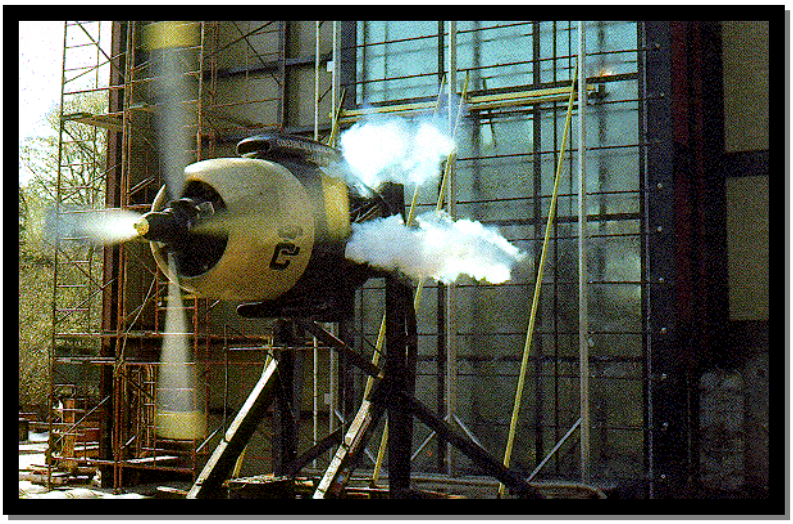
CONSTRUCTION CONSULTING LABORATORY, *INTERNATIONAL*



TEST REPORT:

AAMA 501-05 Performance and ASTM E 1996-09 and
ASTM E 1886-05 Impact and Cyclic Test Report

C. R. Laurence Co., Inc.

Series: StormWall®XL

Product/Type: SSG Twin Span Curtain Wall

REPORT #CCLI-11-238

Test Date: December 12, 2011

Prepared for:

C.R. Laurence Co., Inc.
Los Angeles, California

S-UNITED, INC.
A Quality Control Company

AAMA 501-05 AND ASTM IMPACT PERFORMANCE TEST REPORT
C. R. LAURENCE CO., INC.
SERIES STORMWALL®XL
REPORT #CCLI-11-238

December 29, 2011

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APPENDIXES

Refer to drawings in **Appendix A**, this report is not complete unless these drawings are stamped and initialed by **CCLI** as illustrated below.

Sheet	Details	Date	Stamped as illustrated
1	Elevation and Test Procedure	8/8/11	Construction Consulting Laboratory International 1601 Luna Road Carrollton, Texas 75006 (972) 242-0556
2-4	Horizontals	3/15/11	
5	Verticals	3/15/11	
6 & 7	Anchoring	3/15/11	
8	Splice	3/15/11	
9 & 10	Mid-Span Anchor	3/15/11	
11 & 12	Die Drawings	3/15/11	
13 & 14	Fabricated Parts	3/15/11	
15 & 16	Bill of Materials	3/15/11	

1. PROJECT DATA

1.1. REPORT ISSUED

C. R. Laurence Co., Inc.
2503 E. Vernon Ave.
Los Angeles, CA 90058

1.2. TEST LABORATORY

Construction Consulting Laboratory, International
1601 Luna Road
Carrollton, Texas 75006

2. PROJECT SUMMARY

2.1. **PRODUCT TYPE:** SSG Twin Span Curtain Wall

2.2. **SERIES / MODEL:** StormWall®XL

2.3. **COMPLIANCE STATEMENT:** Results obtained are tested values and were secured by using the designated test methods. The test specimen was tested in accordance with the AAMA 501-05 "Methods of test for Exterior Walls", ASTM E 1886-05 "Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials", and ASTM E 1996-09 "Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes". The specimen met the performance requirements set forth in the specifications and Methods for a +/-90.0 Psf Design Pressure rating.

2.4. **Test Dates: December 12, 2011 thru December 16, 2011**

2.5. **Test Location:** Construction Consulting Laboratory, International in Carrollton, Texas

2.6. **Test Sample Source:** The specimen was manufactured and installed by Oldcastle BuildingEnvelope® at CCLI. Representative samples and drawings will be retained by **CCLI** for a minimum period of ten (10) years from the test completion date.

