

ASTM F1642-04 / GSA TS01 TEST REPORT

Rendered to:

3M Company - St. Paul, Minnesota

PRODUCT TYPE:

Fragment Retention Film on 1/4" Single Pane Glass

SERIES/MODEL:

3M™ Scotchshield™ Ultra S800 Safety and Security Window Film with

3M™ Impact Protection Profile Film Attachment System

or

3M™ Impact Protection Adhesive Film Attachment System

This report contains in its entirety:

Cover Page:	1 page
Summary of Results:	1 page
Report Body:	21 pages
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Pressure-Time Plots:	30 pages
Photographs:	30 pages
Drawings:	8 pages

Report No.: D8962.03-119-12

Test Completion Date: 09/10/14

Report Date: 10/30/14

Test Record Retention Date: 09/10/18

Summary of Results

Specimen No.	Glass Type	Film Attachment Type	Average Peak Reflected Pressure	Average Positive Phase Impulse	Average Positive Phase Duration	GSA Performance Condition	ASTM F1642 Hazard Rating	ASTM F2912-11 System Rating
1	1/4" Tempered	IPP	7.20 psi	45 psi-msec	13.51 msec	2	No Hazard	Minimal Hazard (H2)
2			6.94 psi	44 psi-msec	13.05 msec	2	No Hazard	
3			6.83 psi	43 psi-msec	12.97 msec	2	Minimal Hazard	
4			6.91 psi	42 psi-msec	12.36 msec	2	Minimal Hazard	
5		IPA	6.97 psi	41 psi-msec	12.13 msec	2	No Hazard	No Hazard (H1)
6			6.55 psi	43 psi-msec	13.15 msec	2	No Hazard	
7			7.27 psi	44 psi-msec	13.21 msec	2	No Hazard	
8			9.47 psi	63 psi-msec	15.16 msec	2	No Hazard	
9	1/4" Annealed	IPP	7.03 psi	44 psi-msec	12.72 msec	3a	Minimal Hazard	Minimal Hazard (H2)
10			6.69 psi	43 psi-msec	12.02 msec	2	Minimal Hazard	
11			6.51 psi	42 psi-msec	13.37 msec	2	No Hazard	
12		IPA	7.04 psi	43 psi-msec	12.01 msec	2	Minimal Hazard	Minimal Hazard (H2)
13			6.43 psi	42 psi-msec	12.93 msec	2	No Hazard	
14			6.85 psi	44 psi-msec	13.05 msec	2	Minimal Hazard	
15			9.31	60 psi-msec	15.81 msec	2	Minimal Hazard	

Reference must be made to Report No. D8962.03-119-12, dated 10/30/14 for complete test specimen description and detailed test results.

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

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

3.0 Project Summary:

3.1 Product Type: Fragment Retention Film on 1/4" Single Pane Glass

3.2 Series/Model: 3M™ Scotchshield™ Ultra S800 Safety and Security Window Film with 3M™ Impact Protection Profile or 3M™ Impact Protection Adhesive

3.3 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.

3.4 Test Dates: 06/23/2014 - 09/10/2014

3.5 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.

3.6 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.

3.7 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.

3.8 Data Acquisition: In accordance with ASTM F1642-04 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.

3.9 List of Official Observers:

<u>Name</u>	<u>Company</u>
Josh Scott	Architectural Testing, Inc.
Isaiah W. Gebhart	Architectural Testing, Inc.
Steven A. Neff	Architectural Testing, Inc.
Travis A. Hoover	Architectural Testing, Inc.
Joseph A. Reed, P.E.	Architectural Testing, Inc.
Emily C. Riley	Architectural Testing, Inc.

4.0 Test Specifications:

ASTM F1642-04, Standard Test Method for Glazing and Glazing Systems Subject to Airblast Loading

ASTM F2912-11, 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

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

5.1 Product Sizes: same as .01 except:

Measured Dimensions	Width (inches)	Height (inches)
Overall size	39-1/2	51-1/2
Fixed Day Lite Opening	36	48

5.2 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 shear block at the sill end using four #10 x 2" long Phillips self-tapping pan head screws and were secured to each shear block at the head end using one #10 x 5/8" long Phillips flat head screw
Head	N/A	The head was secured to the shear blocks at each end using four #10 x 2" long Phillips self-tapping pan head screws
Sill	N/A	The sill was secured to the shear blocks at each end using one #10 x 5/8" Phillips flat head screws

5.0 Test Specimen Description: (Continued)

5.3 Glazing:

Glazing Method: All specimens utilized 1/4" thick clear glass with an 8 mil micro-layered 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 filmed glass was anchored to the interior side of the frame using either 3M™ Impact Protection Profile (IPP), a flexible-mechanical rubber gasket type film attachment (Reference Drawing Test-39.5x51.5-Ultra, Details C, D and E), or a continuous bead of 3M™ Impact Protection Adhesive (IPA) a structural sealant wet glaze style film attachment (Reference Drawing Assy_Window_C, Details C, D and E).

Test Specimen	Glazing Method	Glass Type
1	IPP	Tempered
2		
3		
4		
5	IPA	
6		
7		
8		
9	IPP	Annealed
10		
11		
12	IPA	
13		
14		
15		

5.4 Hardware: No hardware was utilized.

5.5 Reinforcement: No reinforcement was utilized.

6.0 Installation: The specimens were placed directly into the shock tube test frame.

7.0 Test Results: The results are tabulated as follows

Test Specimen #1:

Description	Results
Ambient Temperature	80°F
Glazing Temperature	80°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	7.41 psi
Right Pressure	7.65 psi
Shell Pressure	6.53 psi
Average Pressure	7.20 psi
Witness Chamber Pressure	0.34 psi

Peak Positive Phase Duration	
Top Duration	13.51 msec
Right Duration	13.76 msec
Shell Duration	13.27 msec
Average Duration	13.51 msec

Peak Positive Phase Impulse	
Top Impulse	45 psi*msec
Right Impulse	45 psi*msec
Shell Impulse	45 psi*msec
Average Impulse	45 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results
A dusting of glass was deposited on the witness chamber floor.

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 #2:

Description	Results
Ambient Temperature	81°F
Glazing Temperature	83°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	7.15 psi
Right Pressure	7.30 psi
Shell Pressure	6.36 psi
Average Pressure	6.94 psi
Witness Chamber Pressure	0.57 psi

Peak Positive Phase Duration	
Top Duration	12.33 msec
Right Duration	13.51 msec
Shell Duration	13.32 msec
Average Duration	13.05 msec

Peak Positive Phase Impulse	
Top Impulse	44 psi*msec
Right Impulse	44 psi*msec
Shell Impulse	43 psi*msec
Average Impulse	44 psi*msec

Glazing Response	
Exterior Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results
No debris was observed.

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	78°F
Glazing Temperature	76°F
ASTM Hazard Rating	Minimal Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	7.00 psi
Right Pressure	7.19 psi
Shell Pressure	6.29 psi
Average Pressure	6.83 psi
Witness Chamber Pressure	0.39 psi

Peak Positive Phase Duration	
Top Duration	12.48 msec
Right Duration	13.10 msec
Shell Duration	13.34 msec
Average Duration	12.97 msec

Peak Positive Phase Impulse	
Top Impulse	43 psi*msec
Right Impulse	43 psi*msec
Shell Impulse	43 psi*msec
Average Impulse	43 psi*msec

Glazing Response	
Exterior Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	1-1/2" at upper end of jamb

Witness Chamber Results	
A dusting of glass was deposited on the witness chamber floor.	

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 #4:

Description	Results
Ambient Temperature	82°F
Glazing Temperature	82°F
ASTM Hazard Rating	Minimal Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	7.10 psi
Right Pressure	7.33 psi
Shell Pressure	6.30 psi
Average Pressure	6.91 psi
Witness Chamber Pressure	0.27 psi

Peak Positive Phase Duration	
Top Duration	12.32 msec
Right Duration	12.58 msec
Shell Duration	12.18 msec
Average Duration	12.36 msec

Peak Positive Phase Impulse	
Top Impulse	42 psi*msec
Right Impulse	42 psi*msec
Shell Impulse	42 psi*msec
Average Impulse	42 psi*msec

Glazing Response	
Exterior Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results
No debris was observed.

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 #5:

Description	Results
Ambient Temperature	82°F
Glazing Temperature	82°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	7.14 psi
Right Pressure	7.27 psi
Shell Pressure	6.50 psi
Average Pressure	6.97 psi
Witness Chamber Pressure	0.25 psi

Peak Positive Phase Duration	
Top Duration	12.75 msec
Right Duration	13.40 msec
Shell Duration	10.24 msec
Average Duration	12.13 msec

Peak Positive Phase Impulse	
Top Impulse	42 psi*msec
Right Impulse	41 psi*msec
Shell Impulse	41 psi*msec
Average Impulse	41 psi*msec

Glazing Response	
Exterior Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results
No debris was observed.

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 #6:

Description	Results
Ambient Temperature	81°F
Glazing Temperature	82°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	6.43 psi
Right Pressure	6.80 psi
Shell Pressure	6.42 psi
Average Pressure	6.55 psi
Witness Chamber Pressure	0.33 psi

Peak Positive Phase Duration	
Top Duration	12.86 msec
Right Duration	13.47 msec
Shell Duration	13.11 msec
Average Duration	13.15 msec

Peak Positive Phase Impulse	
Top Impulse	43 psi*msec
Right Impulse	43 psi*msec
Shell Impulse	43 psi*msec
Average Impulse	43 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results
No debris was observed.

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 #7:

Description	Results
Ambient Temperature	78°F
Glazing Temperature	77°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	7.32 psi
Right Pressure	7.82 psi
Shell Pressure	6.66 psi
Average Pressure	7.27 psi
Witness Chamber Pressure	0.31 psi

Peak Positive Phase Duration	
Top Duration	13.21 msec
Right Duration	13.37 msec
Shell Duration	13.04 msec
Average Duration	13.21 msec

Peak Positive Phase Impulse	
Top Impulse	45 psi*msec
Right Impulse	44 psi*msec
Shell Impulse	44 psi*msec
Average Impulse	44 psi*msec

Glazing Response	
Exterior Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results
No debris was observed.

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 #8:

Description	Results
Ambient Temperature	79°F
Glazing Temperature	78°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	9.82 psi
Right Pressure	9.82 psi
Shell Pressure	8.76 psi
Average Pressure	9.47 psi
Witness Chamber Pressure	0.41 psi

Peak Positive Phase Duration	
Top Duration	16.48 msec
Right Duration	14.55 msec
Shell Duration	14.46 msec
Average Duration	15.16 msec

Peak Positive Phase Impulse	
Top Impulse	63 psi*msec
Right Impulse	63 psi*msec
Shell Impulse	62 psi*msec
Average Impulse	63 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results	
No debris was observed.	

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 #9:

Description	Results
Ambient Temperature	79°F
Glazing Temperature	79°F
ASTM Hazard Rating	Minimal Hazard
GSA Performance Condition	3a

Peak Positive Pressure	
Top Pressure	7.15 psi
Right Pressure	7.35 psi
Shell Pressure	6.59 psi
Average Pressure	7.03 psi
Witness Chamber Pressure	0.29 psi

Peak Positive Phase Duration	
Top Duration	13.60 msec
Right Duration	14.19 msec
Shell Duration	10.36 msec
Average Duration	12.72 msec

Peak Positive Phase Impulse	
Top Impulse	44 psi*msec
Right Impulse	44 psi*msec
Shell Impulse	45 psi*msec
Average Impulse	44 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	23" along jamb
Glazing Tearing	2" along jamb

Witness Chamber Results
Several fragments (sum united dimensions totaling < 10 inches) found on witness chamber floor between the 1m and 3m mark.

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 #10:

Description	Results
Ambient Temperature	84°F
Glazing Temperature	84°F
ASTM Hazard Rating	Minimal Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	6.93 psi
Right Pressure	6.91 psi
Shell Pressure	6.24 psi
Average Pressure	6.69 psi
Witness Chamber Pressure	0.34 psi

Peak Positive Phase Duration	
Top Duration	12.42 msec
Right Duration	13.37 msec
Shell Duration	10.27 msec
Average Duration	12.02 msec

Peak Positive Phase Impulse	
Top Impulse	43 psi*msec
Right Impulse	43 psi*msec
Shell Impulse	43 psi*msec
Average Impulse	43 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	1/2" at sill corner

Witness Chamber Results	
No debris was observed.	

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 #11:

Description	Results
Ambient Temperature	84°F
Glazing Temperature	83°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	6.53 psi
Right Pressure	6.79 psi
Shell Pressure	6.20 psi
Average Pressure	6.51 psi
Witness Chamber Pressure	0.33 psi

Peak Positive Phase Duration	
Top Duration	13.14 msec
Right Duration	13.45 msec
Shell Duration	13.53 msec
Average Duration	13.37 msec

Peak Positive Phase Impulse	
Top Impulse	42 psi*msec
Right Impulse	42 psi*msec
Shell Impulse	42 psi*msec
Average Impulse	42 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results
A dusting of glass was deposited on the witness chamber floor.

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 #12:

Description	Results
Ambient Temperature	85°F
Glazing Temperature	86°F
ASTM Hazard Rating	Minimal Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	7.24 psi
Right Pressure	7.39 psi
Shell Pressure	6.48 psi
Average Pressure	7.04 psi
Witness Chamber Pressure	0.65 psi

Peak Positive Phase Duration	
Top Duration	12.31 msec
Right Duration	13.64 msec
Shell Duration	10.08 msec
Average Duration	12.01 msec

Peak Positive Phase Impulse	
Top Impulse	42 psi*msec
Right Impulse	43 psi*msec
Shell Impulse	43 psi*msec
Average Impulse	43 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	9/16" at upper left corner

Witness Chamber Results	
A dusting of glass was deposited on the witness chamber floor.	

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 #13:

Description	Results
Ambient Temperature	82°F
Glazing Temperature	82°F
ASTM Hazard Rating	No Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	6.58 psi
Right Pressure	6.34 psi
Shell Pressure	6.35 psi
Average Pressure	6.43 psi
Witness Chamber Pressure	0.30 psi

Peak Positive Phase Duration	
Top Duration	12.54 msec
Right Duration	13.00 msec
Shell Duration	13.25 msec
Average Duration	12.93 msec

Peak Positive Phase Impulse	
Top Impulse	42 psi*msec
Right Impulse	42 psi*msec
Shell Impulse	42 psi*msec
Average Impulse	42 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	None

Witness Chamber Results	
No debris was observed.	

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 #14:

Description	Results
Ambient Temperature	80°F
Glazing Temperature	78°F
ASTM Hazard Rating	Minimal Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	6.98 psi
Right Pressure	7.27 psi
Shell Pressure	6.31 psi
Average Pressure	6.85 psi
Witness Chamber Pressure	0.27 psi

Peak Positive Phase Duration	
Top Duration	12.53 msec
Right Duration	13.27 msec
Shell Duration	13.34 msec
Average Duration	13.05 msec

Peak Positive Phase Impulse	
Top Impulse	44 psi*msec
Right Impulse	44 psi*msec
Shell Impulse	44 psi*msec
Average Impulse	44 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	2"

Witness Chamber Results	
No debris was observed.	

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 #15:

Description	Results
Ambient Temperature	82°F
Glazing Temperature	82°F
ASTM Hazard Rating	Minimal Hazard
GSA Performance Condition	2

Peak Positive Pressure	
Top Pressure	9.65 psi
Right Pressure	9.62 psi
Shell Pressure	8.66 psi
Average Pressure	9.31 psi
Witness Chamber Pressure	0.41 psi

Peak Positive Phase Duration	
Top Duration	17.68 msec
Right Duration	13.60 msec
Shell Duration	16.15 msec
Average Duration	15.81 msec

Peak Positive Phase Impulse	
Top Impulse	61 psi*msec
Right Impulse	60 psi*msec
Shell Impulse	60 psi*msec
Average Impulse	60 psi*msec

Glazing Response	
Lite	Fractured
Glazing Pullout Length and Location	None
Glazing Tearing	1/2"

Witness Chamber Results	
A dusting of glass was deposited on the witness chamber floor.	

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

Architectural Testing will service this report for the entire test record retention period. Test records that are retained such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be retained by Architectural Testing, Inc. for the entire test record retention period.

Results obtained are tested values and were secured 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.

For ARCHITECTURAL TESTING, INC.:

Emily C. Riley - Project Manager
Structural Systems Testing

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

ECR:jar/jas

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

- Appendix A: Test Facility (1)
- Appendix B: Pressure Time Plots (30)
- Appendix C: Photographs (30)
- Appendix D: Drawings (8)

Revision Log

<u>Rev. #</u>	<u>Date</u>	<u>Page(s)</u>	<u>Revision(s)</u>
0	10/30/14	N/A	Original report issue

APPENDIX A

Test Facility



Figure #1
Shock Tube and Test Facility

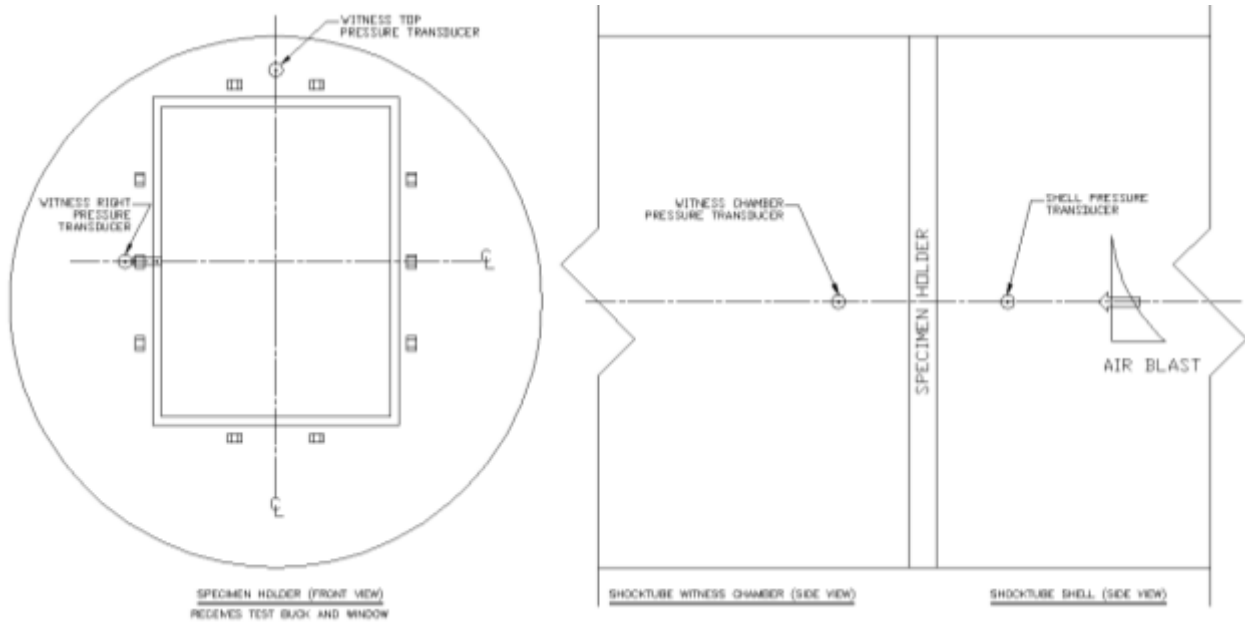


Figure #2
Pressure Sensor Locations

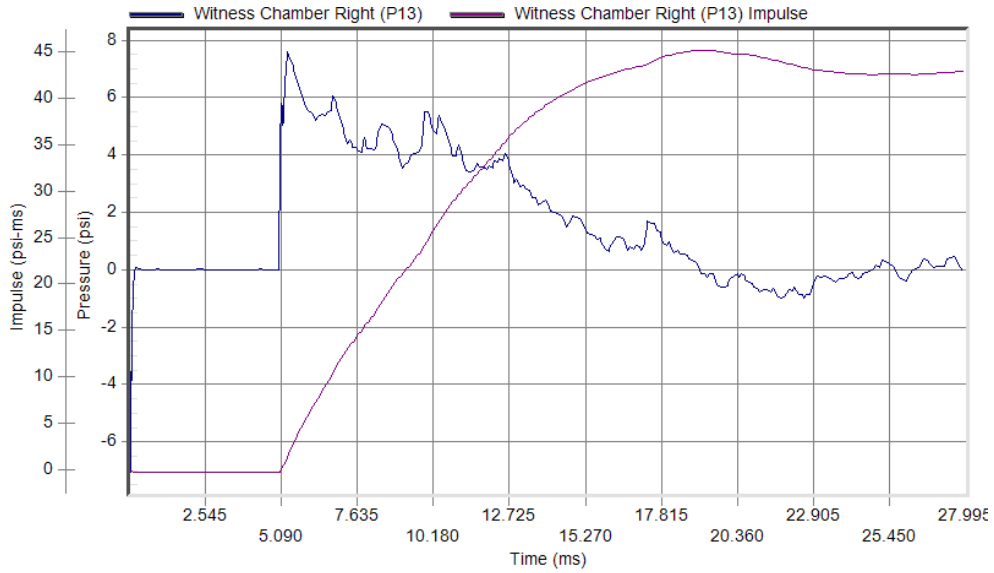


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APPENDIX B

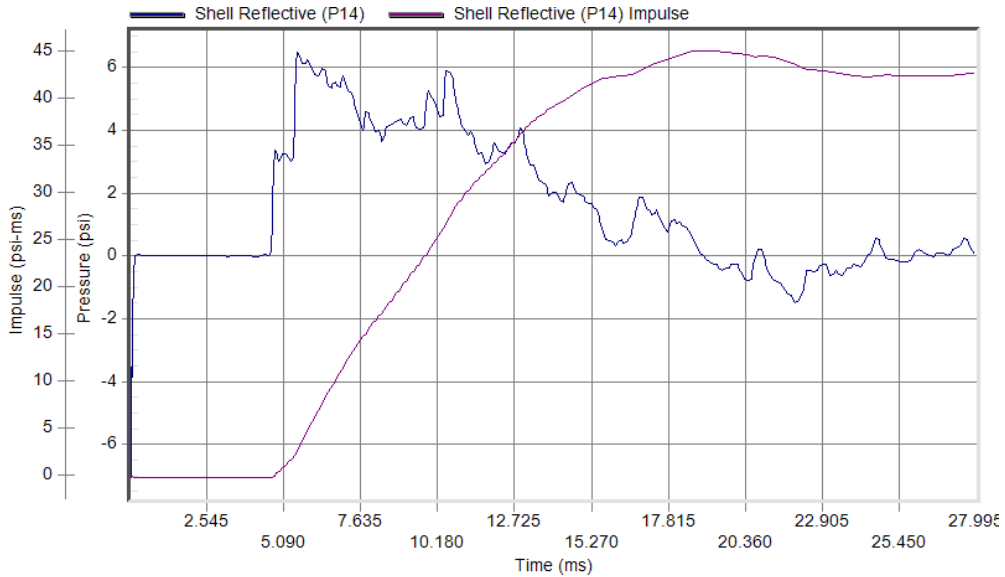
Pressure Time Plots

Specimen #1



Peak Pressure: 7.65 psi at 5.32 ms
Duration: 13.76 ms

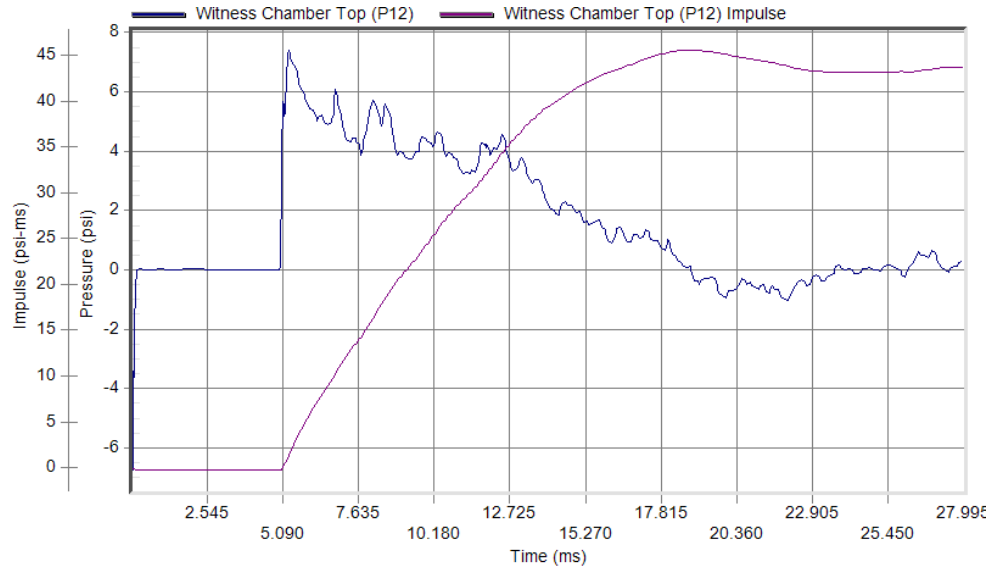
Test Date: 6/23/2014
Test Time: 10:46 am



