ASTM F 1642-04/GSA TS01
TEST REPORT

Rendered to:

UNITED STATES ALUMINUM

SERIES/MODEL: BW3250
PRODUCT TYPE: Aluminum Combination Fixed Window

<table>
<thead>
<tr>
<th>Title</th>
<th>Test Specimen #1</th>
<th>Test Specimen #2</th>
<th>Test Specimen #3</th>
<th>Test Specimen #4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASTM Hazard Rating</td>
<td>Very Low Hazard</td>
<td>Very Low Hazard</td>
<td>Low Hazard</td>
<td>Low Hazard</td>
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<tr>
<td>GSA Performance Condition</td>
<td>4</td>
<td>2</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Average Peak Blast Pressure</td>
<td>6.7 psi</td>
<td>6.6 psi</td>
<td>7.1 psi</td>
<td>7.2 psi</td>
</tr>
<tr>
<td>Average Positive Phase Impulse</td>
<td>47 psi-msec</td>
<td>45 psi-msec</td>
<td>47 psi-msec</td>
<td>46 psi-msec</td>
</tr>
<tr>
<td>Average Positive Phase Duration</td>
<td>13 sec</td>
<td>13 msec</td>
<td>14 msec</td>
<td>13 msec</td>
</tr>
</tbody>
</table>

This report contains in its entirety:
- Cover Page: 1 page
- Report Body: 9 pages
- Test Facility: 1 page
- Pressure-Time Plots: 8 pages
- Photographs: 8 pages
- Drawings: 20 pages

Reference should be made to Architectural Testing, Inc. Report No. A8997.01-122-12 for complete test specimen description and data.
Project Summary: Architectural Testing, Inc. was contracted by United States Aluminum to perform testing on four Series/Model BW3250 aluminum combination fixed windows. Test specimen descriptions and results are reported herein. The samples were provided by the client.

Test Specification: The test specimens were evaluated in accordance with:


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.

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.

Drawing Reference: The attached drawings have been verified by Architectural Testing, Inc. and are representative of the samples tested. Drawings are provided in Appendix D.
Test Specimen Description: The following descriptions apply to all specimens.

Test Series/Model: BW3250 System

Product Type: Combination Fixed Window

Overall Size: 82-3/4" wide by 82-3/4" high

Interior Top Left Fixed Daylight Opening: 23" wide by 69-1/2" high

Interior Top Right Fixed Daylight Opening: 52-1/2" wide by 69-1/2" high

Interior Bottom Left Fixed Daylight Opening: 23" wide by 6" high

Interior Bottom Right Fixed Daylight Opening: 52-1/2" wide by 6" high

Overall Area: 47.55ft²

Reinforcement: No reinforcement was utilized.

Finish: Aluminum

Glazing Details: Each lite was glazed with a 1" thick insulating glass unit. The outboard lite was constructed of 1/4" thick clear annealed glass and the inboard lite was constructed of 1/4" thick clear laminated glass separated by an aluminum spacer system. The laminated glass was constructed of two sheets of 1/8" thick clear annealed glass separated by a 0.030" thick PVB Butacite® interlayer. The glazing was installed from the exterior onto a bed of silicone sealant with a rubber gasket spacer against the glass. The exterior side was secured with an aluminum pressure plate and rubber gasket. The pressure plate was secured to the screw race of the framing members with 1/4" x 1" hex head screws spaced approximately 9" on center. The glazing bite measured 5/8". An aluminum snap cover was installed over the pressure plate.

Note #1: The tested glazing represents the minimum allowable glazing thickness as per section B-3.1.1.1 and Table B-3.
Test Specimen Description: (Continued)

**Frame Construction:** All frame members were constructed of extruded aluminum, with coped and butted corners and sealed with silicone sealant. All horizontal to vertical connections utilized a shear block. Three 5/8" x 5" long bolts were used at each shear block connection to the vertical jambs and three 5/8" x 7" long bolts were used at all shear block connection to the intermediate mullion. Bolts extended through the vertical member and shear block and were secured with a washer and lock nut. Horizontal members were secured to the shear block with four #12 x 1" flat head screws extending through the horizontal into the shear block.