2.7. **Drawing Reference:** The specimen drawings have been reviewed by CCLI and are representative of the specimen installed and tested. If observed, deviations shall be listed on the appended drawings.

2.8. **Observers:**

Witnessed By	**(Representative)**		
Oldcastle BuildingEnvelope®	George Gonzalez		
CCLI	Jeffrey Crump	Wesley Wilson	Max Rezadad

3. TEST SPECIFICATIONS / METHODS

AAMA 501-05: Methods of test for Exterior Walls.

ASTM E 1996-09: Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes

ASTM E 1886-05: Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.

4. MOCK-UP DESCRIPTION

Product Type:	Aluminum SSG Twin Span Curtain Wall **Product Drawings, Appendix A**.	
Series Model:	StormWall®XL	
Test Method:	TAS 201-94, 202-94, and 203-94 (+/-90.0 psf)	
Frame Size:	**Width**	**Height**
Frame Size	12'-2½" (146.500")	25'-0" (300")

The mock-up is identified as an C. R. Laurence Co., Inc. StormWall®XL SSG Twin Span Curtain Wall System. The specimen was constructed and installed with an overall width of and height of 12'-2½" by 25'-0", reference**, Elevations Sheet 1**. The mock-up was manufactured and installed by Oldcastle BuildingEnvelope®.

WEEP ARRANGEMENT:

Pressure Plate	(5/16") diameter weep hole spaced approximately 17" from each end
Face Cap	(5/16") diameter weep hole at the underside, mid-span of DLO

GLASS: All Glass Laminated Sealed Insulating Glass (SIG)

Glass	Glass Composition	Manufacturer	Max D.L.O	Max Ft²
G7	1¼" SIG, ¼" tempered, ½" air space, ¼" H.S .060" Butacite PVB interlayer over ¼" H.S.	DuPont	45½" x 84"	26.54
G35	1 ¼" SIG, ¼" H.S, ½" air space, ¼" H.S .075" Vanceva/Storglass interlayer over ¼" H.S.	Solutia	45½" x 96"	30.33
G36	1¼" SIG, ¼" tempered, ½" air space, ¼" H.S .060" Solutia Saflex PVB interlayer over ¼" H.S.	Solutia	45½" x 84"	26.54

GLAZING: All glass is setting block supported part # XLSB2102 and captured at the horizontal edges with exterior pressure plate with EPDM compression gasket part # XLG117 and EPDM thermal isolator gasket part # XLG107 secured to frame and adaptor darts with part # XLF325 (#12-14- 1½") self-tapping screws spaced on 9" centers (max spacing). Exterior vertical edges of glass are structurally sealed with backer rod and Dow Corning 795 silicone. Interior of glass sealed with EPDM Glazing gasket part # FG5185 and Dow Corning 995 structural silicone on Bay 1 and GE SSG-4600 structural silicone on Bay 2 and 3.

SEALANT: The specimen was perimeter sealed with foam backer rod and Dow Corning - 795 silicone. Horizontal-to-vertical connections within the glass pocket were zone plugged with a plastic plug part # XLD352 set in and tooled with Dow Corning 795 structural silicone. Internal horizontal-to-vertical connections sealed with Dow Corning 795 structural silicone. Vertical mullion splice conditions bridged with bond-breaker tape at sleeve and sealed with GE-SSG4600 silicone. Stack head and sill intermediate horizontal part # XL536-BP shear block connected at the splice location and sealed with backer rod and GE-SSG4600 silicone at the interior and exterior lateral edge.

REINFORCEMENT: HW-500 reinforcements are anchored with part# FS-325 #12-14 x 1½" concealed within intermediate horizontal shear blocks.