Peak Pressure: 6.53 psi at 5.59 ms
Duration: 13.27 ms

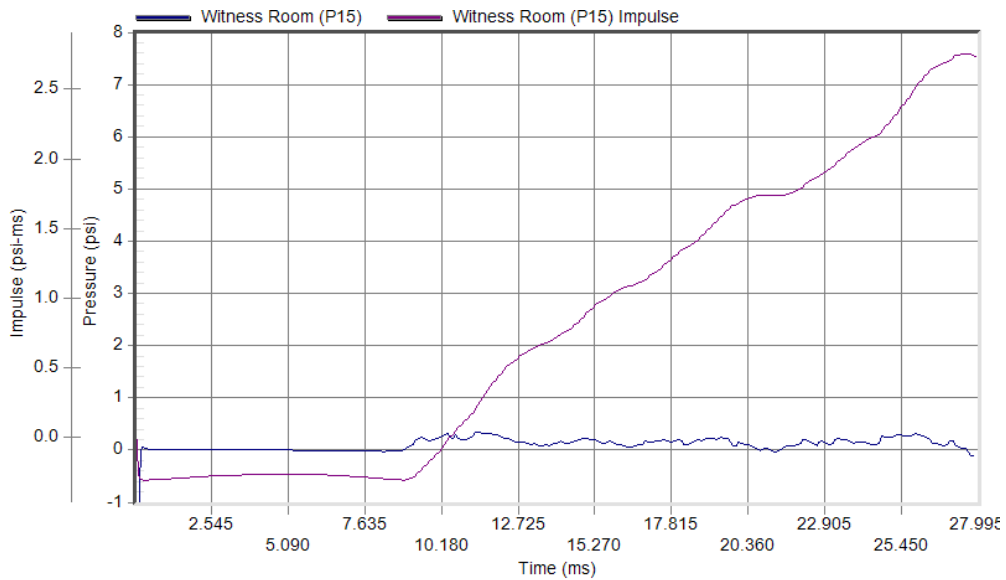
Test Date: 6/23/2014
Test Time: 10:46 am

Specimen #1: (Continued)



Peak Pressure: 7.41 psi at 5.31 ms
Duration: 13.51 ms

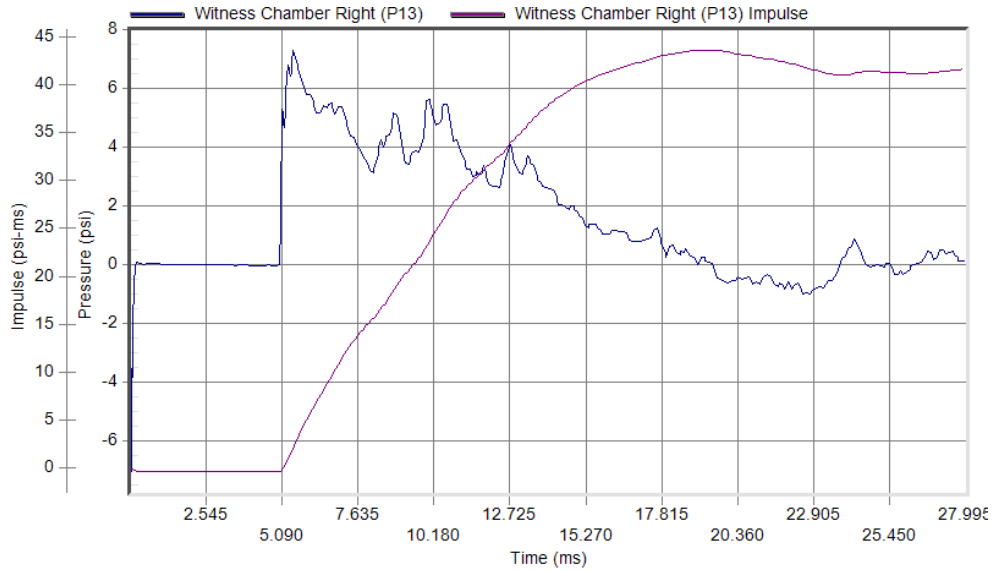
Test Date: 6/23/2014
Test Time: 10:46 am



Peak Pressure: 0.34 psi at 11.41 ms
Duration: 9.27 ms

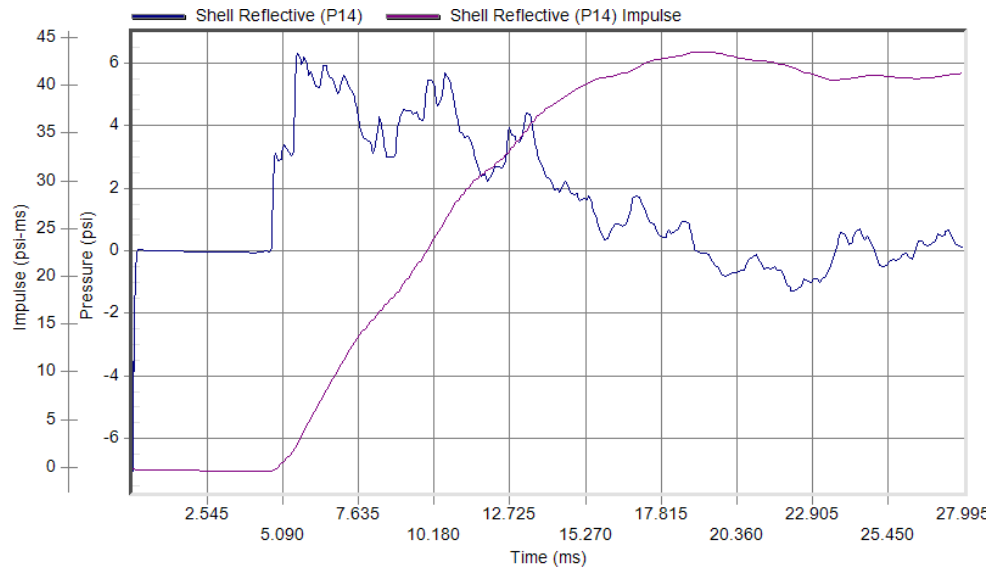
Test Date: 6/23/2014
Test Time: 10:46 am

Specimen #2



Peak Pressure: 7.30 psi at 5.48 ms
Duration: 13.51 ms

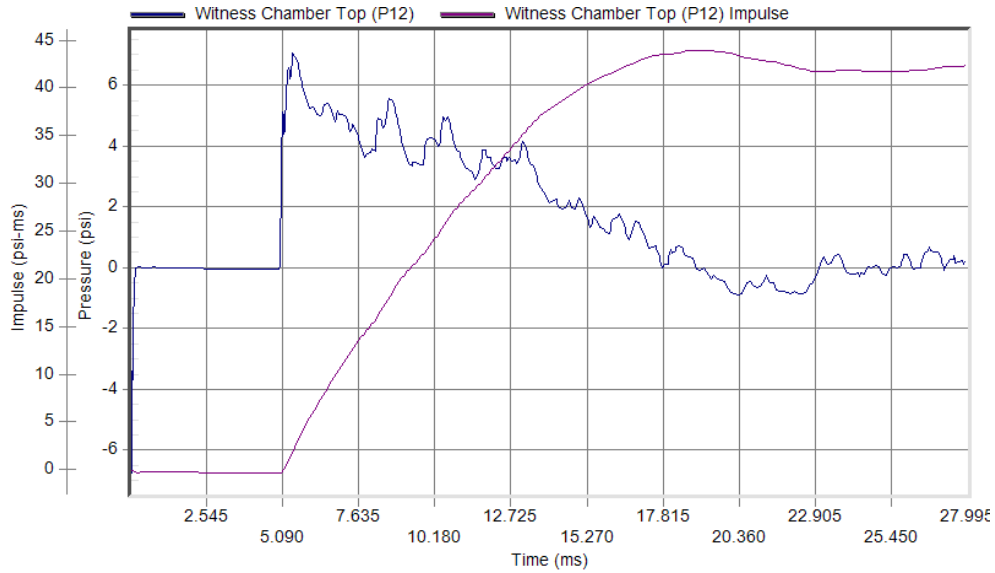
Test Date: 7/15/2014
Test Time: 10:57 am



Peak Pressure: 6.36 psi at 5.63 ms
Duration: 13.32 ms

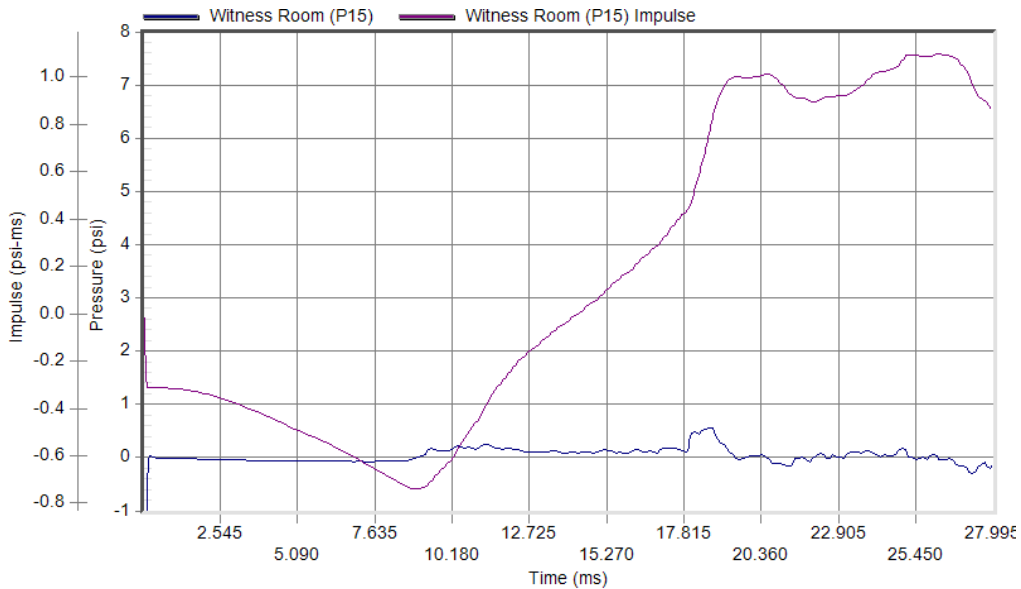
Test Date: 7/15/2014
Test Time: 10:57 am

Specimen #2: (Continued)



Peak Pressure: 7.15 psi at 5.46 ms
Duration: 12.33 ms

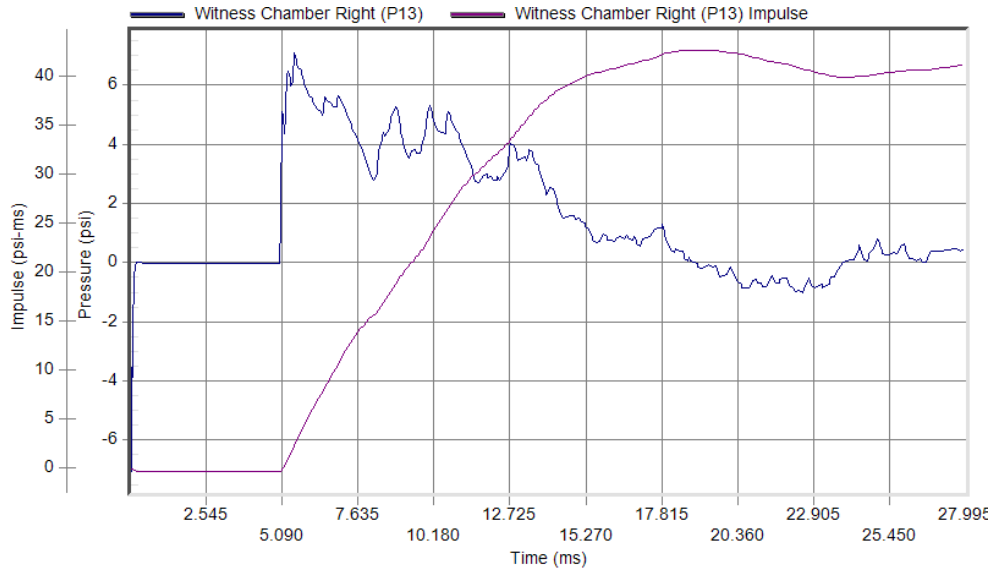
Test Date: 7/15/2014
Test Time: 10:57 am



Peak Pressure: 0.57 psi at 18.68 ms
Duration: 0.83 ms

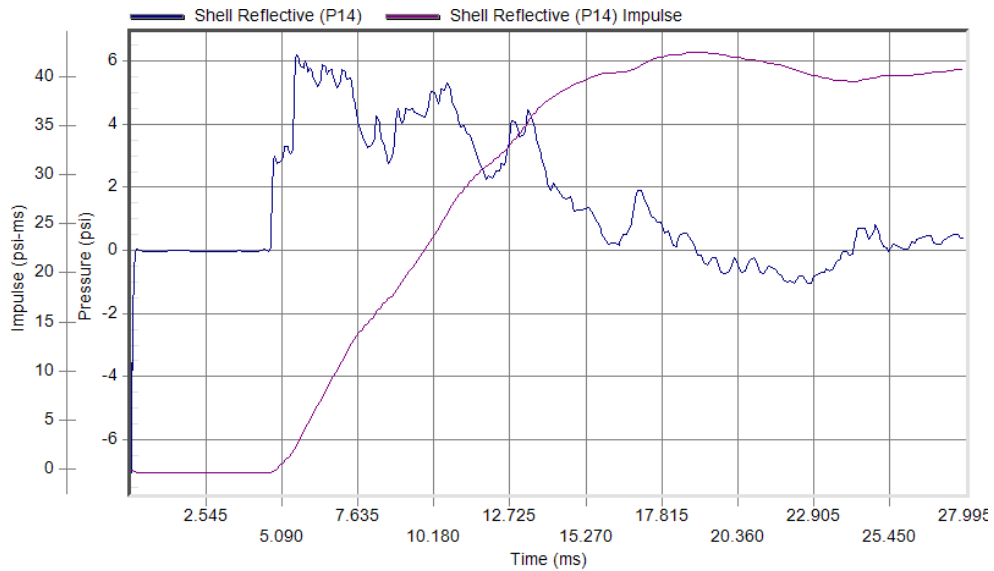
Test Date: 7/15/2014
Test Time: 10:57 am

Specimen #3



Peak Pressure: 7.19 psi at 5.54 ms
Duration: 13.10 ms

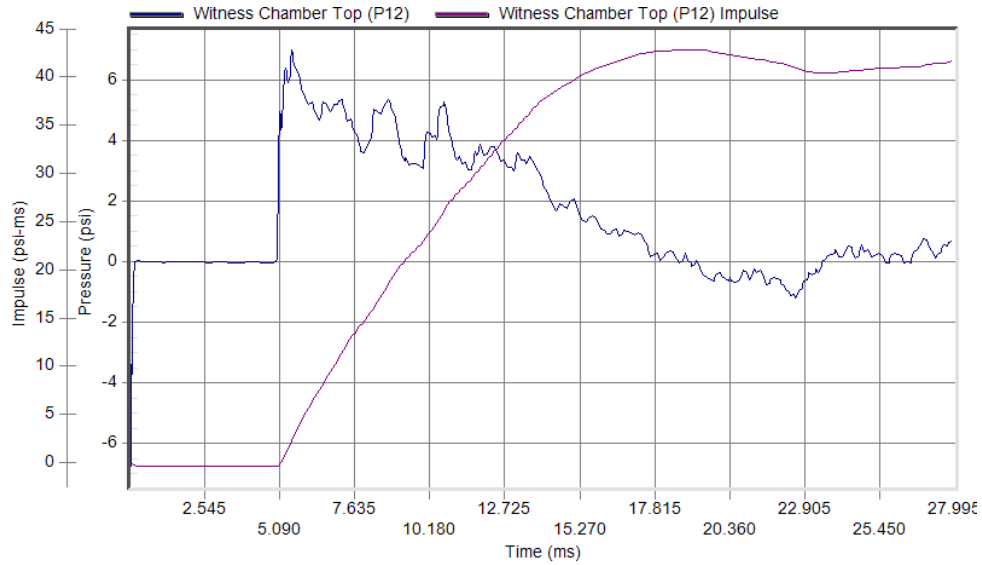
Test Date: 7/18/2014
Test Time: 10:57 am



Peak Pressure: 6.29 psi at 5.62 ms
Duration: 13.34 ms

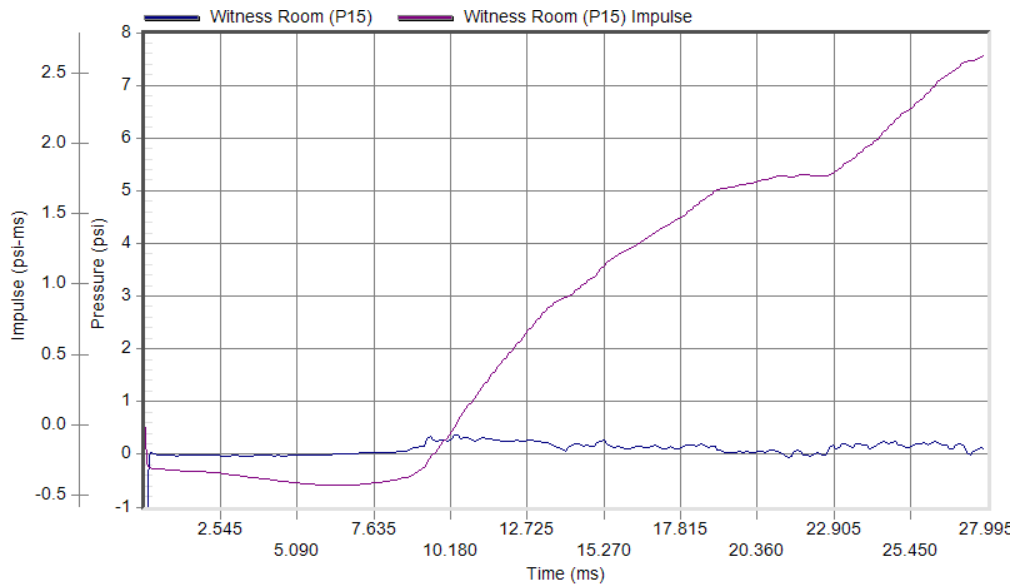
Test Date: 7/18/2014
Test Time: 10:57 am

Specimen #3: (Continued)



Peak Pressure: 7.00 psi at 5.52 ms
Duration: 12.48 ms

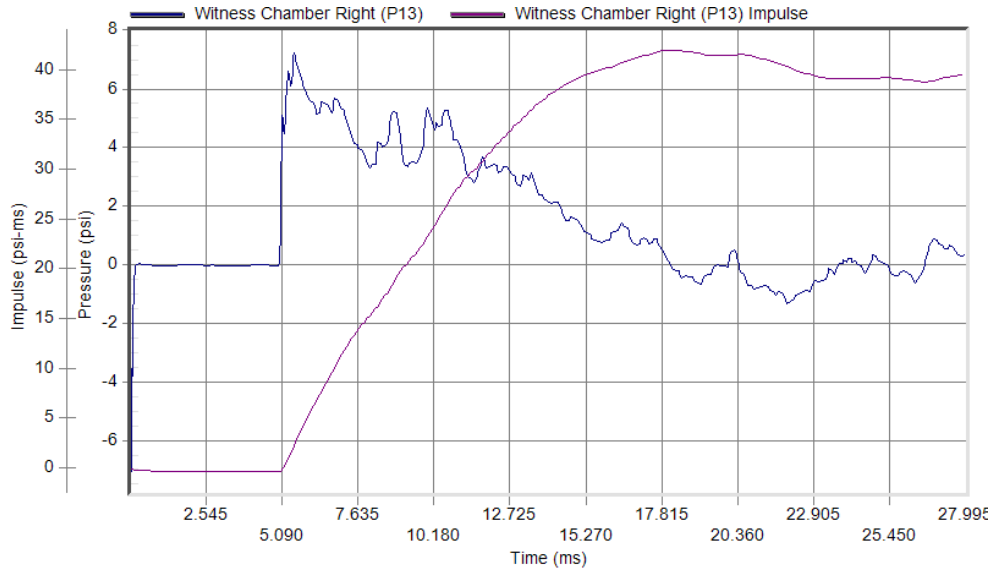
Test Date: 7/18/2014
Test Time: 10:57 am



Peak Pressure: 0.39 psi at 10.36 ms
Duration: 10.82 ms

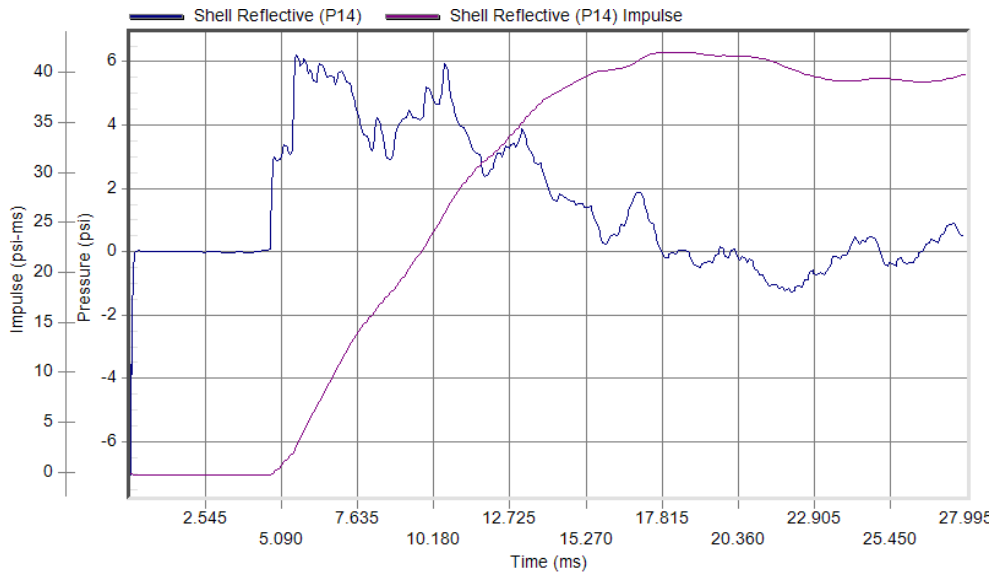
Test Date: 7/18/2014
Test Time: 10:57 am