**Hardware:** No hardware was utilized.

**Installation:** Each specimen was installed into a C8 steel channel test buck. "F" and "T" style anchors were used at the head and sill of the intermediate vertical mullion and at the head and sill of each vertical jamb member. "F" style anchors were secured to the steel channel with four 1/2" grade 5 bolts in a 2" x 3" square pattern in the center of the "F" style anchor. "T" style anchors were secured to the steel channel with four 1/2" grade 5 bolts, two bolts on each side of the anchor, 1-1/4" in from each end spaced 3" apart.
**Test Results:** The results are tabulated as follows:

**Test Specimen #1:**

<table>
<thead>
<tr>
<th>Description</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient Temperature</td>
<td>63°F</td>
</tr>
<tr>
<td>Glazing Temperature</td>
<td>66°F</td>
</tr>
<tr>
<td>Peak Positive Pressure</td>
<td></td>
</tr>
<tr>
<td>Top Pressure</td>
<td>6.7 psi</td>
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<tr>
<td>Right Pressure</td>
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<tr>
<td>Shell Pressure</td>
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<td>Positive Phase Duration</td>
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<td>Top Duration</td>
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<td>Right Duration</td>
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<tr>
<td>Average Duration</td>
<td>13 msec</td>
</tr>
<tr>
<td>Positive Phase Impulse</td>
<td></td>
</tr>
<tr>
<td>Top Impulse</td>
<td>47 psi-msec</td>
</tr>
<tr>
<td>Right Impulse</td>
<td>47 psi-msec</td>
</tr>
<tr>
<td>Shell Impulse</td>
<td>46 psi-msec</td>
</tr>
<tr>
<td>Average Impulse</td>
<td>47 psi-msec</td>
</tr>
</tbody>
</table>

- No pressure rise was measured on the protected side of the specimen.

- Two 24” long tears in the laminate of the large lite and approximately 8” pull-out along the left jamb. One tear approximately 16” long on the large side lite. Total tears and pull-out for the large lite was greater than 20% of the sight perimeter.

- Fragments were observed in the witness area, with a sum total united dimension less than 10” in the 1m-3m area. Three impacts on the back wall were observed below the 24” line.

**ASTM Hazard Rating:** Very Low Hazard

**GSA Performance Condition:** 4

Pressure-time plots are presented in Appendix B. Pre-test and post-test photographs are provided in Appendix C.
Test Results: (Continued)

**Test Specimen #2:**

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<tr>
<td>Glazing Temperature</td>
<td>64°F</td>
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<tr>
<td>Peak Positive Pressure</td>
<td></td>
</tr>
<tr>
<td>Top Pressure</td>
<td>6.8 psi</td>
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<tr>
<td>Right Pressure</td>
<td>6.8 psi</td>
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<td>Right Duration</td>
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</tr>
<tr>
<td>Average Impulse</td>
<td>45 psi-msec</td>
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</table>

- No pressure rise was measured on the protected side of the specimen.
- A 14-1/2" tear in the laminate was observed at the top center of the large lite and 43" of pull-out was observed along the right jamb of the large lite. Total tears and pull-out for the large lite was greater than 20% of the sight perimeter.
- Dusting of glass in the witness area. No fragments or damage to the back panel was observed.

ASTM Hazard Rating: Very Low Hazard

GSA Performance Condition: 2

Pressure-time plots are presented in Appendix B. Pre-test and post-test photographs are provided in Appendix C.
Test Results: (Continued)

Test Specimen #3:

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<tr>
<th>Description</th>
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<td>Peak Positive Pressure</td>
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<tr>
<td>Top Pressure</td>
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<tr>
<td>Right Pressure</td>
<td>7.4 psi</td>
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<td>Top Duration</td>
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<td>Right Duration</td>
<td>14 msec</td>
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<tr>
<td>Shell Duration</td>
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<tr>
<td>Average Duration</td>
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<tr>
<td>Positive Phase Impulse</td>
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<tr>
<td>Top Impulse</td>
<td>47 psi-msec</td>
</tr>
<tr>
<td>Right Impulse</td>
<td>47 psi-msec</td>
</tr>
<tr>
<td>Shell Impulse</td>
<td>46 psi-msec</td>
</tr>
<tr>
<td>Average Impulse</td>
<td>47 psi-msec</td>
</tr>
</tbody>
</table>

- No pressure rise was measured on the protected side of the specimen.