Location	Mullion	Reinforcement	Description
Jambs	XL500-BP	XLBR25	Steel C-Channel 1.875" x 4.721" x .250" x 9'-8"below splice and 13'-10½" above splice.
Mullion	XL504-BP		

JAMB ANCHORAGE: Jamb mullion part # XL500-BP anchored at head and sill with one (1) 6063-T6 Aluminum F-Anchor part # XLA10301 inserted into anchor sleeve part # XLS20001 inside mullion and attached to chamber steel with two (2) Type F ½" x 2" self threading bolts. F-Anchors and Anchor sleeve pinned inside mullion by three (3) shear block fasteners part # XLF009 #14 x 1¼" HH screws per shear block. Steel angle 5" x 4" x $^{5}/_{16}$" thick x 5" tall dead - load anchor welded to chamber steel with a $^{3}/_{16}$" weld by 4" length at the top, bottom, and heel of angle. Mullion fitted with a 5" x 3¾"x ¼"thick steel jamb tap plate attached to lateral face of jamb with eight (8) part # XLF259 ¼-20 x 1" PFH Type F screws. Steel angle shimmed with korolath shim and attached to mullion through tap plate with two (2) $^{5}/_{8}$" 18 x 1¾" Grade 5 Hex Bolts. Mullion spliced with aluminum splice sleeve part # XLS19401 at the stack horizontals attached to lower mullion with two (2) part # XLF325 #12-14 x 1½" screws, one (1) screw per side.

XL504-BP MULLION ANCHORAGE: Mullion anchored at head and sill with one (1) 6063-T6 Aluminum T-Anchor part # XLA10501 inserted into anchor sleeve part # XLS20001 inside mullion and attached to chamber steel with two (2) Type F ½"x 2" self threading bolts, one (1) bolt each side of mullion. T-Anchors and Anchor sleeve pinned inside mullion by three (3) shear block fasteners part # XLF009 #14 x 1¼" HH screws per shear block. Two (2) steel angles 5" x 4" x 5/16" thick x 5" tall dead - load anchors welded to chamber steel with a 3/16" weld by 4" length at the top, bottom, and heel of angles. Steel angle, korolath shim, mullion, and reinforcement are through bolted with two (2) 5/8" 18 x 4½" Grade 5 Hex bolts with flat washer and nut per bolt. Mullion spliced with aluminum splice sleeve part # XLS7401 at the stack horizontals attached to lower mullion with two (2) part # XLF325 #12-14 x 1½" screws, one (1) screw per side.

OTHER FEATURES: Intermediate horizontal-to-intermediate vertical connection by aluminum 6063-T6 shear blocks. Shear Block Part # XLB18301 attached to vertical mullion with four (4) part # XLF009 #14 x 1½" HH screws. Shear Block Part # XLB18401 attached to vertical mullions with three (3) part # XLF009 #14 x 1 ½" HH screws. Horizontals attached to each part # XLB18301 with two (2) part # XLF118 #10 x 1" PFH screws per shear block, and to XLB18401 shear block through glazing pocket, exterior face with one (1) part # XLF118 #10 x 1" PFH screw per shear block.

5. TEST EQUIPMENT

5.1. Test chamber consisted of structural steel beams, columns, and bulkheads and was accessible through a bulkhead door.

5.2. Pressure differentials were created with reversible pumps for positive/negative loading.

5.3. Pressure differentials between the specimen interior and the atmosphere were measured with manometers.

5.4. Air infiltration was measured with a Meriam laminar flow element and inclined manometers. Chamber pressure was measured with a Dwyer inclined manometer.

5.5. Water was applied to the specimen from a spray rack equipped with swirl-type nozzles spaced two feet on center in vertical and horizontal directions, which, under controlled pressure, delivered a minimum of five gallons per square foot per hour on the specimen.

5.6. Structural variations were measured with Chicago Dial gauges with maximum movement hands located throughout the test specimen.

5.7. Large Missile Impact test was performed with a pneumatic charged cannon with laser guided sight and Keyence FS- V31/32 optic with Keyence KV-16ASR timer.

5.8. Small Missile Impact test was performed with a pneumatic charged cannon and chronograph timer.

6. TESTING ALLOWABLES

6.1. AIR INFILTRATION: Total amount of air infiltration shall not exceed **.06 Cfm/ ft²** of the curtain wall area tested. The perimeter sealant was included in the test of the mock-up.

ALLOWABLE INFILITRATION: **18.43 Cfm (Based upon 307.29 ft²)**

6.2. STATIC WATER PENETRATION: There shall be no uncontrolled water penetration during or at the conclusion of this test at the static pressure of **20.0 psf**.