Specimen #4:



Peak Pressure: 7.33 psi at 5.51 ms
Duration: 12.58 ms

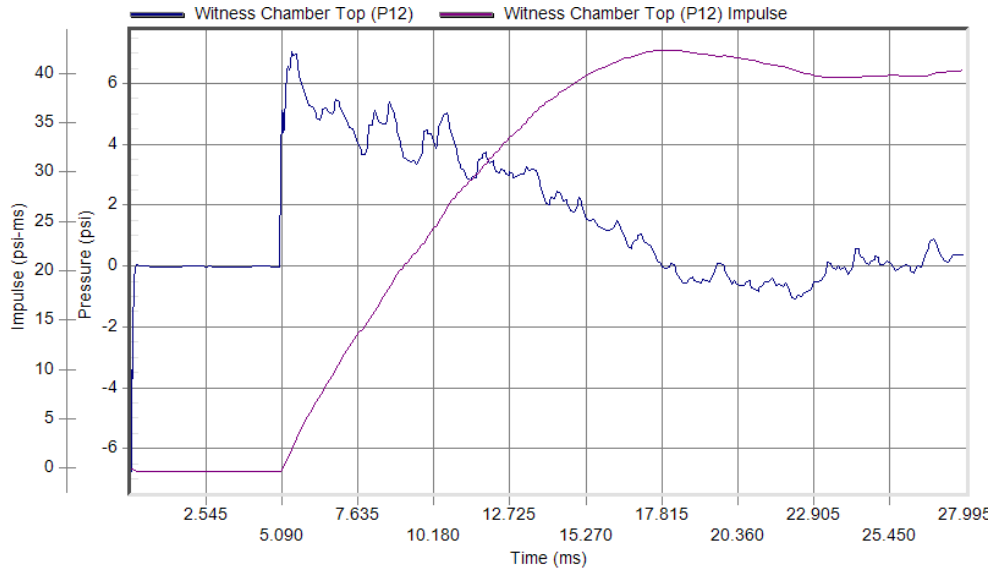
Test Date: 7/21/2014
Test Time: 1:49 pm



Peak Pressure: 6.30 psi at 5.62 ms
Duration: 12.18 ms

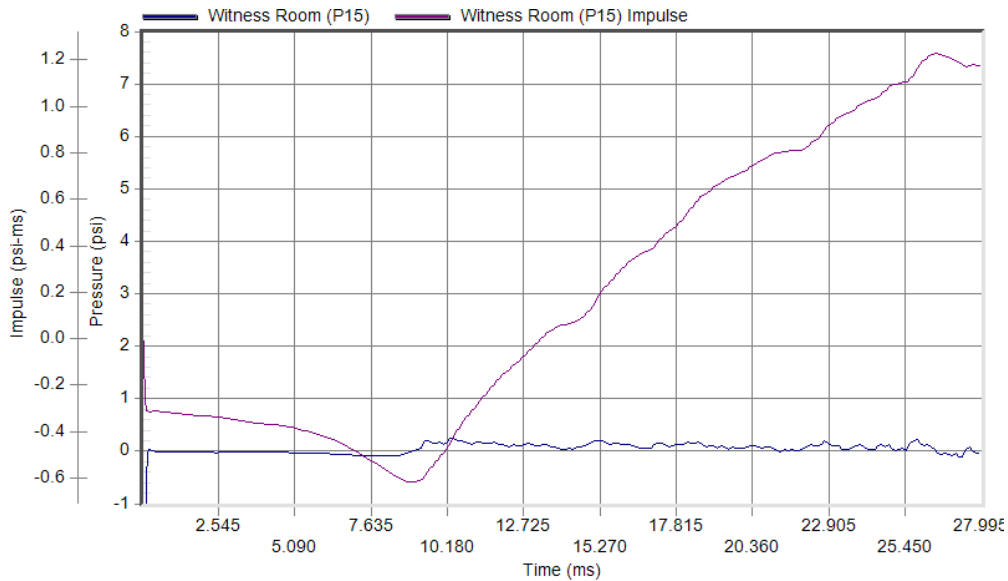
Test Date: 7/21/2014
Test Time: 1:49 pm

Specimen #4: (Continued)



Peak Pressure: 7.10 psi at 5.44 ms
Duration: 12.32 ms

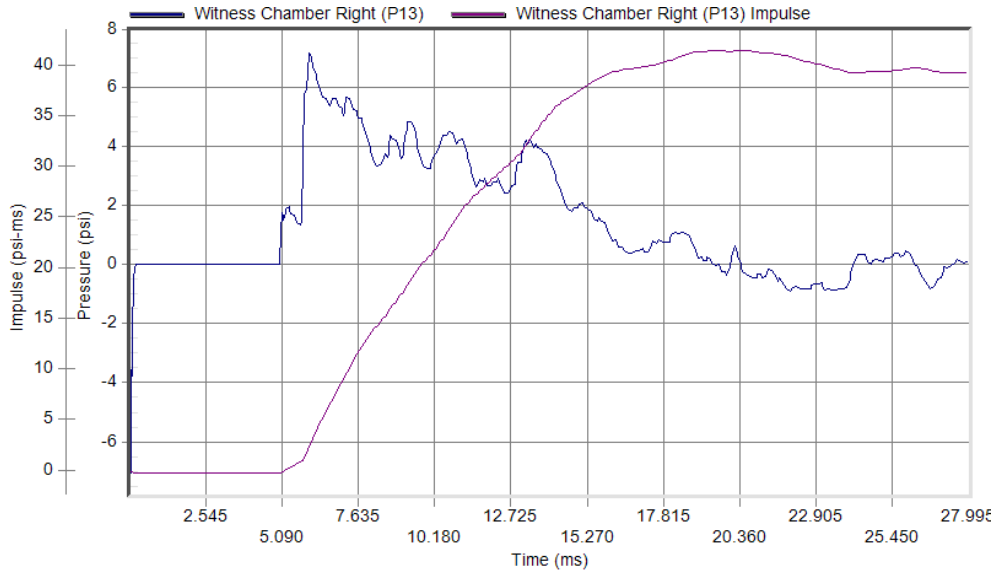
Test Date: 7/21/2014
Test Time: 1:49 pm



Peak Pressure: 0.27 psi at 10.32 ms
Duration: 10.94 ms

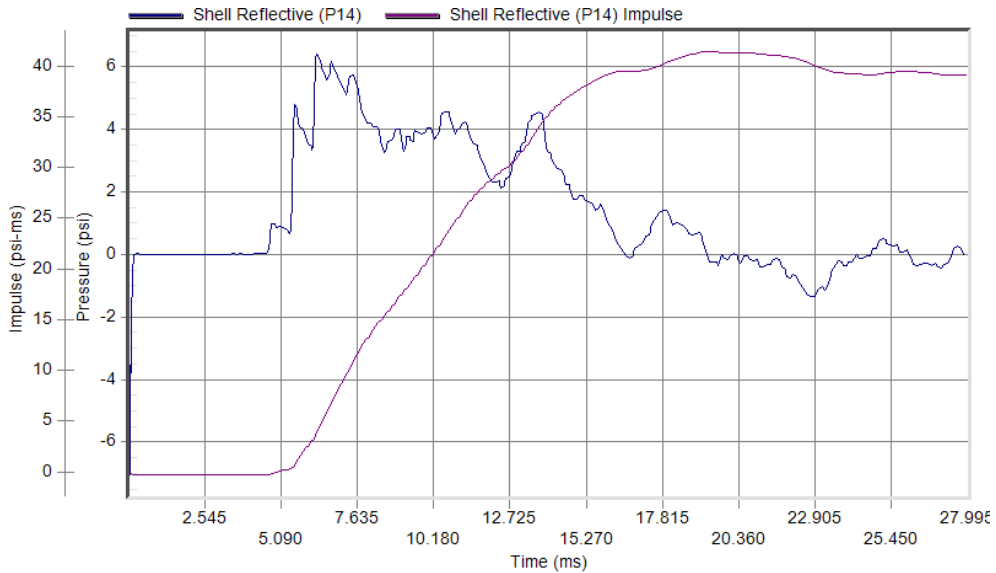
Test Date: 7/21/2014
Test Time: 1:49 pm

Specimen #5:



Peak Pressure: 7.27 psi at 6.04 ms
Duration: 13.40 ms

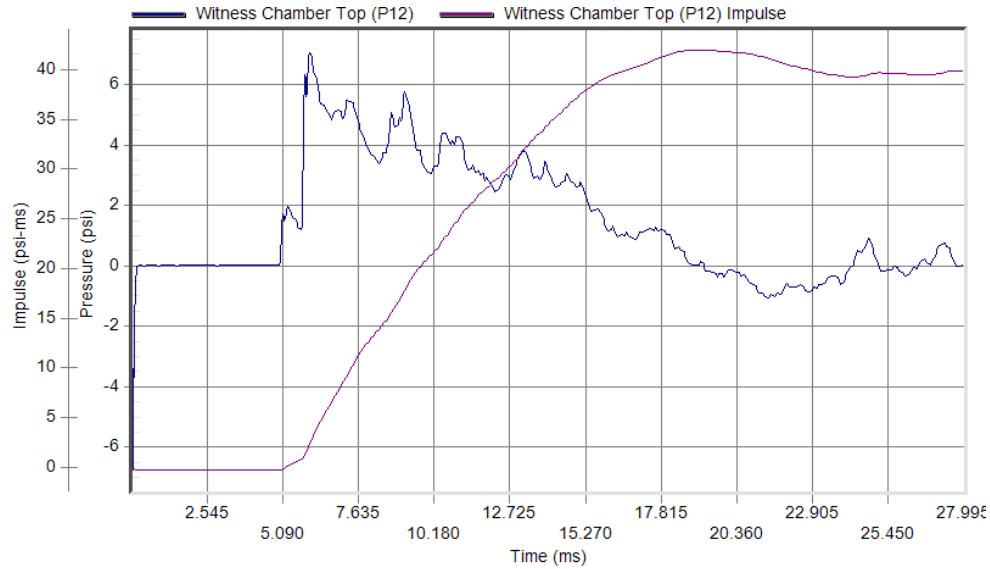
Test Date: 7/16/2014
Test Time: 9:27 am



Peak Pressure: 6.50 psi at 6.30 ms
Duration: 10.24 ms

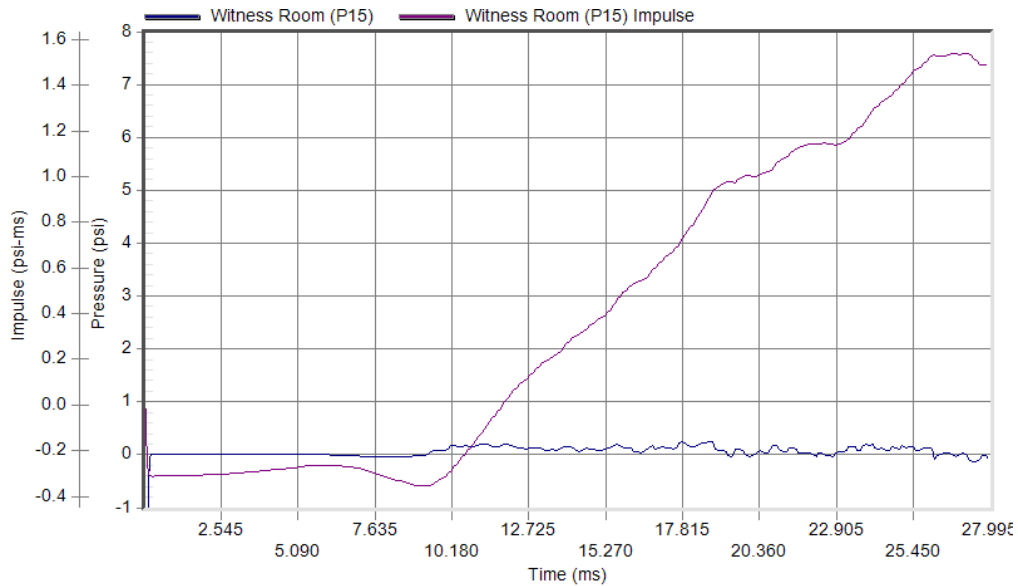
Test Date: 7/16/2014
Test Time: 9:27 am

Specimen #5: (Continued)



Peak Pressure: 7.14 psi at 6.02 ms
Duration: 12.75 ms

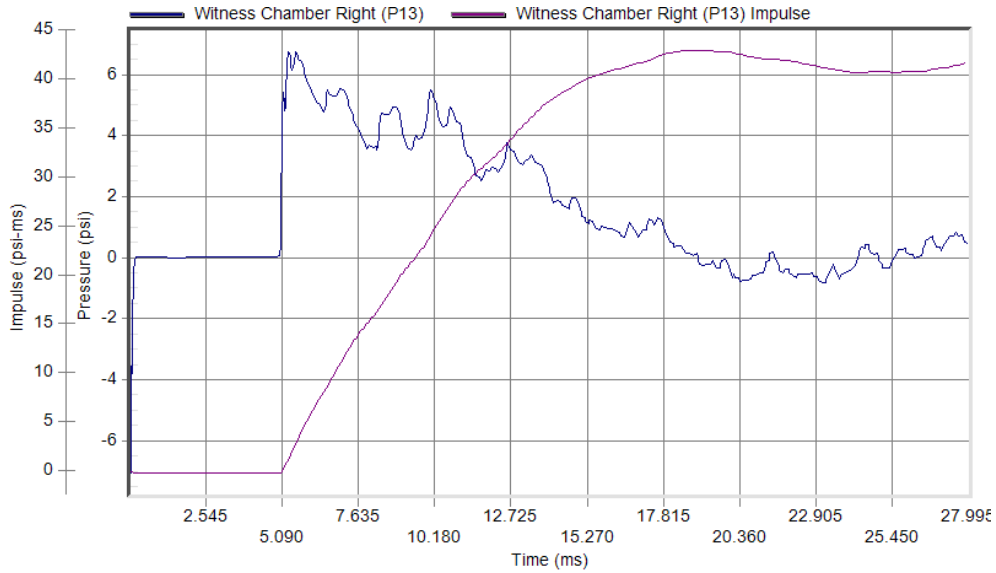
Test Date: 7/16/2014
Test Time: 9:27 am



Peak Pressure: 0.25 psi at 18.70 ms
Duration: 0.60 ms

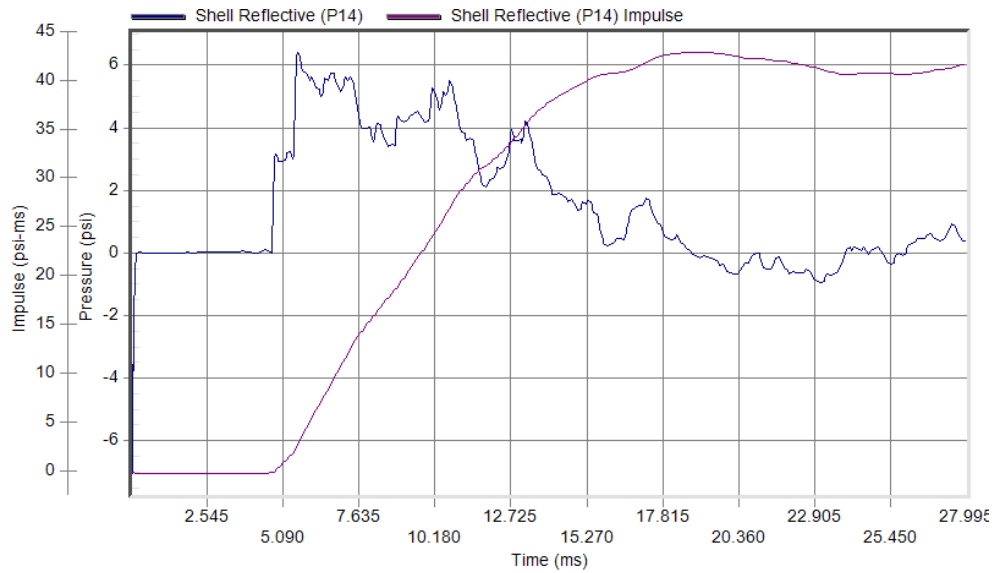
Test Date: 7/16/2014
Test Time: 9:27 am

Specimen #6:



Peak Pressure: 6.80 psi at 5.34 ms
Duration: 13.47 ms

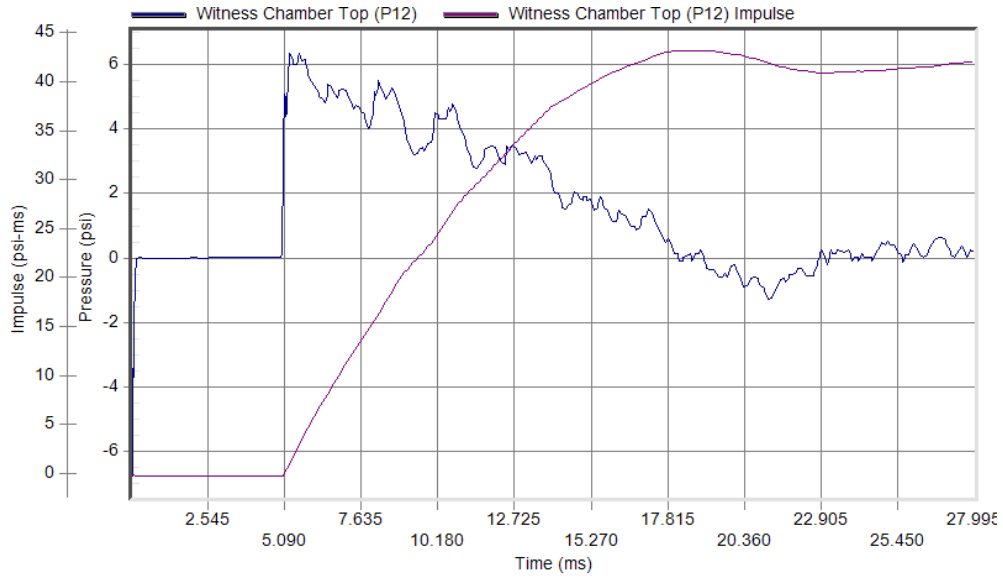
Test Date: 7/17/2014
Test Time: 11:44 am



Peak Pressure: 6.42 psi at 5.62 ms
Duration: 13.11 ms

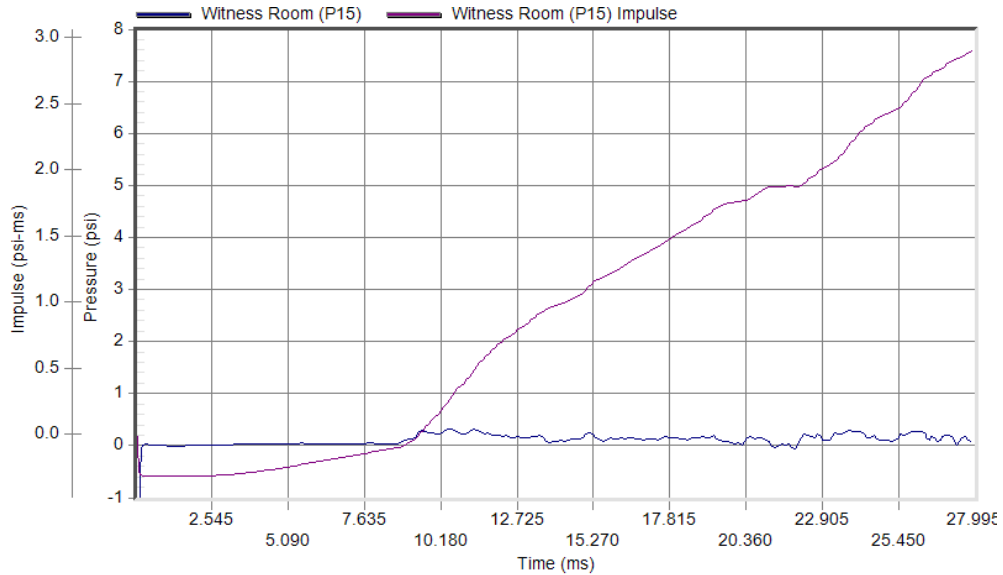
Test Date: 7/17/2014
Test Time: 11:44 am

Specimen #6: (Continued)



Peak Pressure: 6.43 psi at 5.30 ms
Duration: 12.86 ms

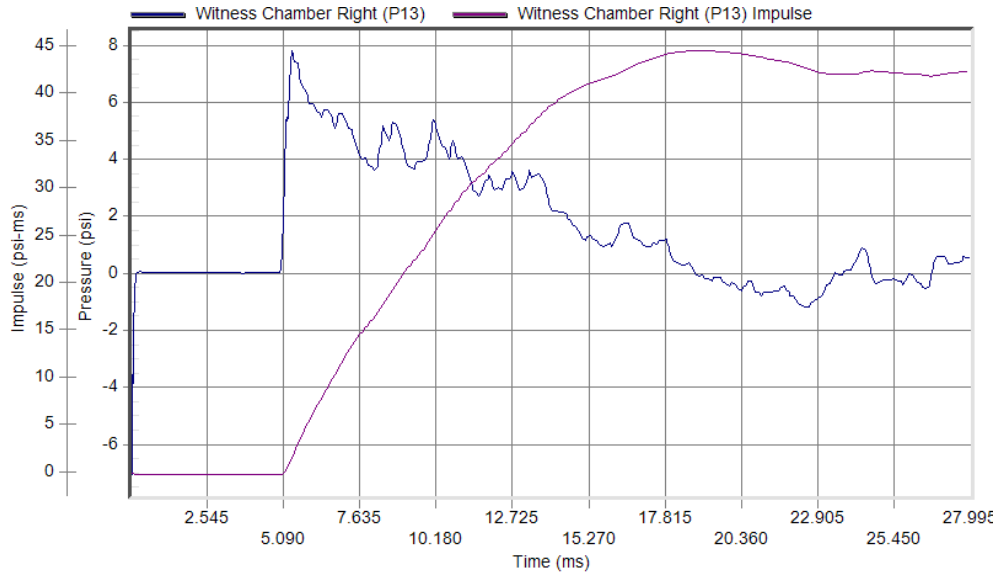
Test Date: 7/17/2014
Test Time: 11:44 am



Peak Pressure: 0.33 psi at 10.39 ms
Duration: 9.83 ms

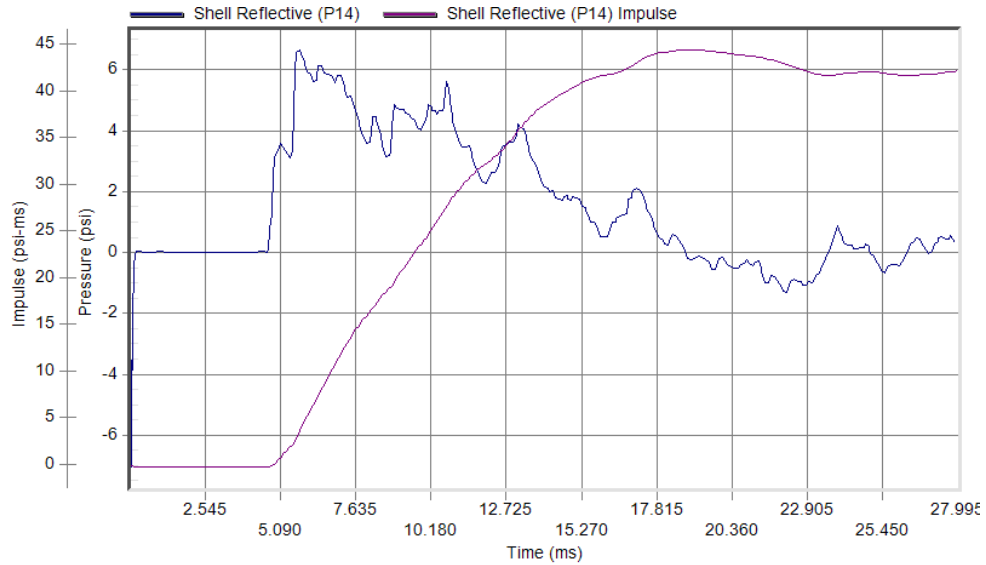
Test Date: 7/17/2014
Test Time: 11:44 am

