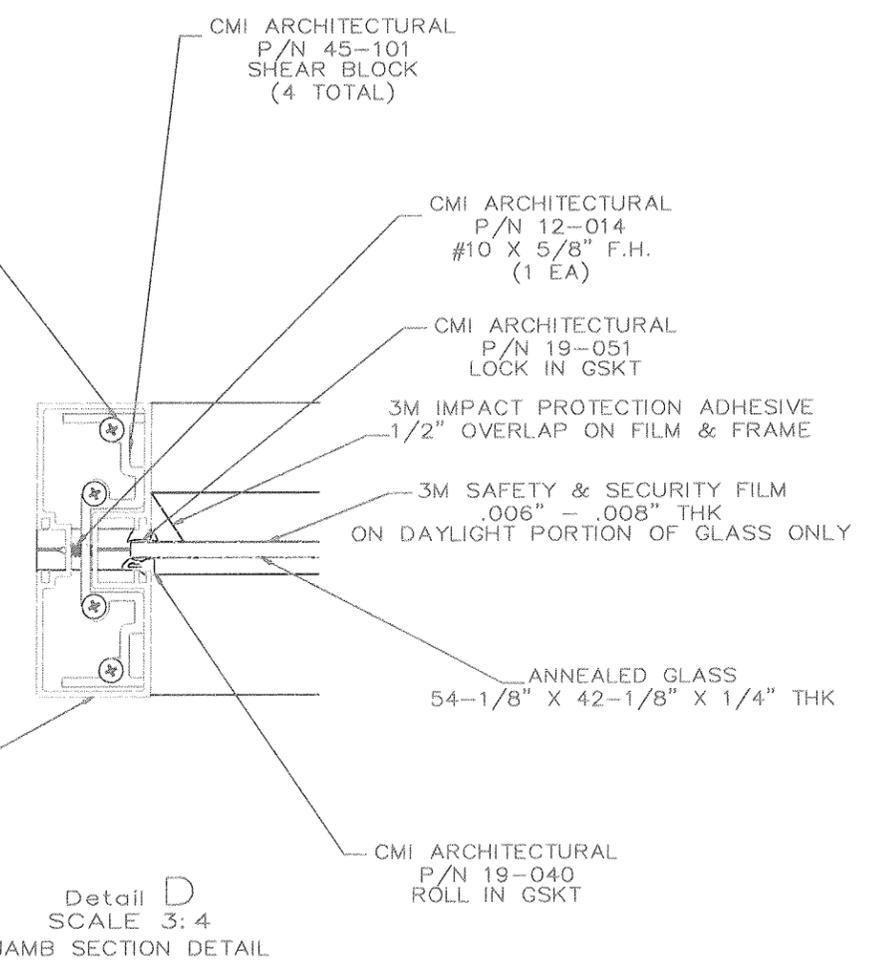
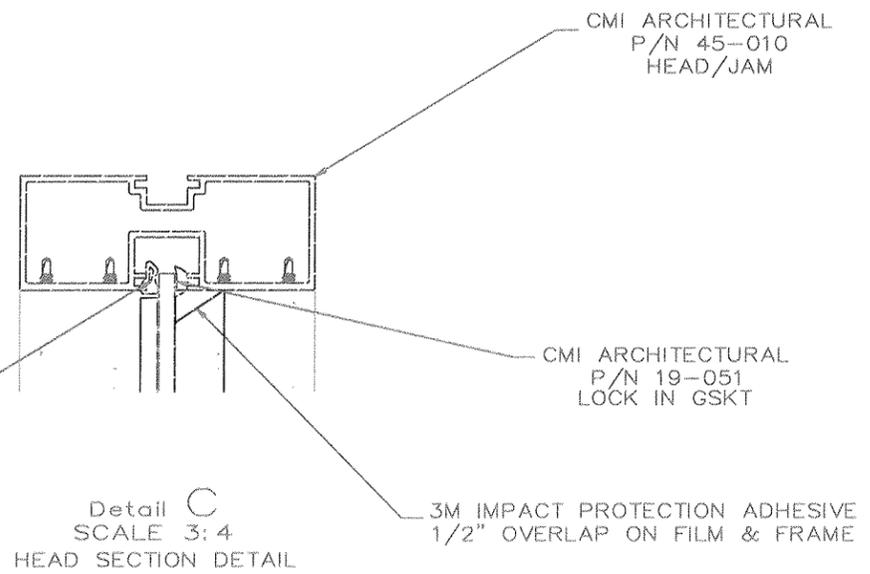
DLO: $53\frac{1}{2} \times 41\frac{1}{2}$

Architectural Testing
 Test sample complies with these details.
 Deviations are noted.
 Report # D0345
 Date 12/4/13 Tech SCZ

| | | | | | | | | |
|------------------------|--|---------------------------------|------|----------------------------|-----|------------------------------|------|------|
| DESIGN REFERENCE | | NEXT ASSEMBLY | | REV | ECO | ISSUE DATE AND DESCRIPTION | DRPT | GRVD |
| | | | | | | OCT 29, 2013 | | |
| DO NOT SCALE DRAWING | | SCALE | 1/8" | TOLERANCES EXCEPT AS NOTED | | 3M | | |
| THIRD ANGLE PROJECTION | | INTERPRET PER ASME Y14.5 - 1994 | | MAX SURFACE ROUGHNESS | | 3M WINDOW TEST FIXTURE W/IPA | | |
| 125 | | ALL SURFACES MARKED ONLY | | ANGLES 1% | | CAGE NUMBER <u>D</u> | | |
| | | | | | | DRAWING NO. <u>D</u> | | |
| | | | | | | REV. <u>A</u> | | |
| | | | | | | SHT 1 OF 3 | | |

8 7 6 5 4 3 2 1

D
C
B
A



Architectural Testing
 Test sample complies with these details.
 Deviations are noted.
 Report # D0345
 Date 12/4/13 Tech COJ

| | | | | | | |
|---------------------------|---------------------------------|---|-----|---|------------|------------|
| DESIGN REFERENCE | NEXT ASSEMBLY | REV | ECO | ISSUE DATE AND DESCRIPTION | DRFT | CHKD |
| | | | | OCT 29, 2013 | | |
| DO NOT SCALE DRAWING | SCALE 1/6 | TOLERANCES EXCEPT AS NOTED | | 3M This document and the information it contains are the property of 3M and may not be reproduced or further disseminated without the permission of 3M. All rights reserved. | | |
| THIRD ANGLE PROJECTION | INTERPRET PER ASME Y14.5 - 1994 | INCHES .015 .005 .0005 .0002 | | 3M WINDOW TEST FIXTURE W/IPA | | |
| MAX SURFACE ROUGHNESS 125 | ✓ | MILLIMETERS 0.125 0.05 0.025 0.0125 | | CAGE NUMBER | SIZE | DRAWING NO |
| REMARKED ONLY | ANGLES 1/2 | MODEL | | REV. A | SHT 2 OF 3 | |

8 7 6 5 4 3 2 1