Note: "Uncontrolled water" is defined as any water that appears on any normally exposed interior surfaces, that is not contained or drained back to the exterior, or that can cause damage to adjacent materials or finishes. Water contained within drained flashings, gutters, and sills is not considered water leakage. The collection of up to one half (½) ounce of water (14.8 cc) in a fifteen (15) minute test period on top of any interior stop or stool integral with the wall system shall not be considered water leakage.

6.3. DESIGN LOAD DEFLECTIONS: There shall be no system failure and deflection of aluminum members at 100% of design load and shall not exceed L/240+.250 on spans exceeding 13'-6" and L/175 for spans up to 13'-6". Deflections recorded on the longest unsupported spans.

TEST SPECIMEN DESIGN CRITERIA
Positive / Negative 90.00 psf (30-Second Duration All Loads)
Vertical Span (L): 150.00" / L/175: Allowable = .857 inches
Horizontal Span (L): 45.50" / L/175: Allowable = 0.260 inches

6.4. PROOF LOAD RESIDUAL: The permanent deformation of the aluminum members shall not exceed 2% of span at 150% of design load.

TEST SPECIMEN PROOF LOAD
Positive / Negative 135.0 Psf (30-Second Duration All Loads)
Vertical Span (L): 150.00" / 500: Allowable = 0.300 inches
Horizontal Span (L): 45.50" / 500: Allowable = 0.091 inches

7. TESTING SEQUENCE

As used throughout this report, positive pressure applied to the test specimen is considered to be **inward** acting and negative pressure is considered to be **outward** acting. All location references or comments are as viewing the test specimen from the interior (room side) of the test chamber and wall system.

	DESIGN CRITERIA: Positive / Negative 90.0 Psf	TEST STANDARD
	AAMA 501-05 Performance Testing	
1	Pre Load Positive / Negative @ 50 % of Design – 50.0 psf	ASTM E 330-02
2	Static Pressure Air Infiltration Test @ 6.24 psf	ASTM E 283-04
3	Structural Load by Static Pressure Test @ 50% & 100% Design Loads	ASTM E 330-02
4	Static Pressure Water Penetration Test @ 20.0 psf	ASTM E 331-00
5	Uniform Load Deflections Positive / Negative @ 150 % of Design	ASTM E 330-02
	ASTM E 1996-09 Impact Performance Testing	
1	Large Missile Impact Testing	ASTM E 1996-09
2	Small Missile Impact Testing	ASTM E 1996-09
	ASTM E 1886-05-94 Uniform Load Cyclic Performance Testing	
1	4,500 Cycles Positive	ASTM E 1886-05
2	4,500 Cycles Negative	ASTM E 1886-05

8. AAMA 501-05 TESTING RESULTS

8.1. Preload to 45.0 psf Positive Pressure per ASTM E 330-02

Subject the test specimen to a static pressure differential of **45.0 psf**. This load was maintained for thirty (30) seconds and released. An inspection was made to determine if any failure occurred.

Results: No damage.

8.2. Static Pressure Air Infiltration Test @ 6.24psf per ASTM E283-04

The specimen and perimeter sealant joints were completely covered with 4-mil sheet plastic material and sealed with duct tape to the chamber perimeter, thus allowing no movement of air through the specimen. The exterior face of the specimen was subjected to a positive pressure differential of 6.24 psf to obtain a leakage rate for the test chamber. The plastic bag was removed and the chamber again pressurized to a positive 6.24 psf to measure total air infiltration. The chamber infiltration was subtracted from the total air infiltration resulting in the infiltration rate of the test specimen

Results:

Chamber	Specimen & Chamber	Cfm	Cfm/ Ft²	Total CFM Allowable
46.25 Cfm	**50.81 Cfm**	**4.56**	**0.014**	**18.43 Cfm**

8.3. **Uniform Structural Load @ 50% & 100% of Design Loads per ASTM E330-02**

Dial indicators were installed to measure deflection and residuals at ends and mid-span of typical horizontal and vertical members.

Test: With the specimen pre loaded in a positive mode, all indicators were set on zero. A positive pressure of **45.0 psf (inward)** equal to 50% of the design load was applied and held for thirty (30) seconds, then released. A positive pressure of **90.0 psf (inward)** equal to 100% of the design load was applied and held for thirty (30) seconds, then released. The indicators were read and the data was recorded.