Specimen #7:



Peak Pressure: 7.82 psi at 5.40 ms
Duration: 13.37 ms

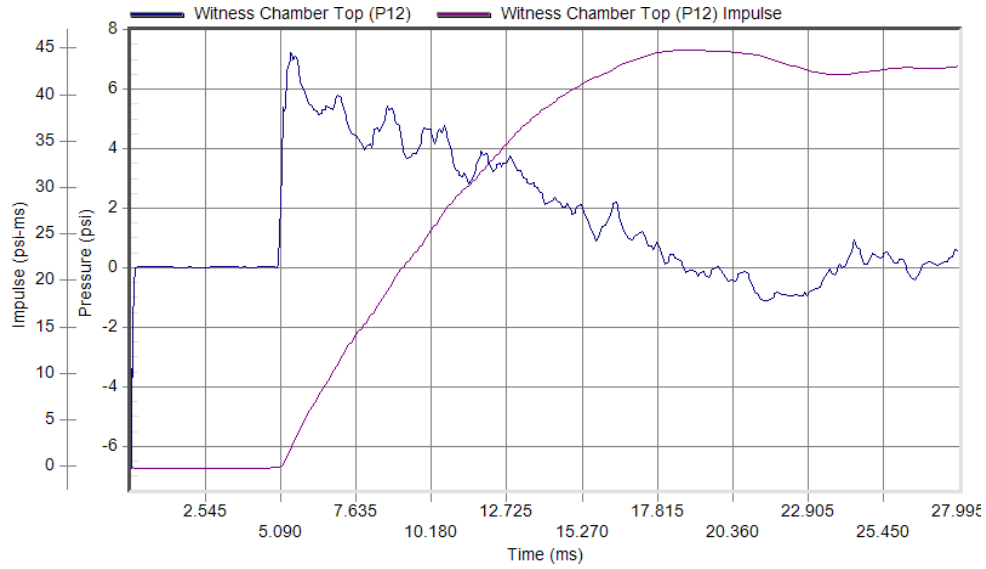
Test Date: 9/8/2014
Test Time: 3:01 pm



Peak Pressure: 6.66 psi at 5.73 ms
Duration: 13.04 ms

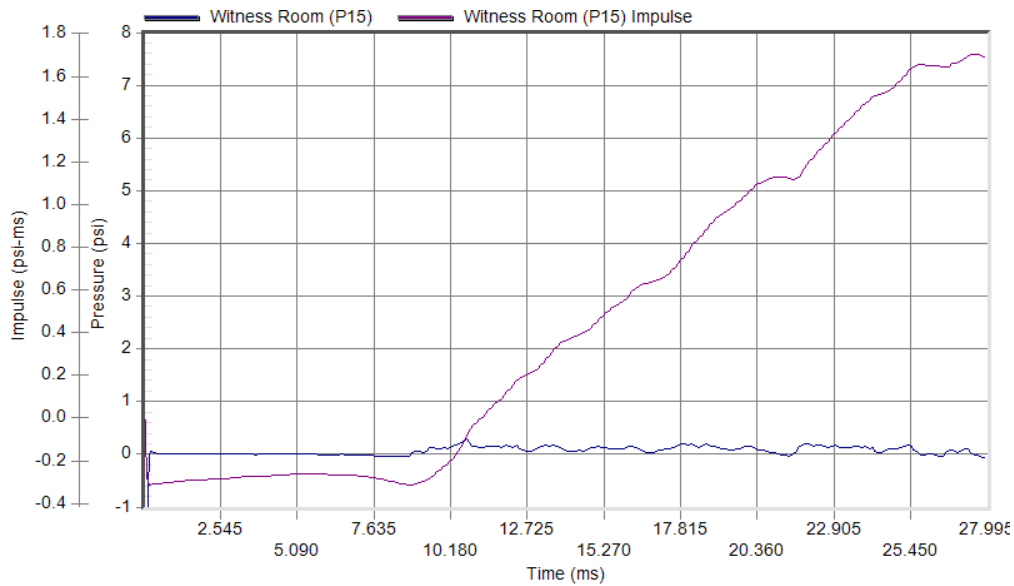
Test Date: 9/8/2014
Test Time: 3:01 pm

Specimen #7: (Continued)



Peak Pressure: 7.32 psi at 5.45 ms
Duration: 13.21 ms

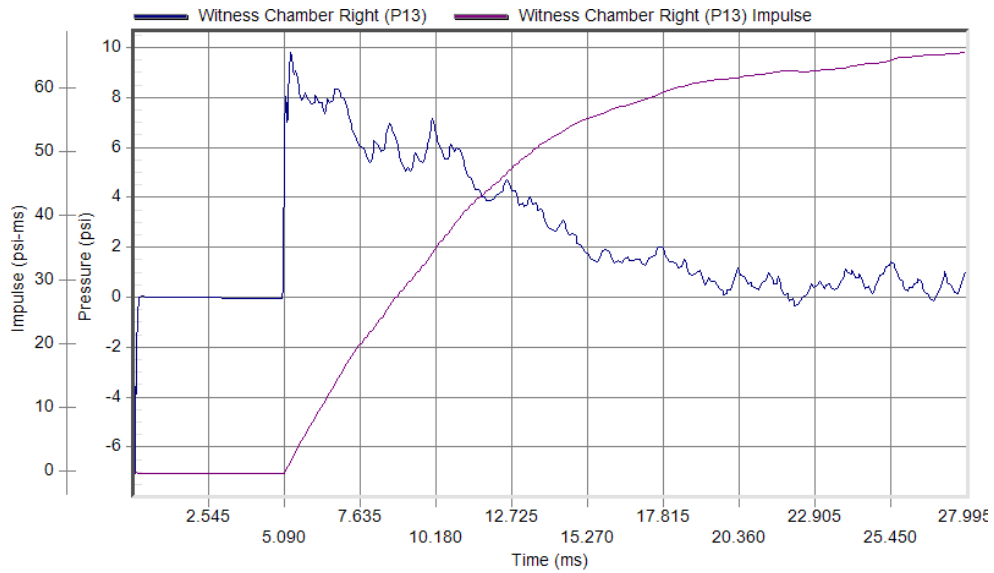
Test Date: 9/8/2014
Test Time: 3:01 pm



Peak Pressure: 0.31 psi at 10.72 ms
Duration: 10.35 ms

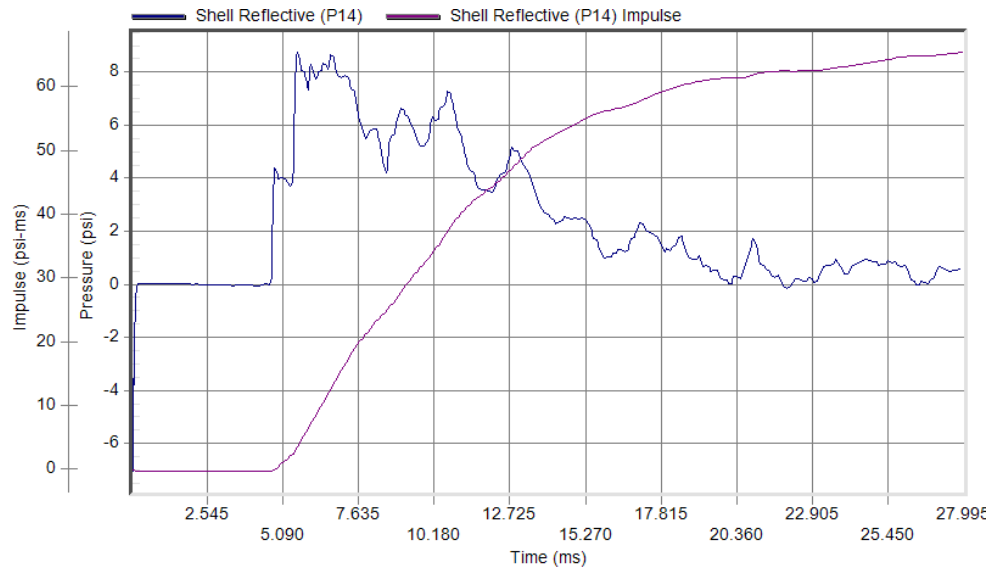
Test Date: 9/8/2014
Test Time: 3:01 pm

Specimen #8:



Peak Pressure: 9.82 psi at 5.31 ms
Duration: 14.55 ms

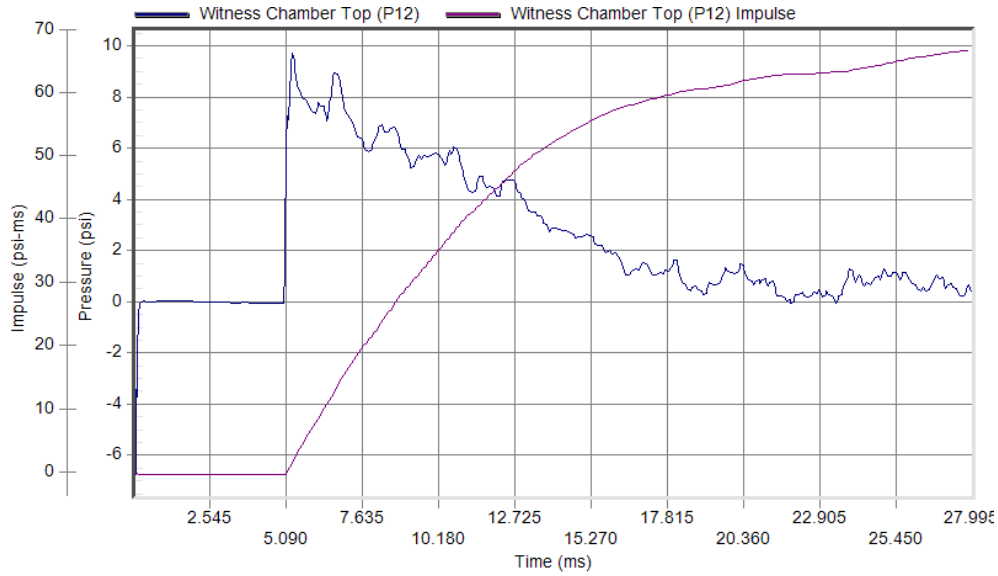
Test Date: 9/9/2014
Test Time: 4:32 pm



Peak Pressure: 8.76 psi at 5.60 ms
Duration: 14.46 ms

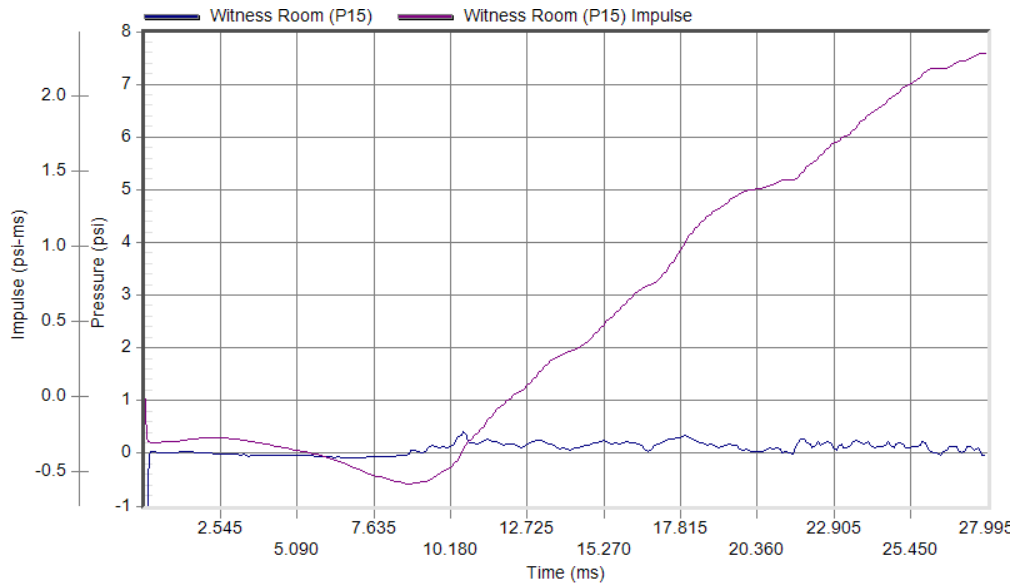
Test Date: 9/9/2014
Test Time: 4:32 pm

Specimen #8: (Continued)



Peak Pressure: 9.82 psi at 5.31 ms
Duration: 16.48 ms

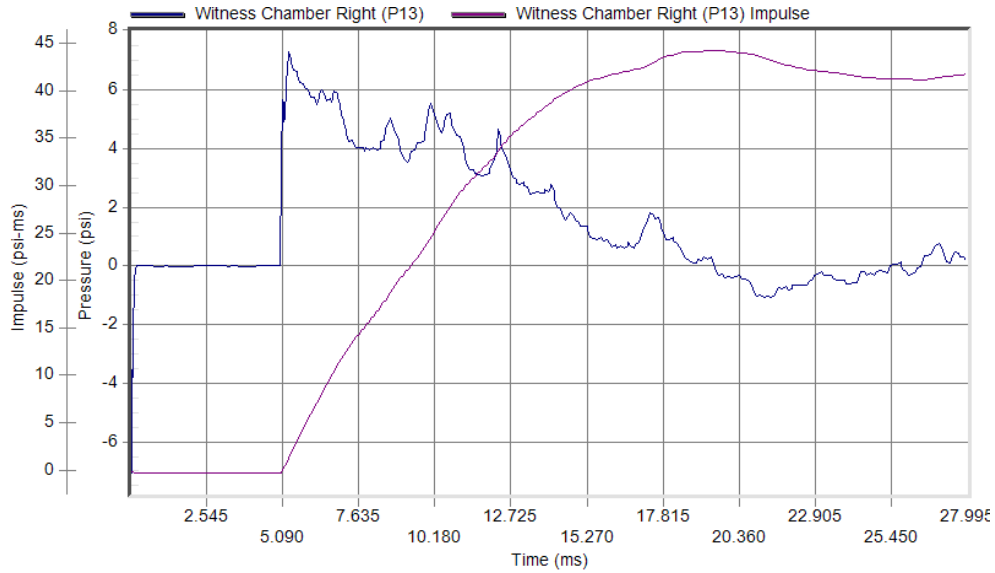
Test Date: 9/9/2014
Test Time: 4:32 pm



Peak Pressure: 0.41 psi at 10.64 ms
Duration: 10.77 ms

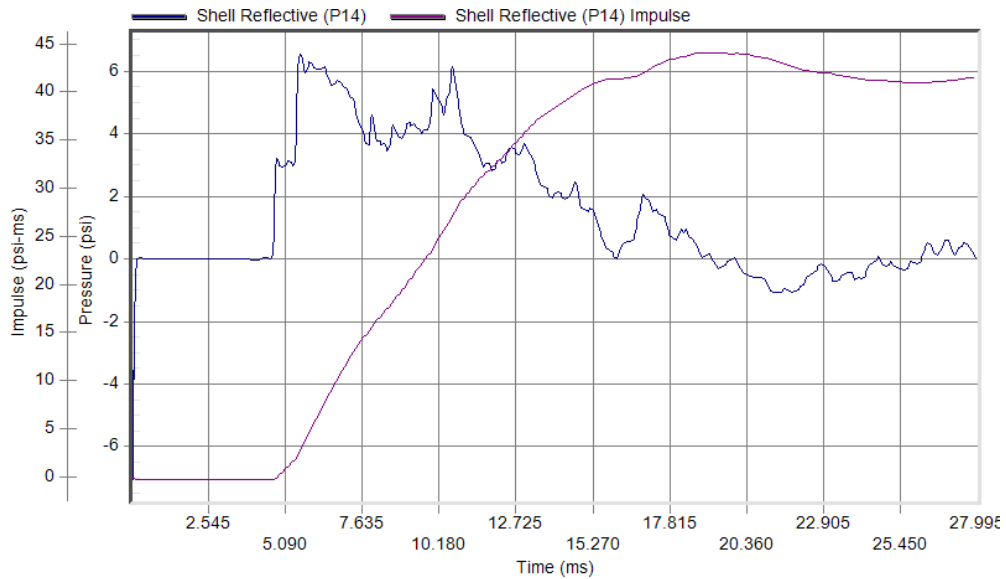
Test Date: 9/9/2014
Test Time: 4:32 pm

Specimen #9:



Peak Pressure: 7.35 psi at 5.33 ms
Duration: 14.19 ms

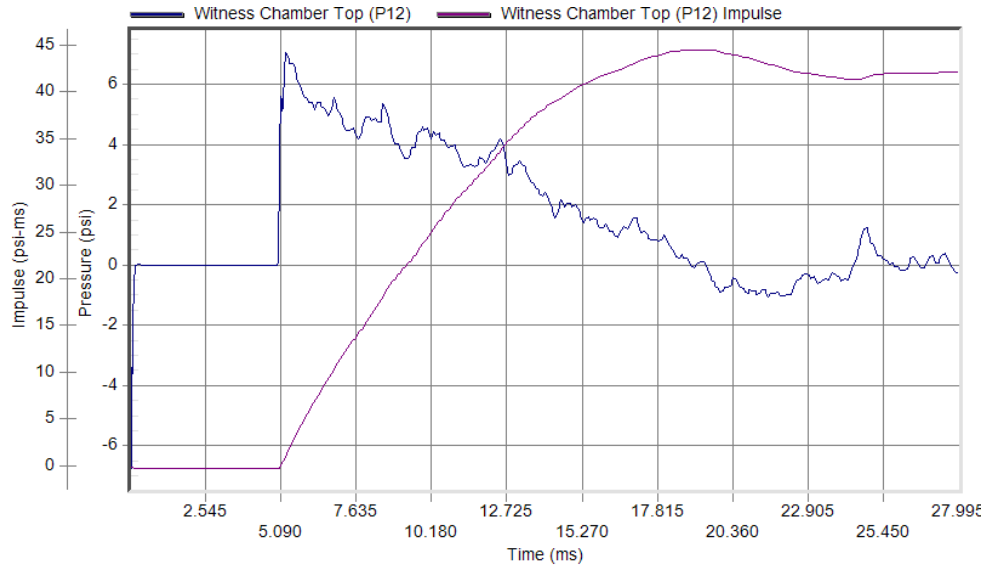
Test Date: 6/23/2014
Test Time: 8:53 am



Peak Pressure: 6.59 psi at 5.60 ms
Duration: 10.36 ms

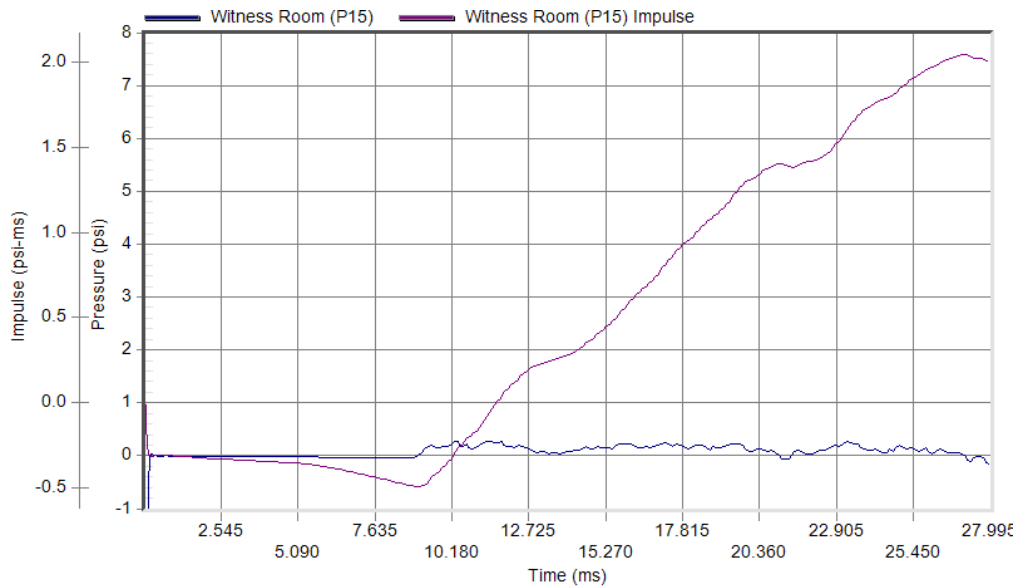
Test Date: 6/23/2014
Test Time: 8:53 am

Specimen #9: (Continued)



Peak Pressure: 7.15 psi at 5.31 ms
Duration: 13.60 ms

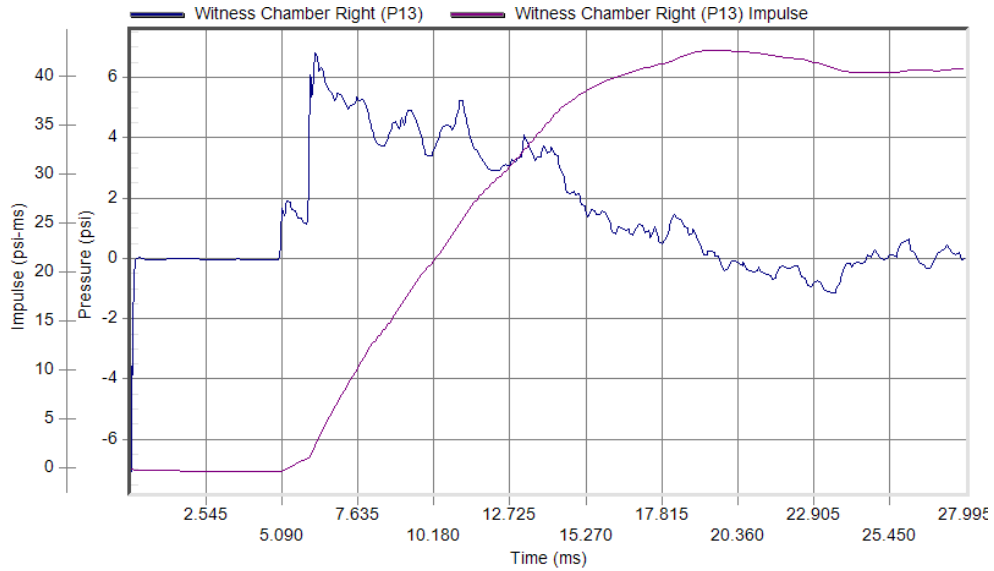
Test Date: 6/23/2014
Test Time: 8:53 am



Peak Pressure: 0.29 psi at 11.40 ms
Duration: 9.60 ms

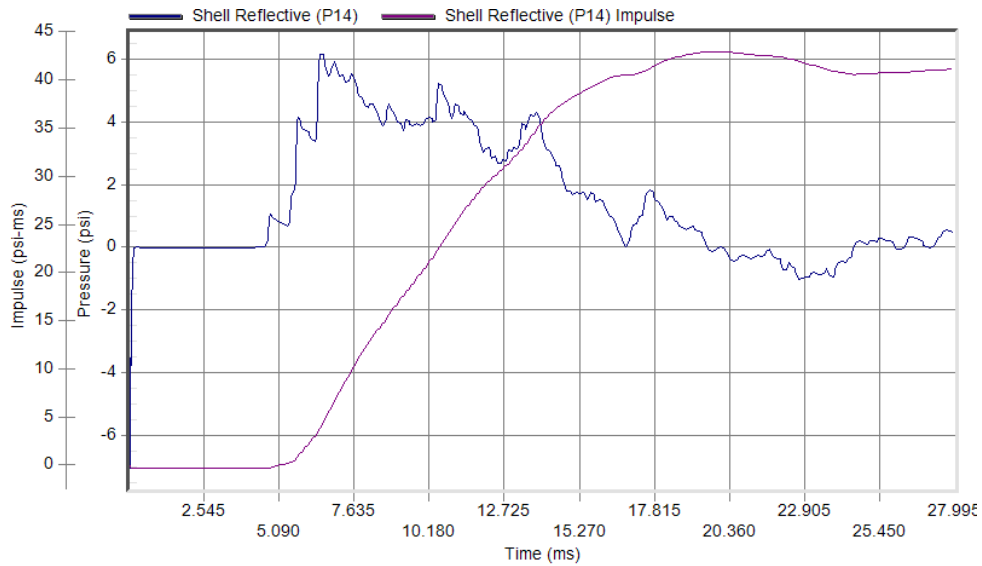
Test Date: 6/23/2014
Test Time: 8:53 am

Specimen #10:



Peak Pressure: 6.91 psi at 6.25 ms
Duration: 13.37 ms

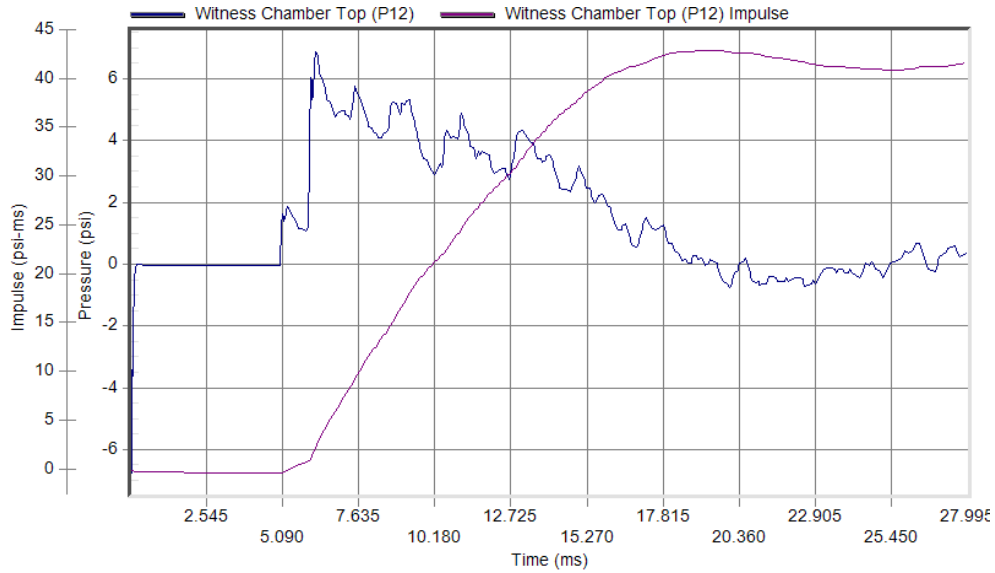
Test Date: 7/15/2014
Test Time: 1:26 pm



Peak Pressure: 6.24 psi at 6.54 ms
Duration: 10.27 ms

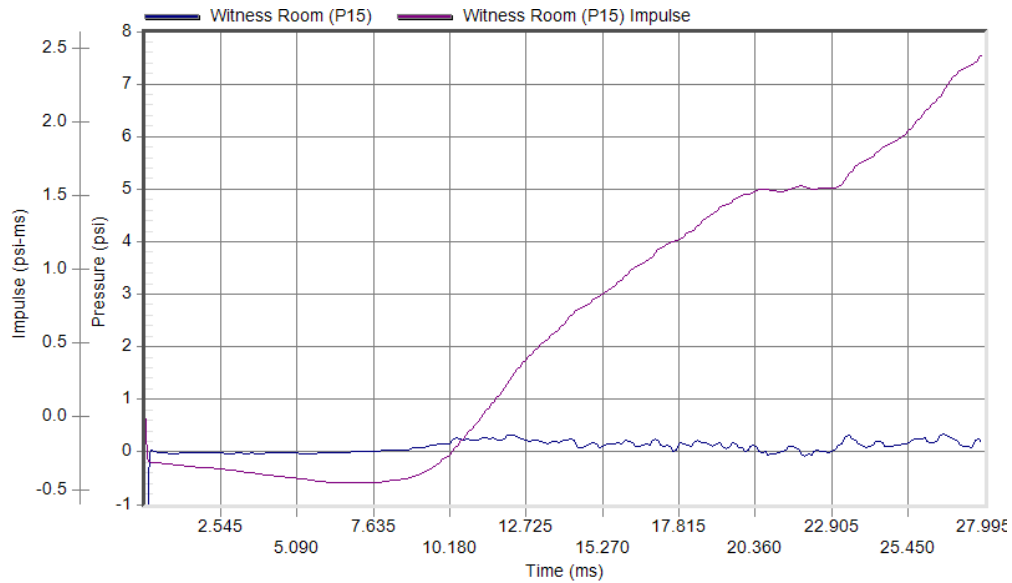
Test Date: 7/15/2014
Test Time: 1:26 pm

Specimen #10: (Continued)



Peak Pressure: 6.93 psi at 6.23 ms
Duration: 12.42 ms

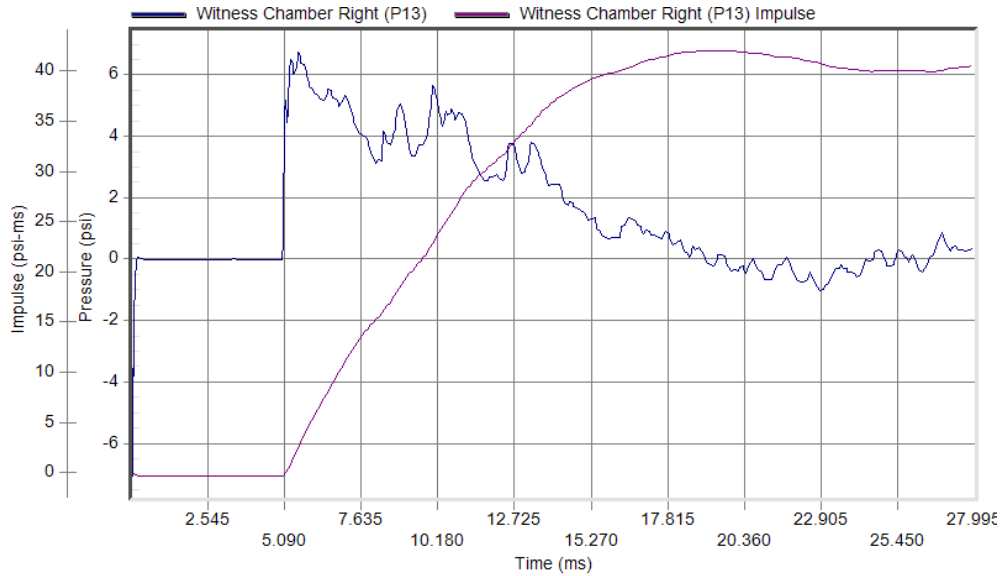
Test Date: 7/15/2014
Test Time: 1:26 pm



Peak Pressure: 0.34 psi at 26.66 ms
Duration: 0.00 ms

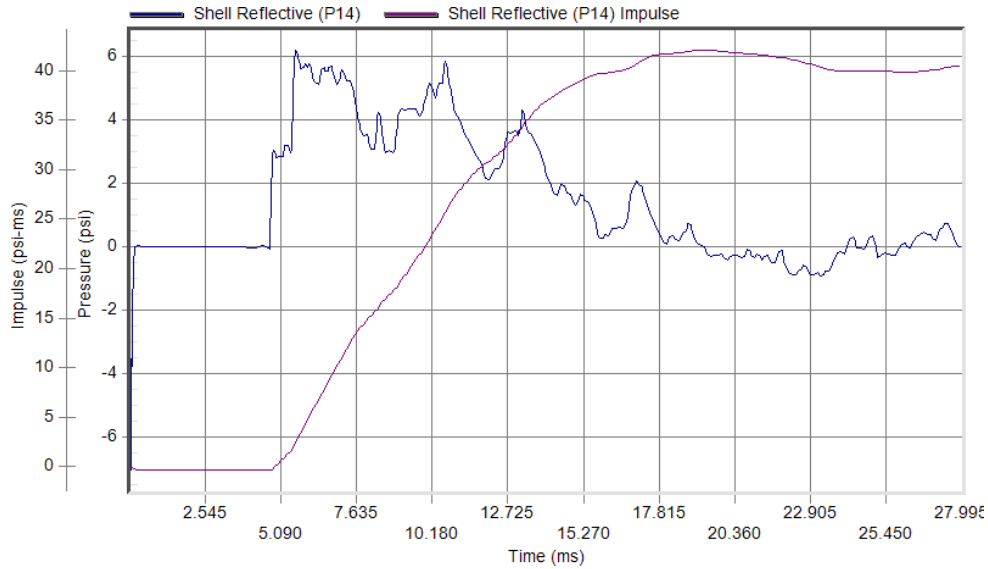
Test Date: 7/15/2014
Test Time: 1:26 pm

Specimen #11:



Peak Pressure: 6.79 psi at 5.59 ms
Duration: 13.45 ms

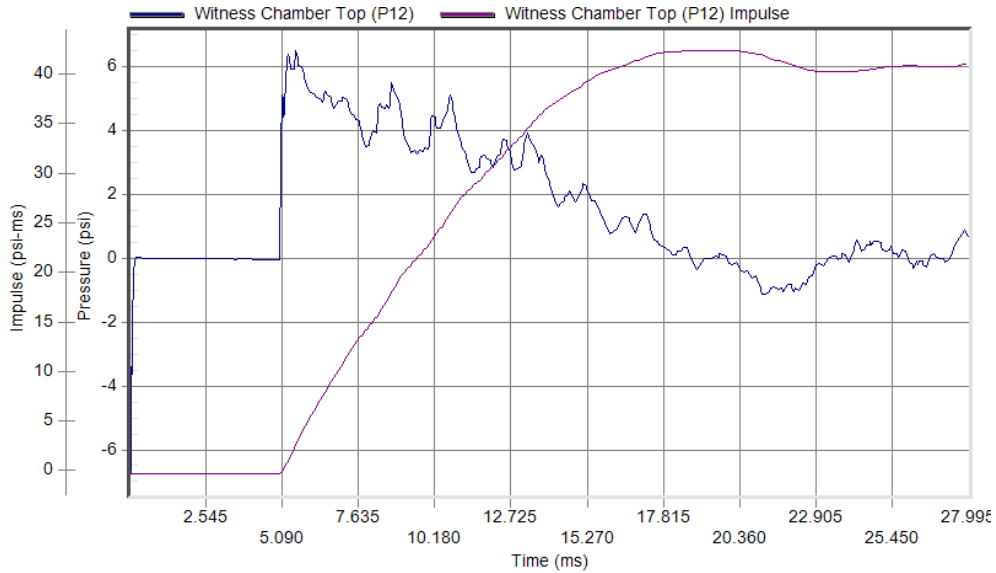
Test Date: 7/17/2014
Test Time: 3:02 pm



Peak Pressure: 6.20 psi at 5.63 ms
Duration: 13.53 ms

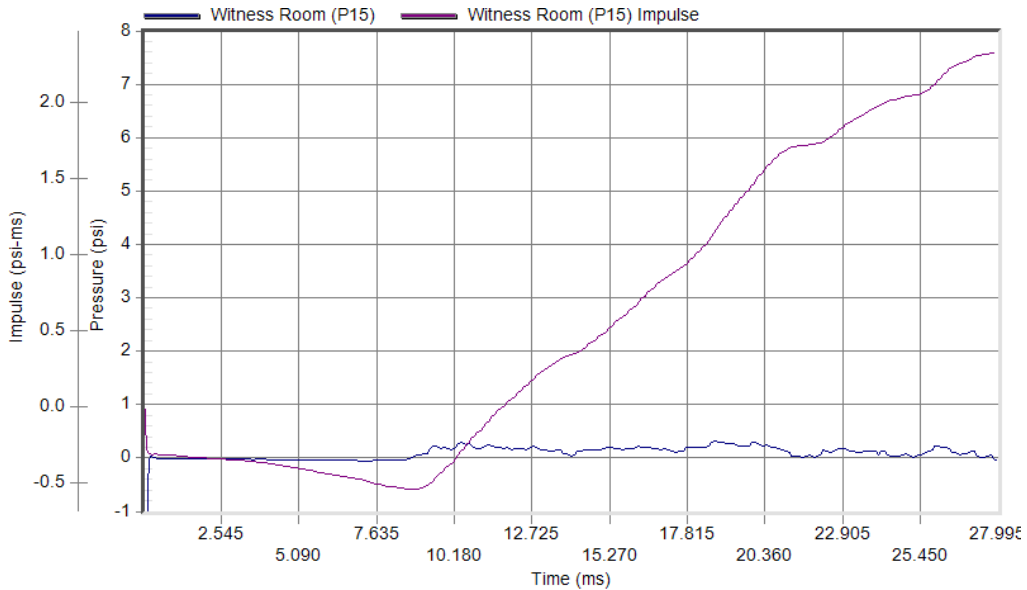
Test Date: 7/17/2014
Test Time: 3:02 pm

Specimen #11: (Continued)



Peak Pressure: 6.53 psi at 5.57 ms
Duration: 13.14 ms

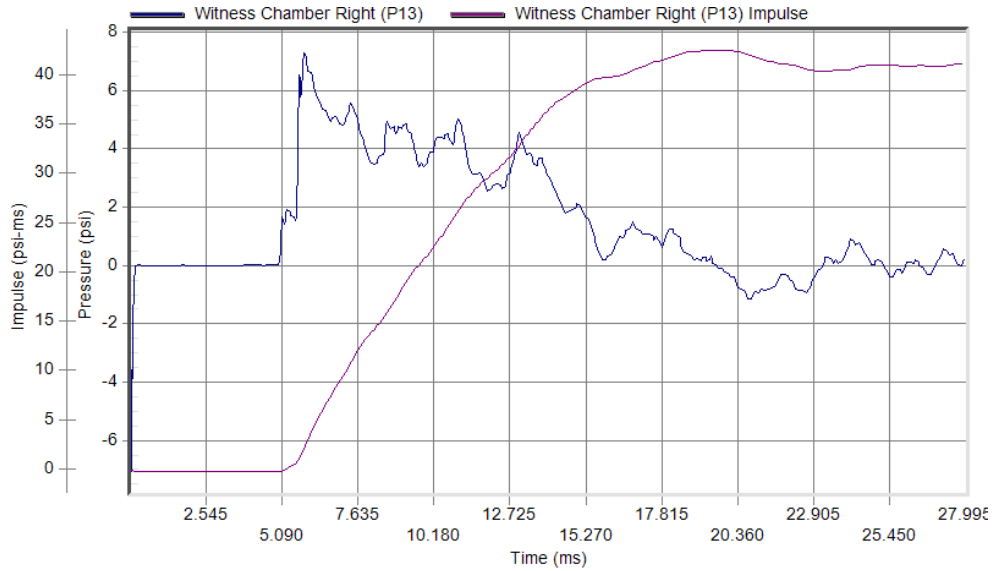
Test Date: 7/17/2014
Test Time: 3:02 pm



Peak Pressure: 0.33 psi at 18.64 ms
Duration: 8.75 ms

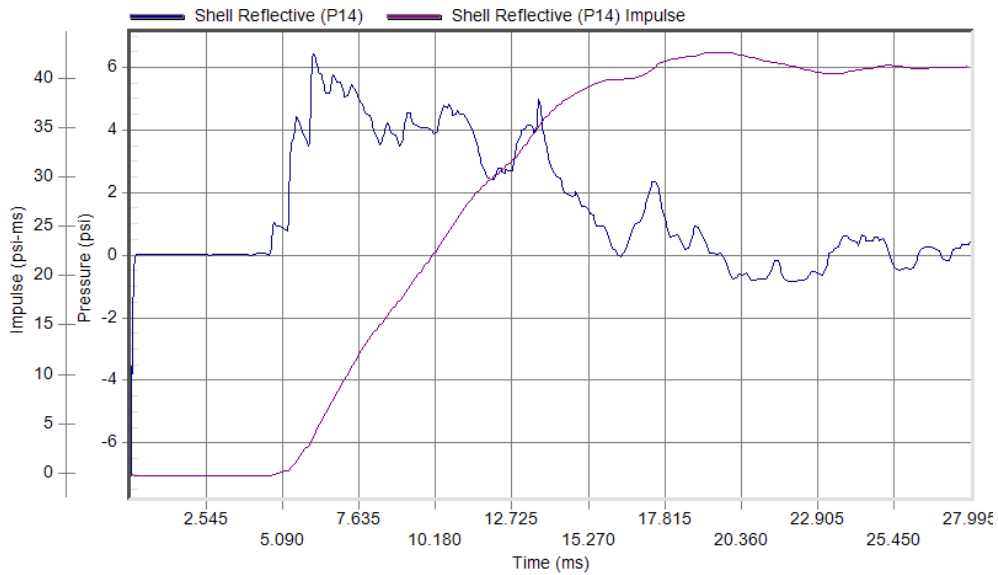
Test Date: 7/17/2014
Test Time: 3:02 pm

Specimen #12:



Peak Pressure: 7.39 psi at 5.88 ms
Duration: 13.64 ms

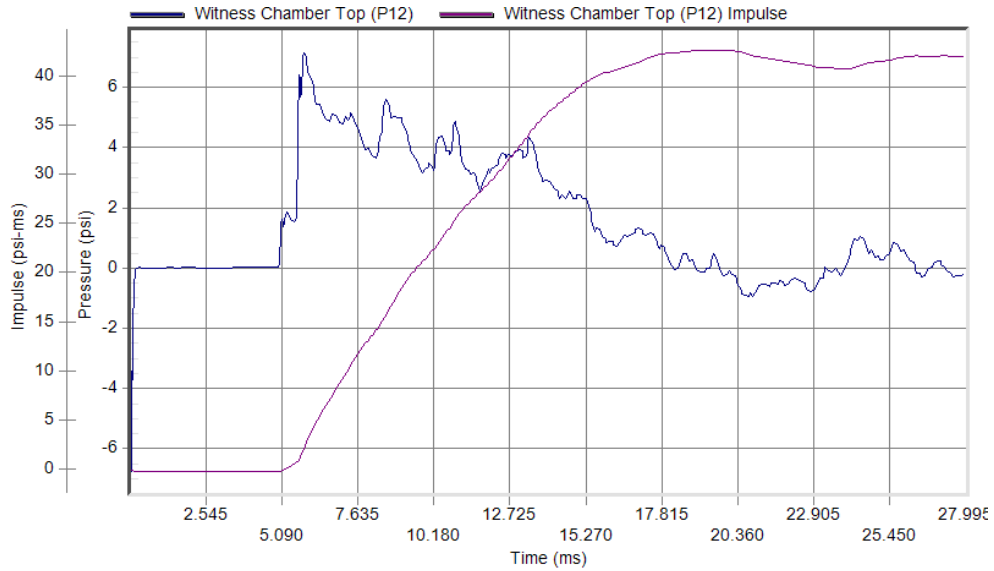
Test Date: 7/15/2014
Test Time: 3:32 pm



Peak Pressure: 6.48 psi at 6.13 ms
Duration: 10.08 ms

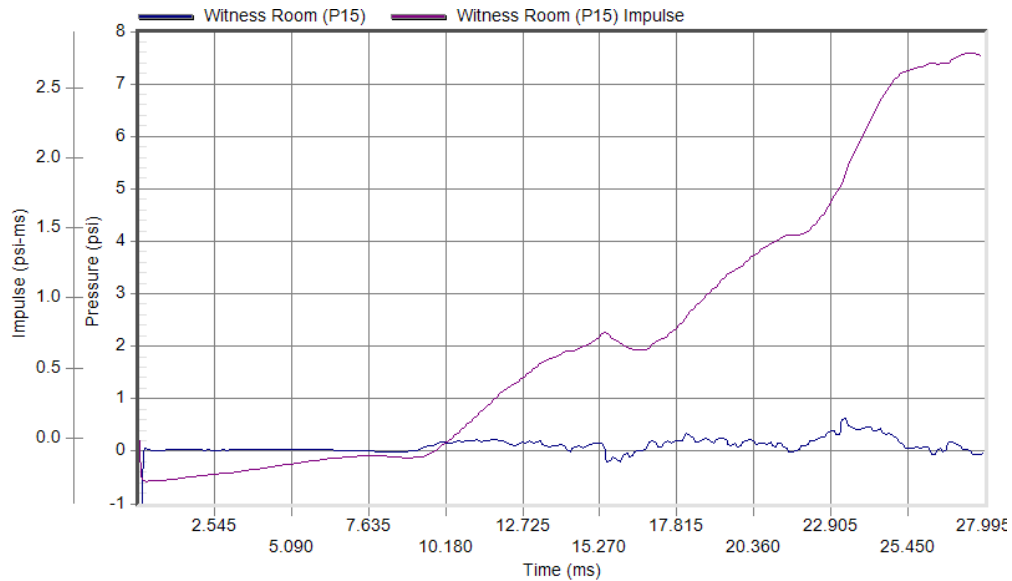
Test Date: 7/15/2014
Test Time: 3:32 pm

Specimen #12: (Continued)