- A 43" long vertical tear in the laminate was observed at the center of the large lite. No pull-out was observed at the perimeter glazing.

- Multiple fragments were observed in the witness area with approximately 63" sum total united dimensions in the 1m-3m area. Thirteen indents were observed in the wall panel below the 24" line.

ASTM Hazard Rating: Low Hazard

GSA Performance Condition: 4

Pressure-time plots are presented in Appendix B. Pre-test and post-test photographs are provided in Appendix C.
Test Results: (Continued)

Test Specimen #4:

<table>
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<th>Description</th>
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<tbody>
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<tr>
<td>Glazing Temperature</td>
<td>67°F</td>
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</tbody>
</table>

Peak Positive Pressure

- Top Pressure: 7.3 psi
- Right Pressure: 7.4 psi
- Shell Pressure: 6.8 psi
- Average Pressure: 7.2 psi

Positive Phase Duration

- Top Duration: 13 msec
- Right Duration: 13 msec
- Shell Duration: 13 msec
- Average Duration: 13 msec

Positive Phase Impulse

- Top Impulse: 46 psi-msec
- Right Impulse: 47 psi-msec
- Shell Impulse: 46 psi-msec
- Average Impulse: 46 psi-msec

- No pressure rise was measured on the protected side of the specimen.

- A 43" horizontal tear in the laminate was observed at the center of the large lite, 39-1/2" of pull-out was observed out along the mullion and 29-1/2" pull-out was observed along the left jamb of the large lite. Total tears and pull-out for the large lite was greater than 20% of the sight perimeter.

- Multiple fragments were observed in the witness area with approximately 14" sum total united dimensions in the 1m-3m area. One fragment indent was observed on the back witness panel, 1" from the floor.

ASTM Hazard Rating: Low Hazard

GSA Performance Condition: 4

Pressure-time plots are presented in Appendix B. Pre-test and post-test photographs are provided in Appendix C.
List of Official Observers:

<table>
<thead>
<tr>
<th>Name</th>
<th>Company</th>
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<tbody>
<tr>
<td>Brady W. McNaughton, P.E.</td>
<td>Architectural Testing, Inc.</td>
</tr>
<tr>
<td>Russell W. Clark</td>
<td>Architectural Testing, Inc.</td>
</tr>
</tbody>
</table>

Detailed drawings, data sheets, representative samples of test specimens, a copy of this report, and 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 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 specimens tested. This report may not be reproduced, except in full, without the written approval of Architectural Testing, Inc.

For ARCHITECTURAL TESTING, INC:

Russell W. Clark  Brady W. McNaughton, P.E.
Technician        Senior Project Engineer

RWC:ddr/cmd

Attachments (pages): This report is complete only when all attachments listed are included.
- Appendix-A: Test Facility (1)
- Appendix-B: Pressure-Time Plots (8)
- Appendix-C: Photographs (8)
- Appendix-D: Drawings (20)
### Revision Log

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<th>Date</th>
<th>Page(s)</th>
<th>Revision(s)</th>
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<tr>
<td>0</td>
<td>05/05/11</td>
<td>N/A</td>
<td>Original report issue</td>
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</tbody>
</table>

This report produced from controlled document template ATI 00368, issued 04/13/09.
Appendix A

Test Facility
Figure #1
Shock Tube and Test Facility

Figure #2
Pressure Sensor Locations
Appendix B

Pressure-Time Plots
Specimen #1

Architectural Testing

Peak Pressure: 6.26 psi at 8.26 ms
Duration: 10.00 ms
Test Date: 4/20/2011
Test Time: 11:41 am

Peak Pressure: 7.07 psi at 5.32 ms
Duration: 14.04 ms
Test Date: 4/20/2011
Test Time: 11:41 am
Specimen #1: (Continued)