Peak Pressure: 7.24 psi at 5.86 ms
Duration: 12.31 ms

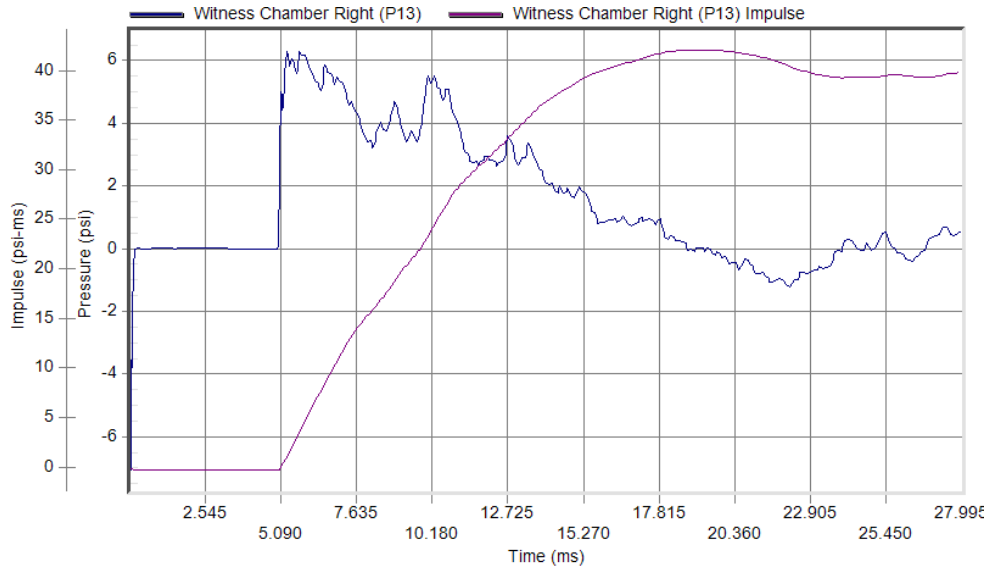
Test Date: 7/15/2014
Test Time: 3:32 pm



Peak Pressure: 0.65 psi at 23.33 ms
Duration: 2.89 ms

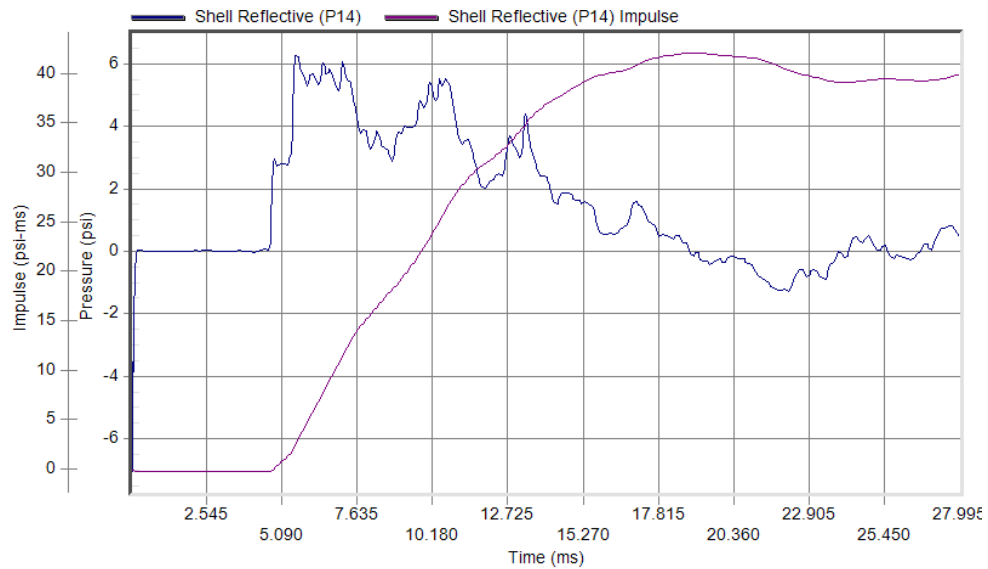
Test Date: 7/15/2014
Test Time: 3:32 pm

Specimen #13:



Peak Pressure: 6.34 psi at 5.74 ms
Duration: 13.00 ms

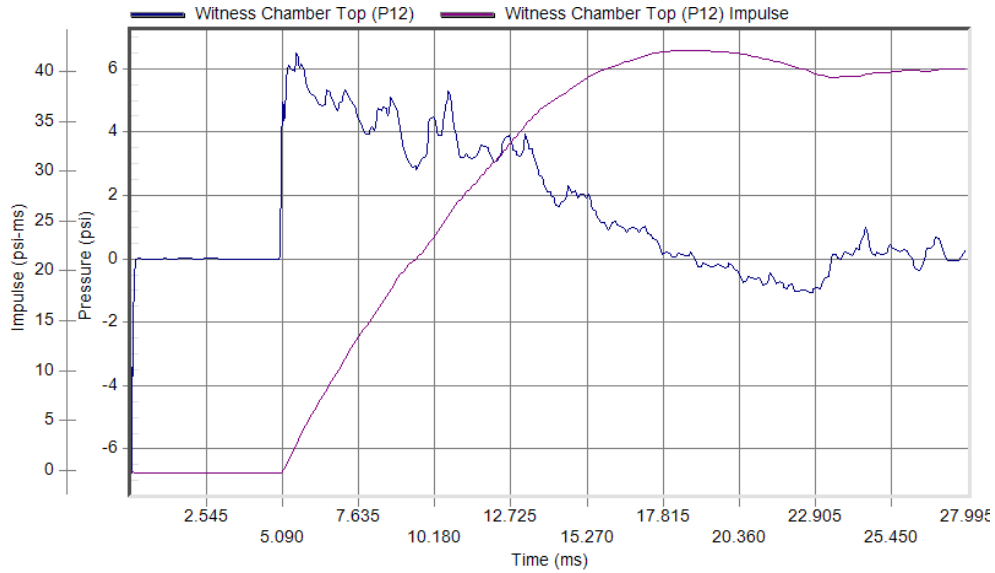
Test Date: 7/16/2014
Test Time: 3:57 pm



Peak Pressure: 6.35 psi at 5.61 ms
Duration: 13.25 ms

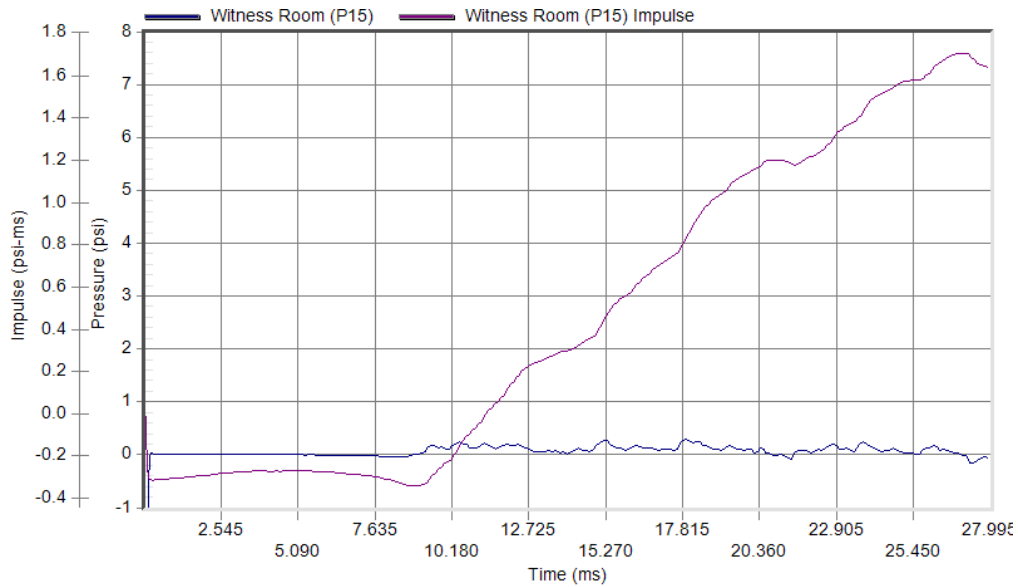
Test Date: 7/16/2014
Test Time: 3:57 pm

Specimen #13: (Continued)



Peak Pressure: 6.58 psi at 5.58 ms
Duration: 12.54 ms

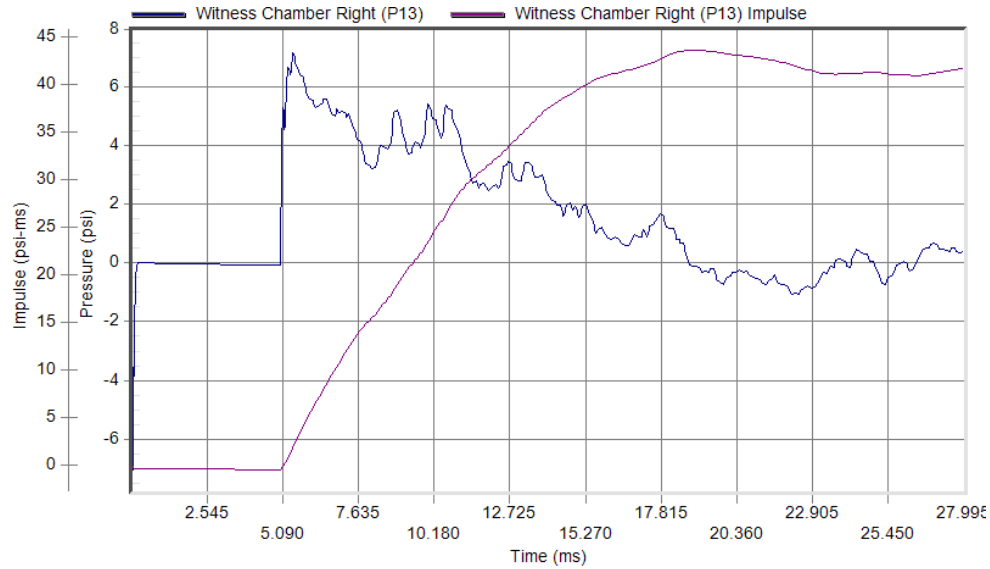
Test Date: 7/16/2014
Test Time: 3:57 pm



Peak Pressure: 0.30 psi at 17.91 ms
Duration: 2.84 ms

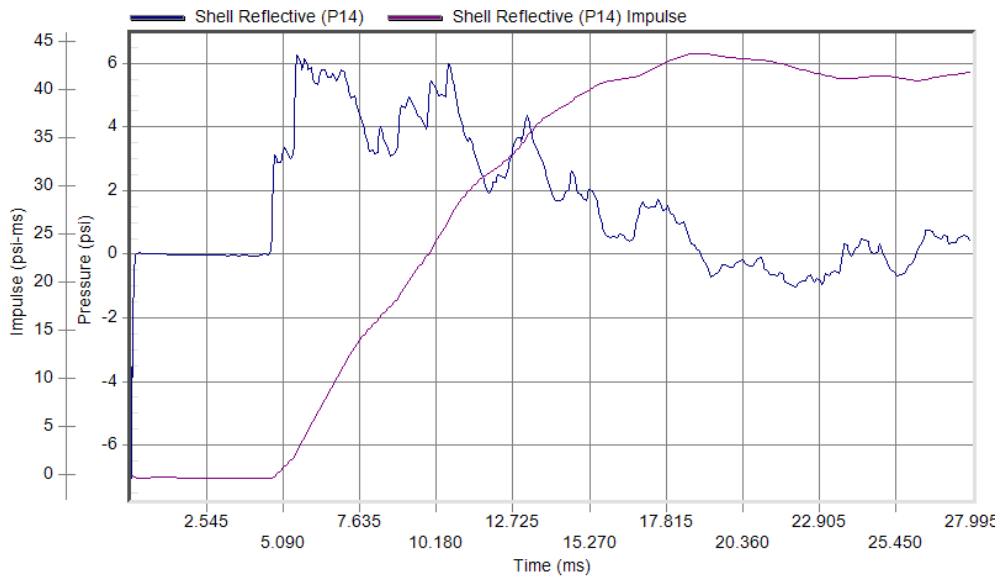
Test Date: 7/16/2014
Test Time: 3:57 pm

Specimen #14:



Peak Pressure: 7.27 psi at 5.45 ms
Duration: 13.27 ms

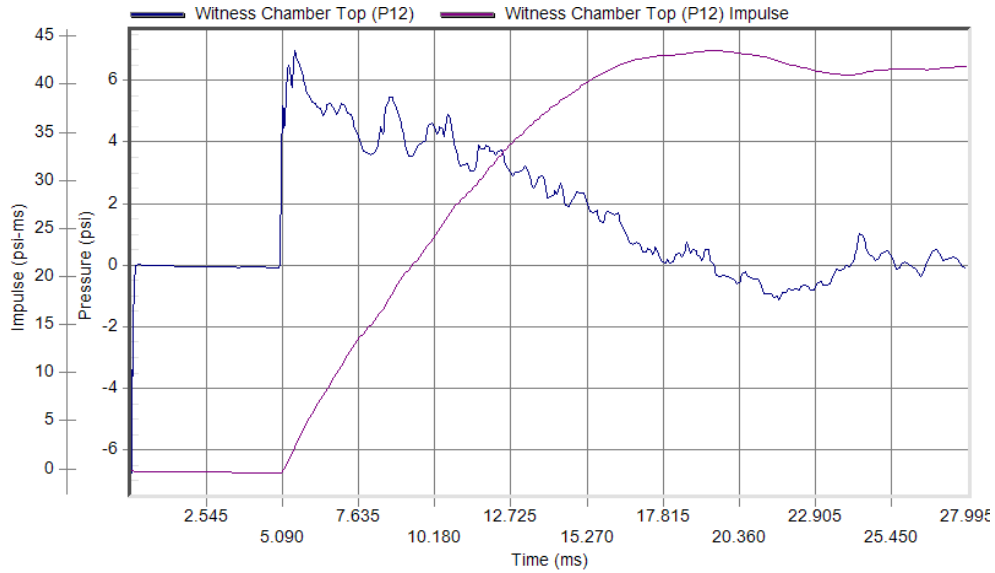
Test Date: 9/9/2014
Test Time: 1:33 pm



Peak Pressure: 6.31 psi at 5.60 ms
Duration: 13.34 ms

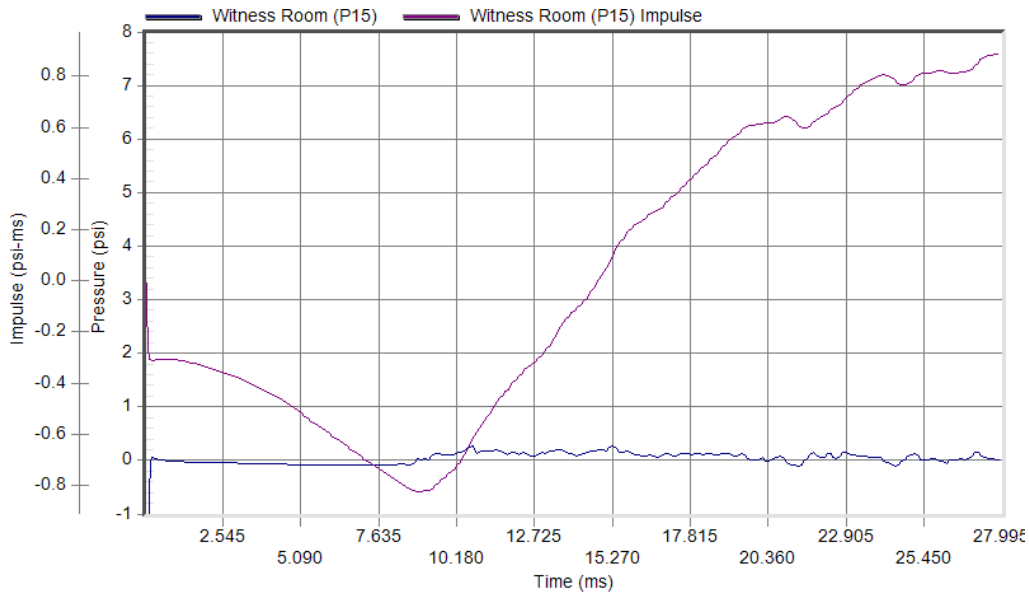
Test Date: 9/9/2014
Test Time: 1:33 pm

Specimen #14: (Continued)



Peak Pressure: 6.98 psi at 5.52 ms
Duration: 12.53 ms

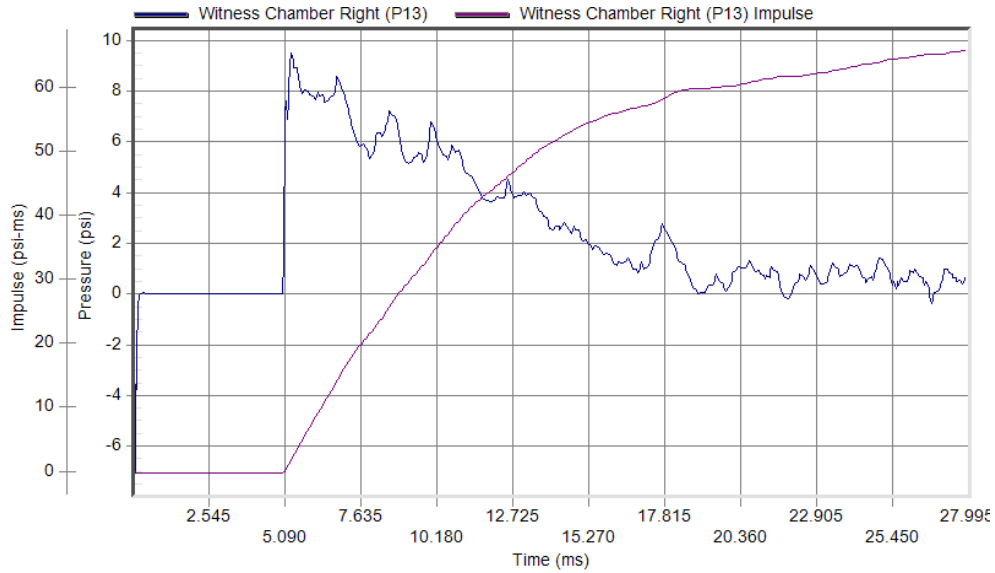
Test Date: 9/9/2014
Test Time: 1:33 pm



Peak Pressure: 0.27 psi at 15.27 ms
Duration: 4.68 ms

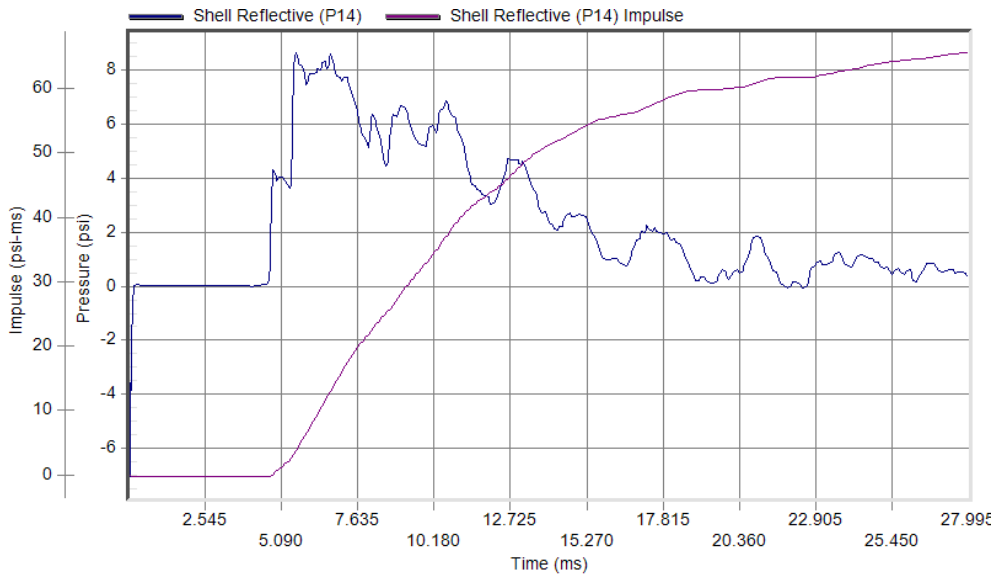
Test Date: 9/9/2014
Test Time: 1:33 pm

Specimen #15:



Peak Pressure: 9.62 psi at 5.30 ms
Duration: 13.60 ms

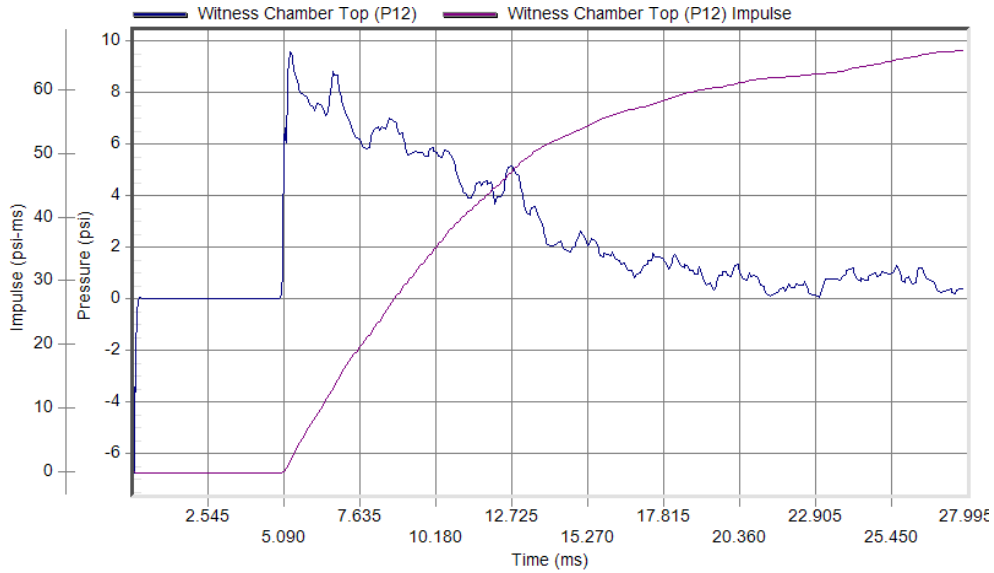
Test Date: 9/10/2014
Test Time: 3:15 pm



Peak Pressure: 8.66 psi at 5.60 ms
Duration: 16.15 ms

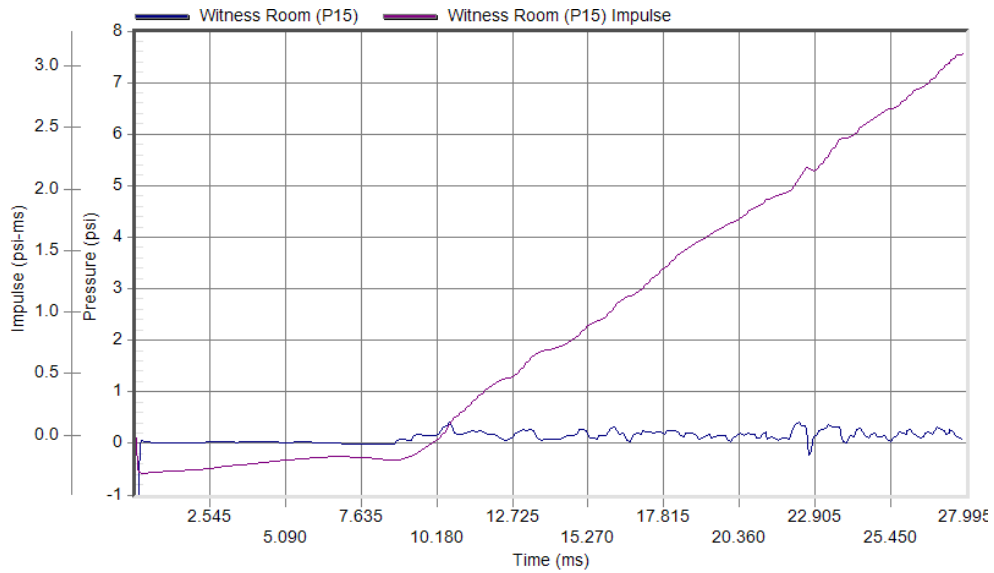
Test Date: 9/10/2014
Test Time: 3:15 pm

Specimen #15: (Continued)



Peak Pressure: 9.65 psi at 5.32 ms
Duration: 17.68 ms

Test Date: 9/10/2014
Test Time: 3:15 pm



Peak Pressure: 0.41 psi at 10.63 ms
Duration: 12.04 ms

Test Date: 9/10/2014
Test Time: 3:15 pm

APPENDIX C

Photographs



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

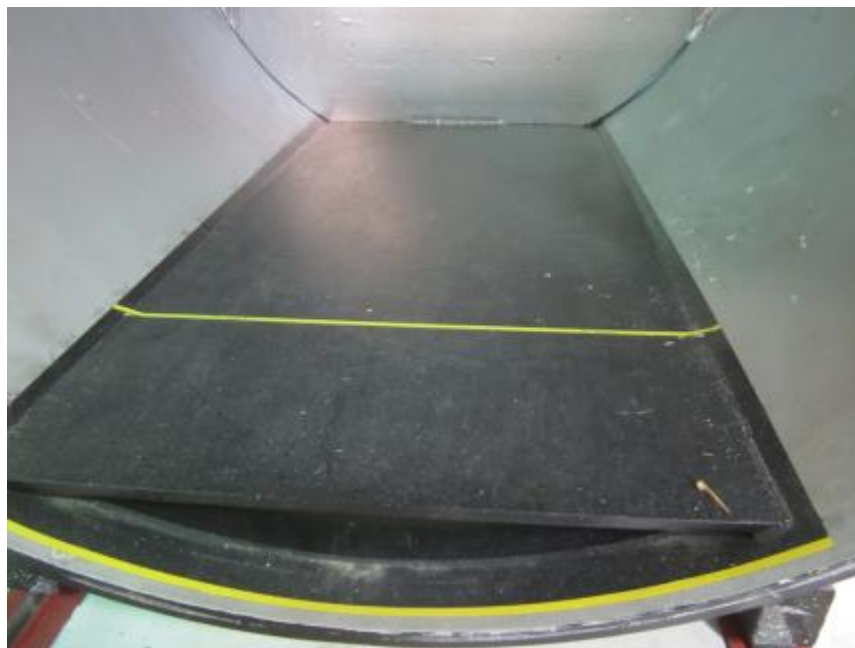


Photo No. 2
Post-test Specimen #1, Witness Chamber



Photo No. 3
Post-test Specimen #1, Interior

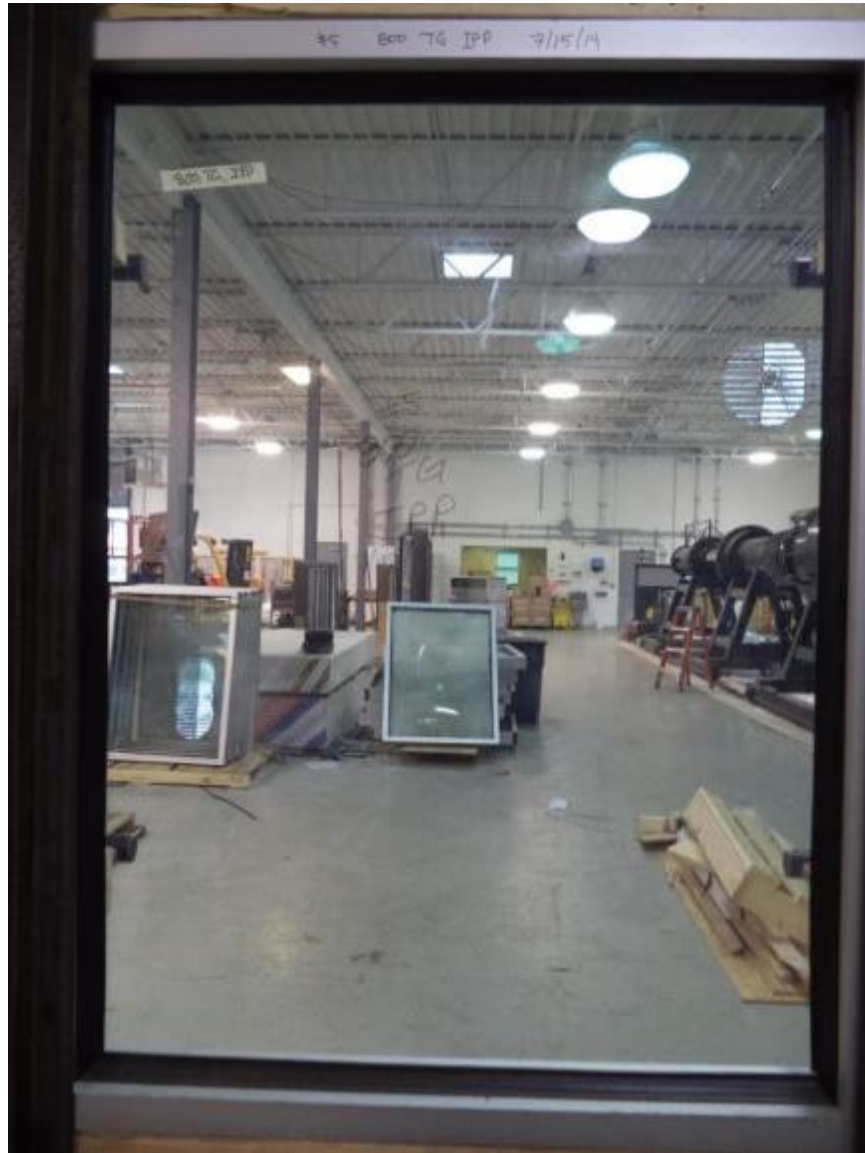


Photo No. 4
Pre-test Specimen #2, Interior



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

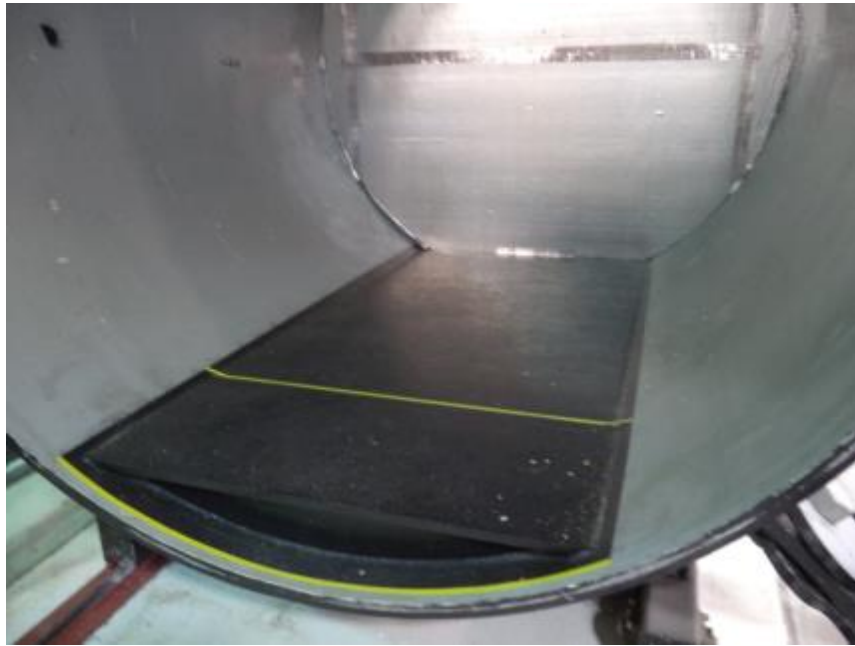


Photo No. 6
Post-test Specimen #2, Witness Chamber



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



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



Photo No. 9
Pre-test Specimen #4, Interior

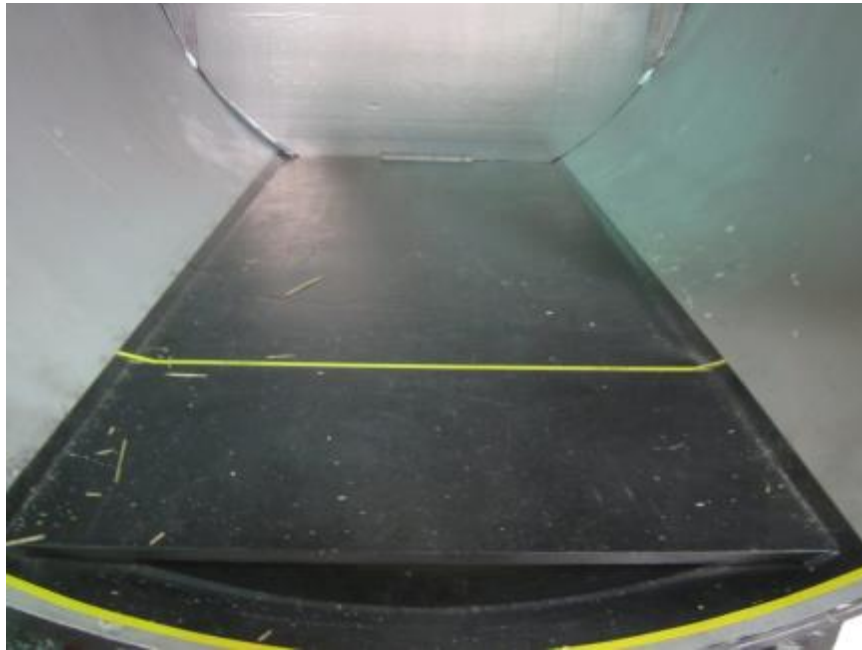


Photo No. 10
Post-test Specimen #4, Witness Chamber

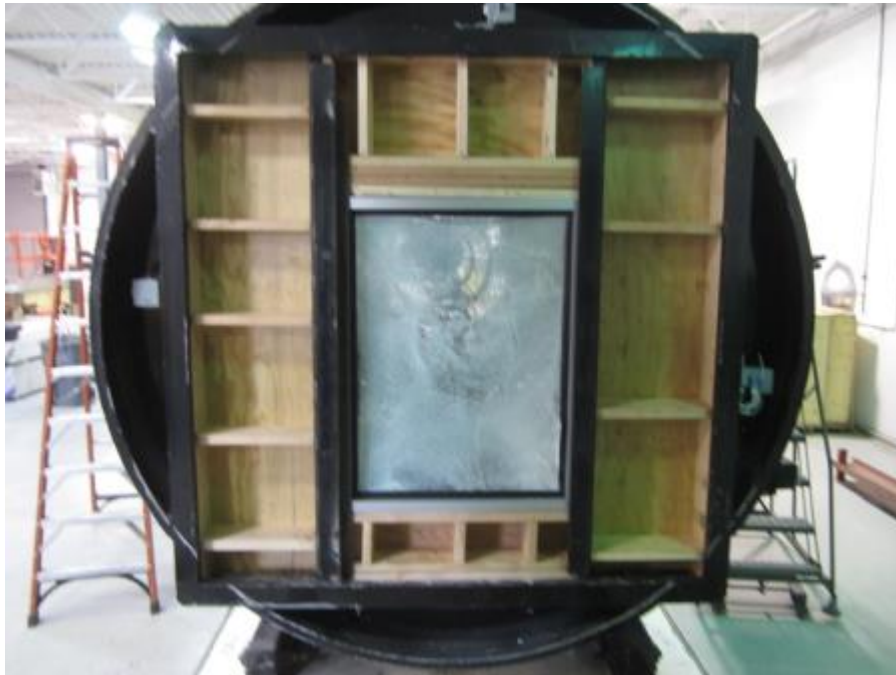


Photo No. 11
Post-test Specimen #4, Interior

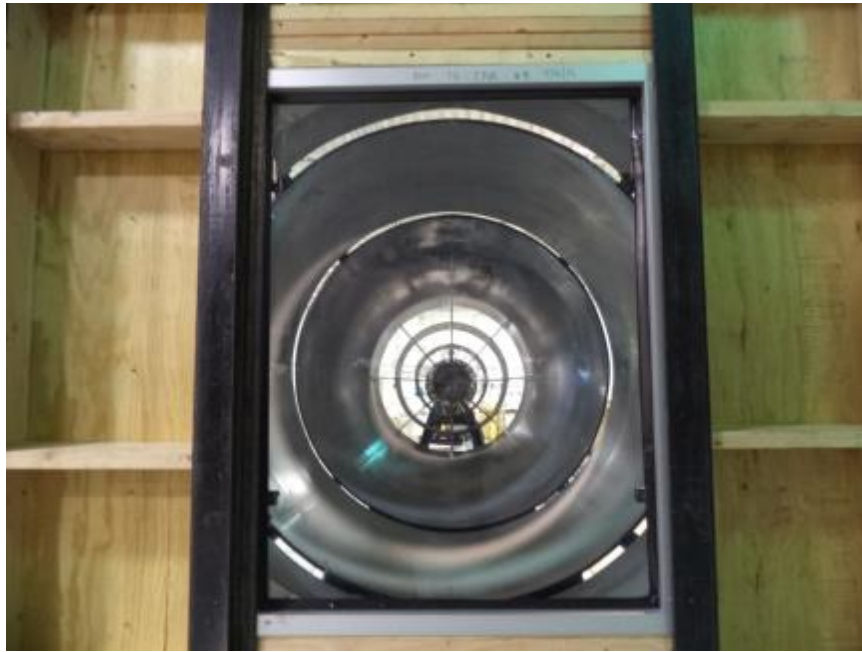


Photo No. 12
Pre-test Specimen #5, Interior



Photo No. 13
Post-test Specimen #5, Witness Chamber



Photo No. 14
Post-test Specimen #5, Interior



Photo No. 15
Pre-test Specimen #6, Interior



Photo No. 16
Post-test Specimen #6, Interior

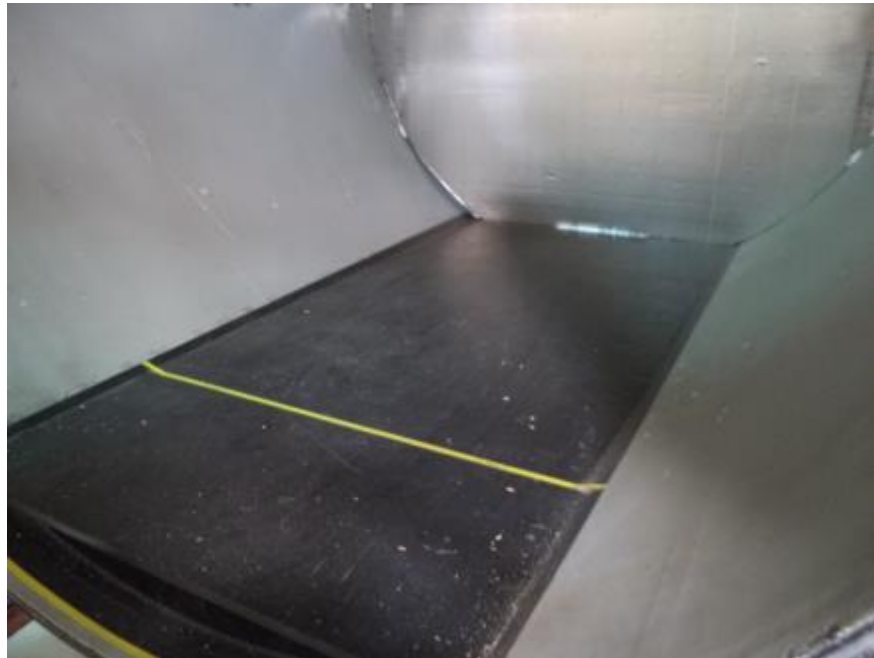


Photo No. 17
Post-test Specimen #6, Witness Chamber



Photo No. 18
Pre-test Specimen #7, Interior



Photo No. 19
Post-test Specimen #7, Interior



Photo No. 20
Post-test Specimen #7, Witness Chamber



Photo No. 21
Pre-test Specimen #8, Interior



Photo No. 22
Post-test Specimen #8, Interior

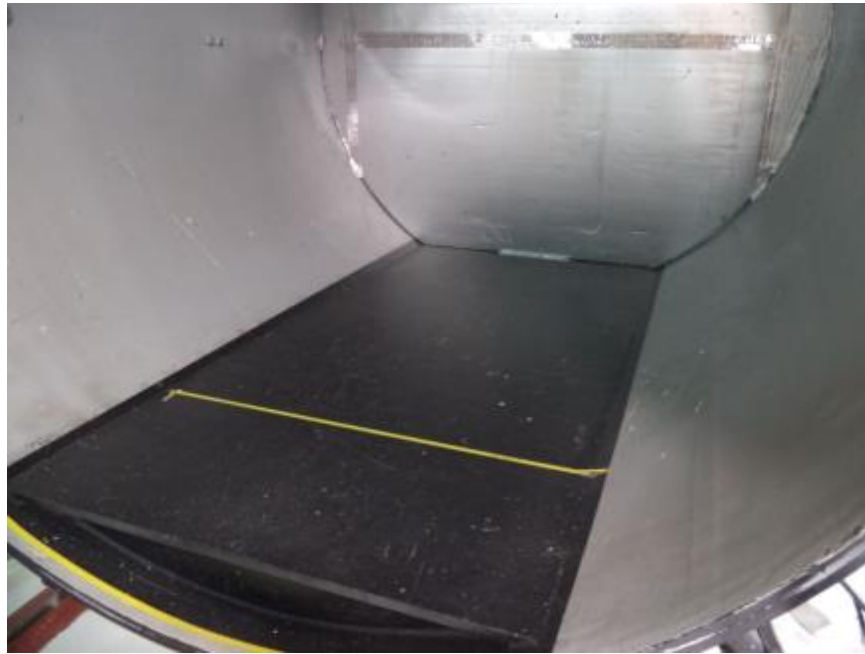


Photo No. 23
Post-test Specimen #8, Witness Chamber



Photo No. 24
Pre-test Specimen #9, Interior



Photo No. 25
Post-test Specimen #9, Interior



Photo No. 26
Pre-test Specimen #10, Interior



Photo No. 27
Post-test Specimen #10, Interior

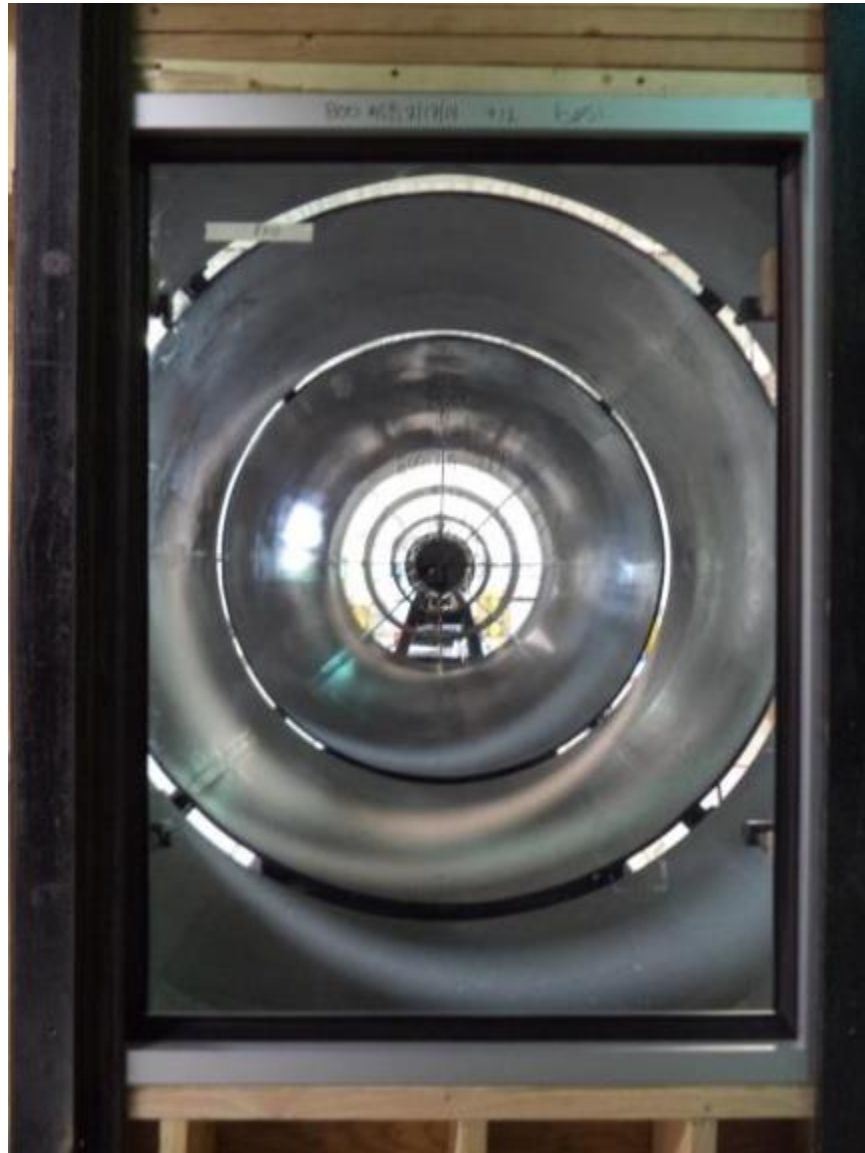


Photo No. 28
Pre-test Specimen #11, Interior



Photo No. 29
Post-test Specimen #11, Interior

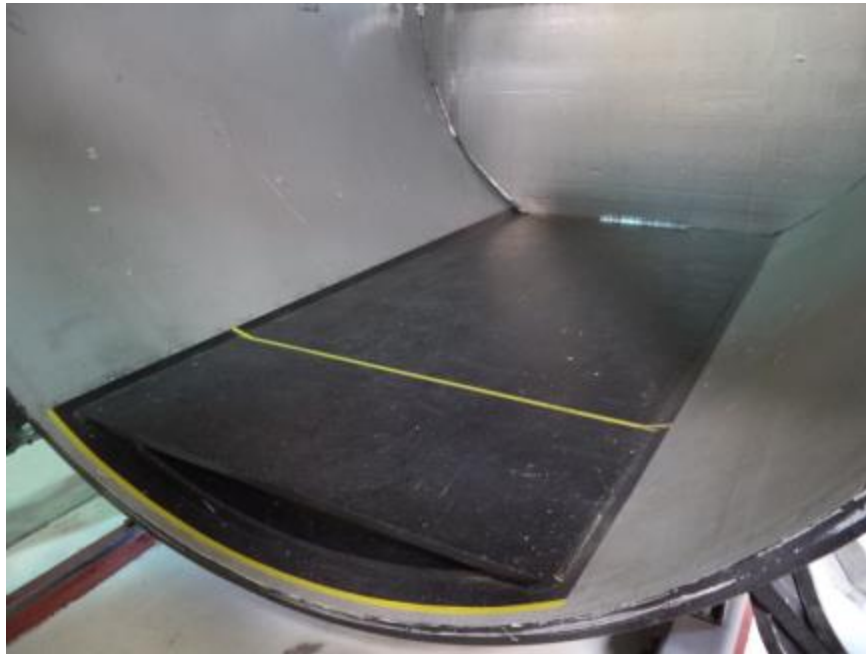


Photo No. 30
Post-test Specimen #11, Witness Chamber



Photo No. 31
Pre-test Specimen #12, Interior



Photo No. 32
Post-test Specimen #12, Interior



Photo No. 33
Pre-test Specimen #13, Interior



Photo No. 34
Post-test Specimen #13, Interior

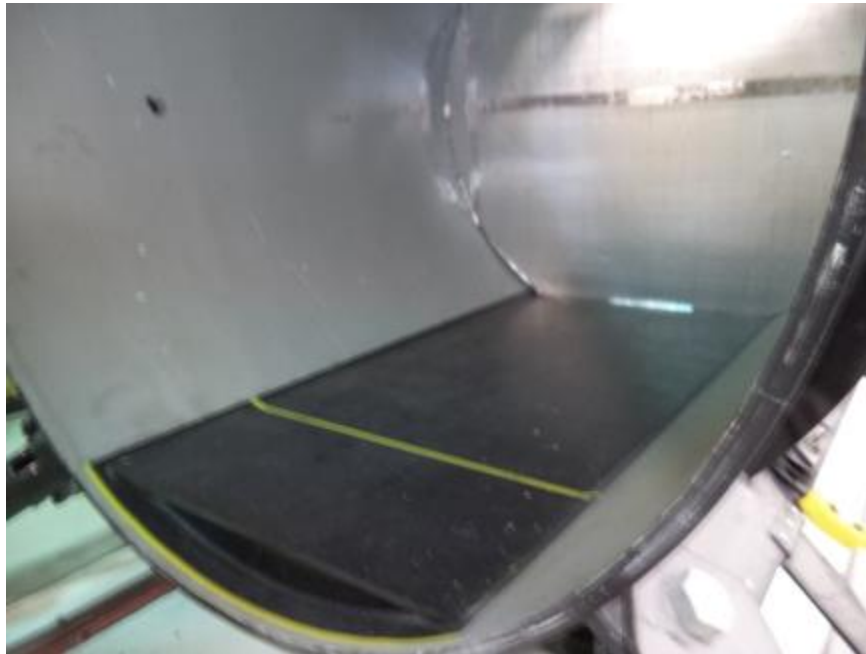


Photo No. 35
Post-test Specimen #13, Witness Chamber



Photo No. 36
Pre-test Specimen #14, Interior



Photo No. 37
Post-test Specimen #14, Interior

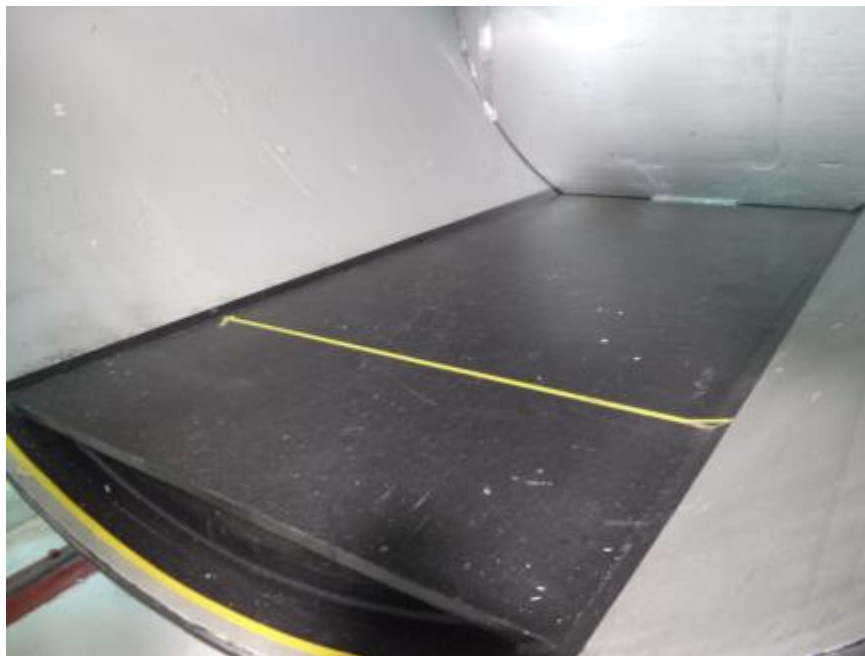


Photo No. 38
Post-test Specimen #14, Witness Chamber



Photo No. 39
Pre-test Specimen #15, Interior



Photo No. 40
Post-test Specimen #15, Interior

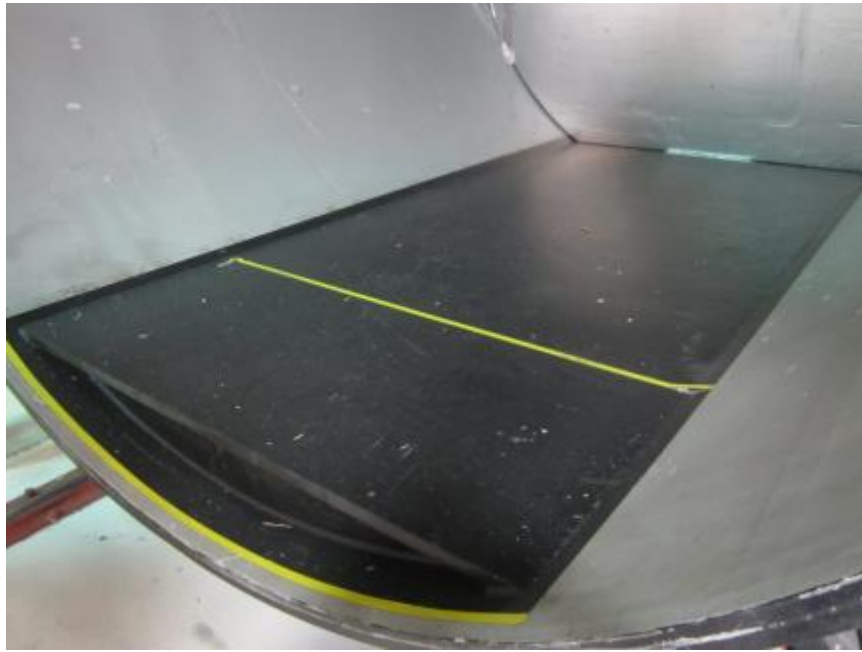
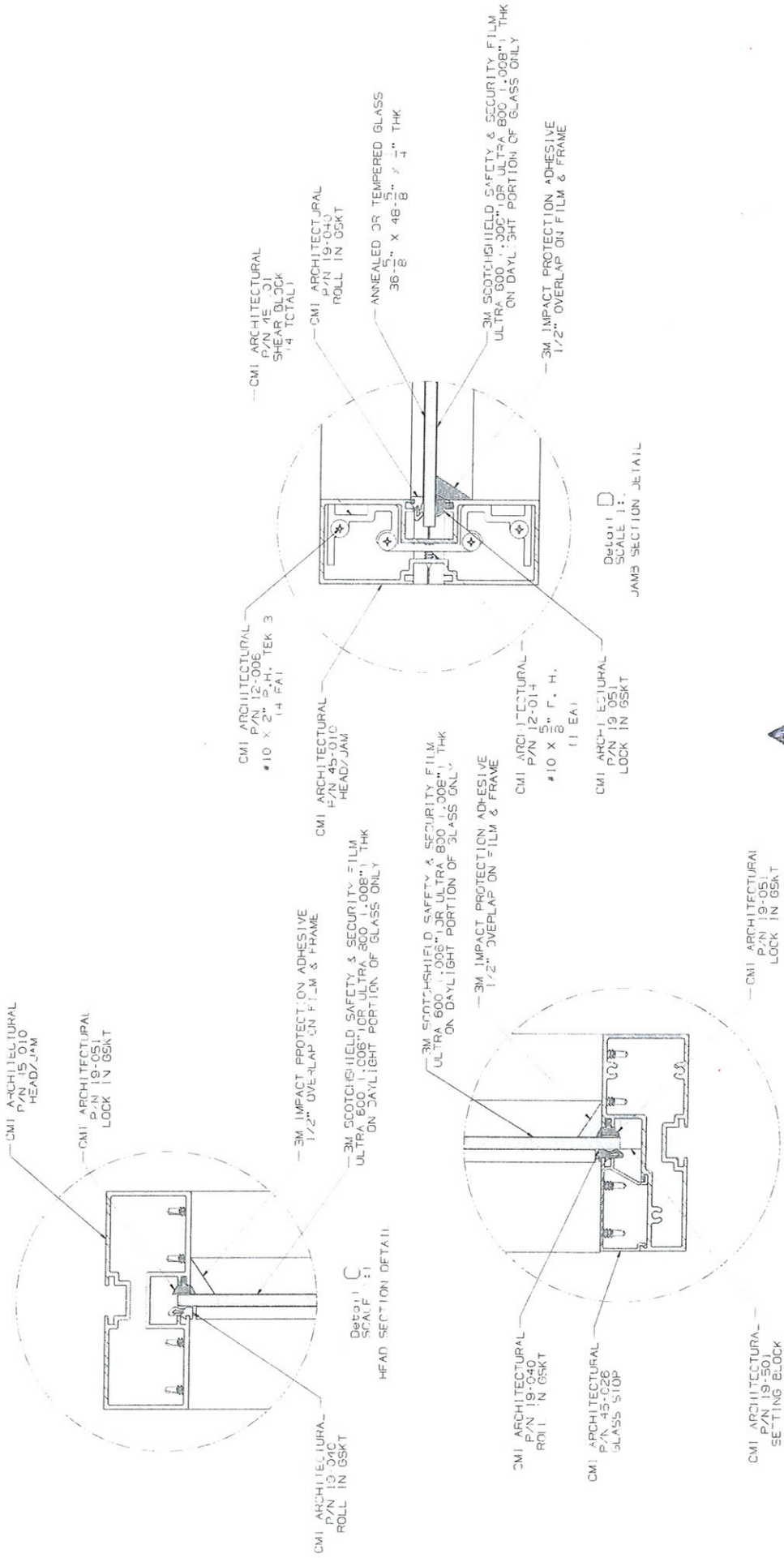


Photo No. 41
Post-test Specimen #15, Witness Chamber

APPENDIX D

Drawings



Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report # **D89162**

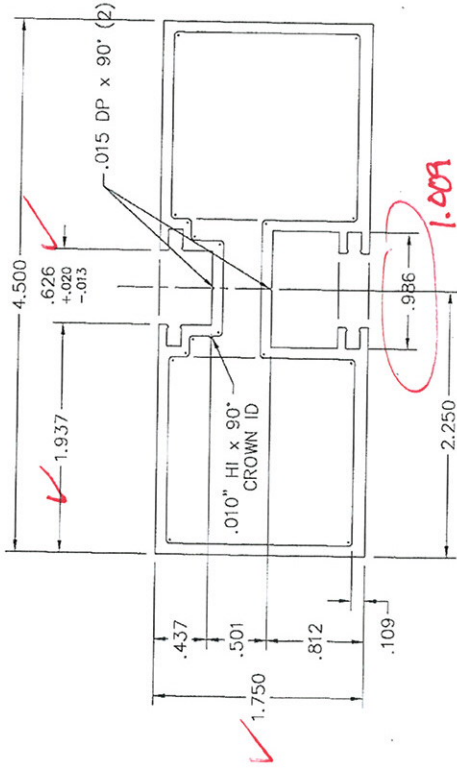
Date **10/14/14** Tech **Ed**

DATE	05-20-2014
SCALE	AS SHOWN
PROJECT	3M
TEST TYPE	IMPACT
TEST STANDARD	ASTM E1886
TEST RESULT	PASS
TESTER	3M
TEST LOCATION	3M
TEST NUMBER	1
TEST DATE	05-20-2014
TEST TIME	09:00 AM
TEST DURATION	1.5 HRS
TEST COMMENTS	SINGLE PANE WINDOW ULTRA 600 SAFETY FILM CLEAR ULTRA SAFETY FILM AND IPA
TESTER SIGNATURE	[Signature]
TESTER TITLE	TEST ENGINEER
TESTER COMPANY	3M
TESTER PHONE	612-552-3000
TESTER FAX	612-552-3000
TESTER EMAIL	TESTING@3M.COM
TESTER WEBSITE	WWW.3M.COM
TESTER ADDRESS	3M CENTER DRIVE ST. PAUL, MN 55144-0001
TESTER CITY	ST. PAUL, MN
TESTER STATE	MINN.
TESTER ZIP	55144
TESTER COUNTRY	USA
TESTER PHONE	612-552-3000
TESTER FAX	612-552-3000
TESTER EMAIL	TESTING@3M.COM
TESTER WEBSITE	WWW.3M.COM