Peak Pressure: 6-69 psi at 5.30 ms
Duration: 13.25 ms

Test Date: 4/20/2011
Test Time: 11:41 am
Specimen #2

Peak Pressure: 6.21 psi at 7.21 ms
Duration: 11.02 ms

Test Date: 4/21/2011
Test Time: 12:24 pm

Peak Pressure: 6.83 psi at 5.31 ms
Duration: 13.76 ms

Test Date: 4/21/2011
Test Time: 12:24 pm
Specimen #2: (Continued)

[Graph showing pressure and impulse over time with specific details such as peak pressure of 6.77 psi at 5.31 ms, duration of 13.20 ms, test date of 4/21/2011, and test time of 12:24 pm.]
Specimen #3: (Continued)

![Graph showing pressure and impulse over time]

- Peak Pressure: 7.20 psi at 5.30 ms
- Duration: 13.22 ms
- Test Date: 4/21/2011
- Test Time: 4:26 pm
Specimen #4

**Peake Pressure:** 6.76 psi at 5.58 ms
**Duration:** 13.20 ms

**Test Date:** 4/25/2011
**Test Time:** 11:26 am

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**Witness Chamber Right (P13)**

**Peake Pressure:** 7.38 psi at 5.30 ms
**Duration:** 13.43 ms

**Test Date:** 4/25/2011
**Test Time:** 11:26 am
Specimen #4: (Continued)

Peak Pressure: 7.32 psi at 5.29 ms
Duration: 13.15 ms

Test Date: 4/25/2011
Test Time: 11:26 am
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
Photo No. 10
Pre-test Specimen #4, Interior

Photo No. 11
Post-test Specimen #4, Interior
Photo No. 12
Post-test Specimen #4, Witness Chamber
Appendix D

Drawings
Test sample complies with these details. Deviations are noted.

Report #: A8977.01-152-12

Date: 5/5/11   Tech: P-C-0W
Architectural Testing

Test sample complies with these details. Deviations are noted.

Report #: A8977.01-172-12
Date: 5/5/11  Tech: R. Clark

United States Aluminum
- 720 Cel-River Road
- Rock Hill, SC 29730
- 200 Singleton Drive
- Waxahachie, TX 75167

Series BR3250
BLAST WALL SYSTEM
FOR DOB

Details: VERT. MULLION

Subsidiary of International Aluminum Corporation

USA-3145  9 of 20
Architectural Testing

Test sample complies with these details.
Deviations are noted.
Report # A8771.01-122-12
Date 5/8/11  Tech RC

United States Aluminum
722 Col-River Road
Ridgefield, SC 29730
220 Singleton Drive
Waxahachie, TX 75165

Series BR3250
Blast Wall System
FDR DoD

Details
Shear Block
Details At Vertical

Size
Full USA-3145 10 of 20
Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report # A8977-01-122-12
Date 5/9/11 Tech R. Clark

6 PSI LOAD

United States Aluminum
720 On-River Road
Rock Hill, SC 29730
200 Singleton Drive
Waxahachie, TX 75169

Series BR3250
Blast Wall System
For DoD

F CLIP - Upper Right Corner

USA-3145 15 of 20
Architectural Testing

Test sample complies with these details.
 Deviations are noted.

Report No: 48977.01-122-17
Date 5/9/11  Tech R. Clark
83.000 NET FRAME DIM.

52.500 DLO

23.000 DLO

7.055 SQ. FT.

13.722 SQ. FT.

4.651 SQ. FT.

6.722 SQ. FT.

9.917 SQ. FT.

11.997 SQ. FT.

2.759 SQ. FT.

1.249 SQ. FT.

FUS 01-040-01 B-3.1.2.3

CONNECTIONS

1. 10.8 PSI FOR LESS THAN 10.8 SQ. FT.
2. 4.4 PSI FOR GREATER THAN 10.8 SQ. FT. BUT LESS THAN 32 SQ. FT.

ARCHITECTURAL TESTING

Test sample complies with these details.

Deviations are noted.

Report # A89777.01-22-12

Date 7/9/11 Tech RClarm