TESTER ADDRESS	3M CENTER DRIVE ST. PAUL, MN 55144-0001
TESTER CITY	ST. PAUL, MN
TESTER STATE	MINN.
TESTER ZIP	55144
TESTER COUNTRY	USA

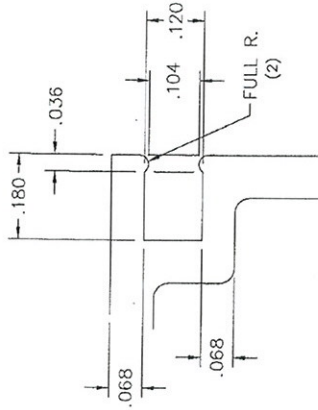
FRONT REVISIONS	DATE

12580
Die Number
45-010
Customer Number

ACTUAL SIZE



ENTIRE OUTSIDE SURFACE EXPOSED



DETAIL "A"
4 x SIZE



Test sample complies with these details.
Deviations are noted.

Report # **D8962**

Date **10/14/14** Tech **ESP**

STANDARD TOLERANCES APPLY UNLESS OTHERWISE NOTED

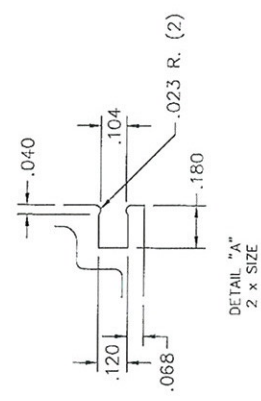
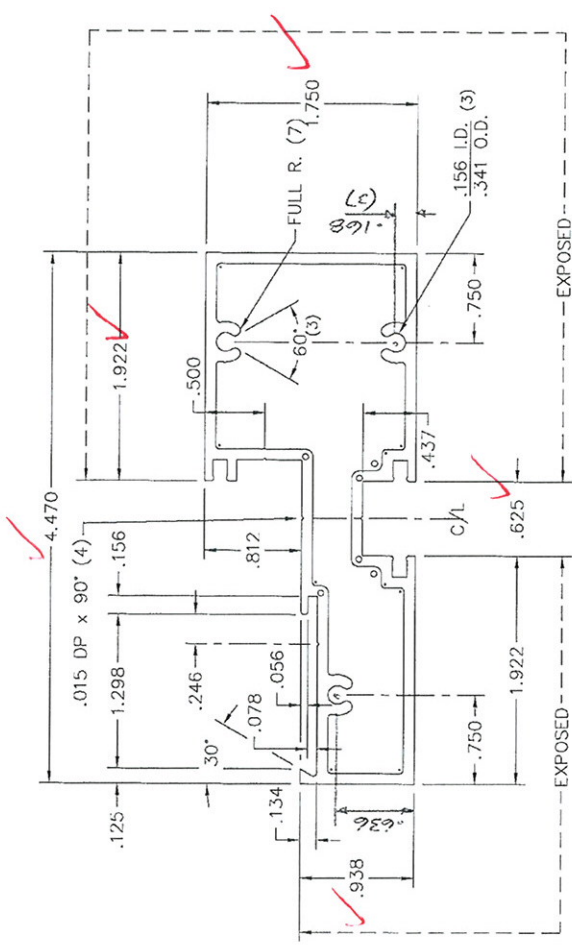
03-24-11 added .625 tolerance
TYPICAL WALL UNLESS OTHERWISE NOTED: .090

BREAK UNSPECIFIED CORNER: .010 R.		DIE # 12580	
ESTIMATED DIE DATA		SCALE FULL & NOTED	
ALLOY/TEMPER: 6063-T5	AREA 1.445 WT/FT 1.733	DATE 12-11-08	
PERIMETER 31.168	SIZE 4 - 5	LAST REVISION 03-24-11	
OUTSIDE PERIMETER 17.197	FACTOR 18	DRAWN TCC	
EXPOSED PERIMETER 17.197	HOLLOW	CUSTOMER NUMBER 45-010	
LEGEND		PART NAME MULLION	
<ul style="list-style-type: none"> • = .031 R. ◦ = .062 R. x = .125 R. ⊗ = .250 R. * = 		<p>Crown Extrusions, Inc. 122 Columbia Court N. Chaska, MN 55318 952-446-3333 Fax: 952-446-3328</p> <p>CMI Architectural CMI Architectural Products, Inc. 20621 SD Highway 25 DeSmet, SD 57231-5827 605-864-3326 Fax: 605-864-3620</p>	

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

CRM-44

REV. DELHI TIFTON BOTH



Test sample complies with these details.
Deviations are noted.

Report # **D9962**
Date **10/14/14** Tech **COX**

ESTIMATED DIE DATA		DIE DATA	
INTERNAL USEL	6063-T5	WT/FT	1.624
AREA	1.354	CIRCLE SIZE	4 - 5
PERMETER	29.721	FACTOR	18
SAFETY PERMETER	15.421	HOLLOW II	
EXPOSED PERMETER		DATE	

LEGEND	
•	.031 R.
◦	.062 R.
x	.125 R.
⊗	.250 R.

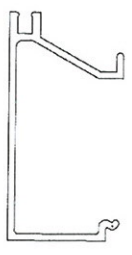
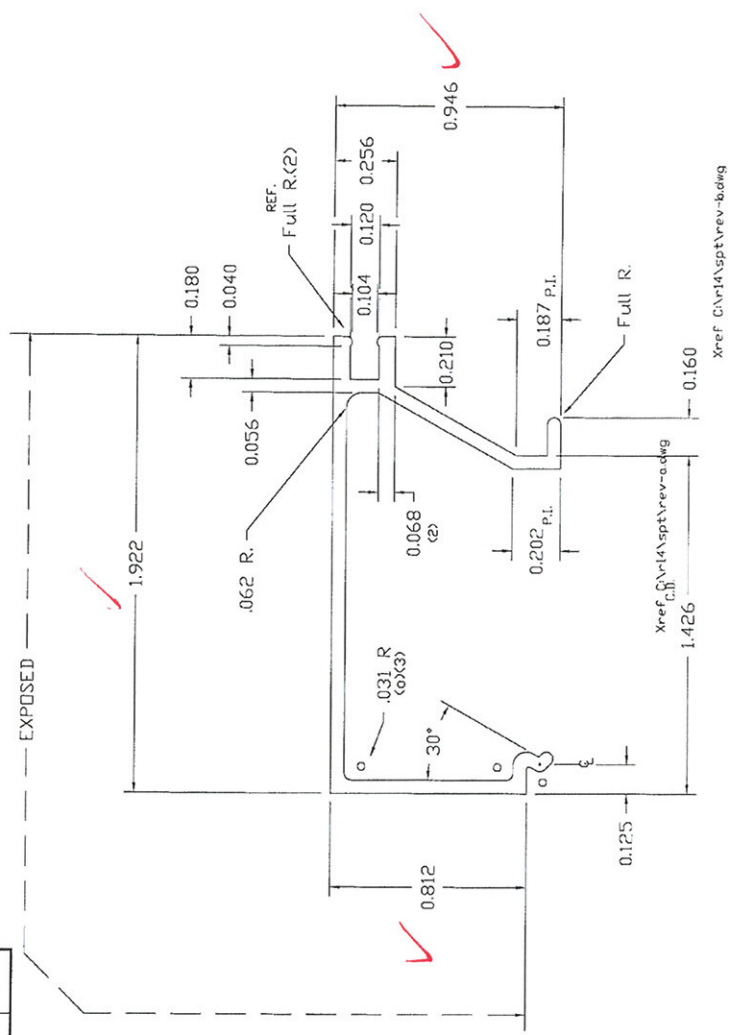
BREAK UNSPECIFIED CORNERS	.010 R.	.090 TYPICAL WALL UNLESS SPECIFIED OTHERWISE.
CAD #	CRM-44	350
SCALE	FULL & NOTED	
DATE	7-29-98	
LAST REVISION		
DRAWN	Michael Brycam	
JOB		
CUSTOMER NUMBER	45-018	

CUSTOMER	sapa: Sapa Extrusions, Inc. BEILIA71232
CUSTOMER	CMI ARCHITECTURAL PRODUCTS
CUSTOMER	2800 FREEWAY BOULEVARD
CUSTOMER	SUITE 205
CUSTOMER	MINNEAPOLIS, MN 55430
APPLICATION	F.G. SILL 1/4"

CRM-49 B

REV. DELHI TIFTON BOTH

PRINT REVISIONS	DATE



Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report # **08962**

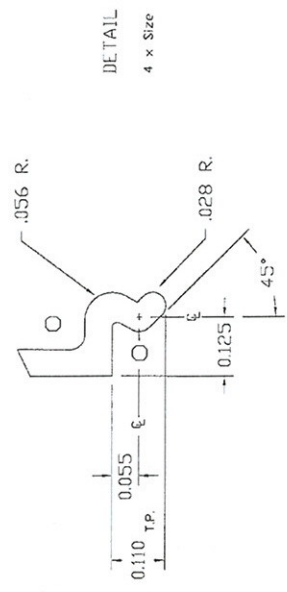
Date **10/14/14** Tech **EAR**

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

sapa: Sapa Extrusions, Inc. DELU, LA 71232		SCALE 2 x & Noted
CUSTOMER CRONSTROMS		DATE 10-31-88
MINNEAPOLIS, MN		LAST REVISION
APPLICATION SILL STOP 1/4" TO 1"		DRAWN J. ALBERIZ
JOB		CUSTOMER NUMBER 45-026

ESTIMATED DIE DATA	
INTERNAL USE	6063-T5
AREA	.243
WT/FT	.291
PERIMETER	8.478
CIRCLE SIZE	2-3
PIUNIFORM	FACTOR 29
EXPOSED PERIMETER	2.734
DATE	1-5-88
A REF. DESIGNED	2-13-89
B SHORTENED LEG	

LEGEND	
○	.031 R
○	.062 R
x	.125 R
⊗	.250 R
*	*

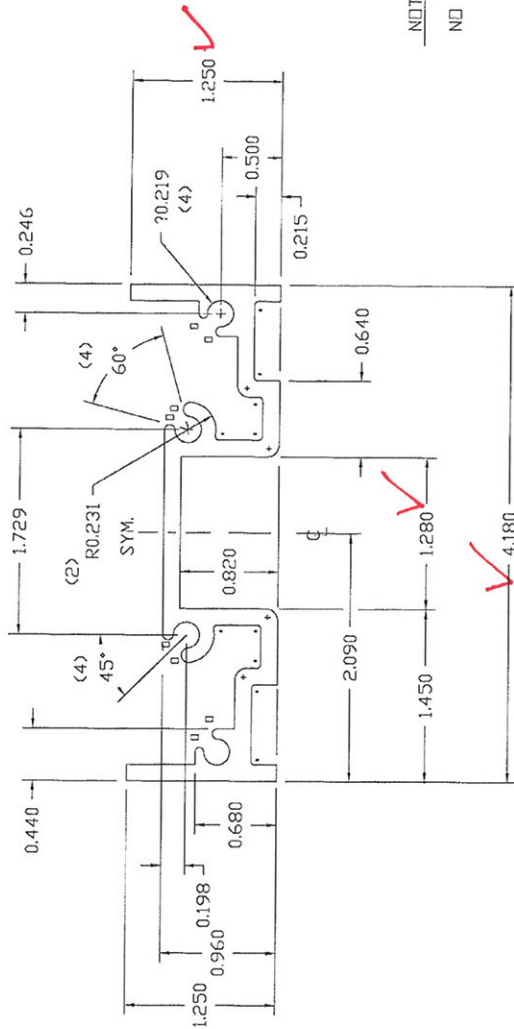


CRM-62

REV.

DELHI TIFTON BOTH

PRINT REVISIONS	DATE



NOTE:
 NO EXPOSED SURFACE
 Test sample complies with these details.
 Deviations are noted.

Report # D89167

Date 10/17/14 Tech EAR

LEGEND:

- = 0.031 R. (10)
- + = 0.100 R. (4)
- u = FULL R. (8)

BREAK UNSPECIFIED CORNERS 0.010 R. 0.140 TYPICAL WALL UNLESS SPECIFIED OTHERWISE.

ESTIMATED DIE DATA		DATE	
INTERNAL USE	6063-T5	SCALE	ACTUAL
AREA	1.389	W/FT	1.667
PERIMETER	23.555	CIRCLE SIZE	4-5
OUTSIDE PERIMETER		FACTOR	12
EXPOSED PERIMETER		DATE	
DIE REVISIONS			
PRINTS SIZE			
LEGEND			
• = 0.031 R.			
+ = 0.100 R.			
x = 0.125 R.			
⊗ = 0.250 R.			
* =			
sapa: Sapa Extrusions, Inc. DELHI, LA 71332		CAND # MRC---10 010	
CUSTOMER		SCALE	
CRONSTROMS		ACTUAL	
MINNEAPOLIS, MINN.		DATE	
		12-3-88	
		LAST REVISION	
		BRANN, M. COPEL	
		JOB	
		CUSTOMER NUMBER	
		32-002	
APPLICATION		MULL. CLIP	