Test: With the specimen pre loaded in a negative mode, all indicators were set on zero. A negative pressure of **–45.0 psf (outward)** equal to 50% of the design load was applied and held for thirty (30) seconds, then released. A negative pressure of **-90.0 psf (outward)** equal to 100% of the design load was applied and held for thirty (30) seconds, then released. The indicators were read and the data was recorded.

Results: All the positive and negative net deflections were below the allowable, for indicator locations, **See Indicator Location Plan View, Appendix B.**

50% & 100% DESIGN STRUCTURAL DEFLECTION TABLE													
	+45.0 Psf			+90.0 Psf			-45.0 Psf			-90.0 Psf			
Ind.	Total	Set	Net	Total	Set	Net	Total	Set	Net	Total	Set	Net	Allowable
1	.02	.00		.03	.00		.03	.00		.04	.01		
2	.41	.00	.375	.76	.03	.72	.62	.00	.565	.78	.05	.705	.857
3	.05	.00		.05	.03		.08	.01		.11	.05		
4	.01	.00		.03	.02		.01	.01		.06	.05		
5	.00	.00		.00	.00		.04	.03		.07	.05		
6	.00	.00		.00	.00		.00	.00		.00	.00		
7	.00	.00	.00	.00	.00	.00	.00	.00	.00	.04	.00	.04	.260
8	.00	.00		.00	.00		.00	.00		.01	.00		
9	.00	.00		.00	.00		.00	.00		.00	.00		
10	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.260
11	.00	.00		.00	.00		.00	.00		.00	.00		

8.4. **Static Pressure Water Penetration Test @ 20.0 psf per ASTM E331-00**

Water was applied to the exterior face of the specimen at a minimum rate of five (5) gallons per square foot per hour of wall area, in such a way as to continuously and completely cover the exterior face of the specimen. Simultaneously, a positive **inward** differential static pressure of **20.0 psf** was applied against the face. The application of pressure and water was maintained for a period of fifteen (15) minutes, with observers inside the chamber checking for water penetration.

Results: No water penetration observed.

8.5. **Uniform Structural Proof Load @ 150% of Design Loads per ASTM E330-02**

Dial indicators were installed to measure deflection and residuals at mid-span of typical horizontal and vertical members.

Test: With the specimen preloaded, all indicators were set on zero. The following pressures were applied and held for a period of thirty (30) seconds. At the conclusion of each load the indicators were read and the data recorded.

Results: All the positive and negative permanent sets were below the allowable, for indicator locations, **see Indicator Location Plan View, Appendix B.**

100% & 150% DESIGN STRUCTURAL DEFLECTION TABLE													
	+90.0 Psf			+135.0 Psf			-90.0 Psf			-135.0 Psf			
Ind.	Total	Set	S-Net	Total	Set	S-Net	Total	Set	S-Net	Total	Set	S-Net	Allowable
1	.03	.00		.06	.00		.04	.01		.08	.02		
2	.76	.03	.02	1.18	.03	.01	.78	.05	.02	1.34	.12	.07	.300
3	.05	.03		.06	.04		.11	.05		.10	.08		
4	.03	.02		.04	.04		.06	.05		.10	.07		
5	.00	.00		.02	.02		.07	.05		.05	.04		
6	.00	.00		.00	.00		.00	.00		.00	.00		
7	.00	.00	.00	.04	.00	.00	.04	.00	.04	.05	.00	.00	.091
8	.00	.00		.00	.00		.01	.00		.00	.00		
9	.00	.00		.00	.00		.00	.00		.00	.00		
10	.00	.00	.00	.01	.00	.00	.00	.00	.00	.00	.00	.00	.091
11	.00	.00		.00	.00		.00	.00		.00	.00		

9. ASTM E 1996-09 IMPACT TESTING RESULTS

9.1. The specimen was Large Missile impacted with a #2 yellow pine nominal 2" x 4" x 8'-2" length. Large Missile Impact locations on the mock-up were to the glazing, horizontal, and vertical mullions. The missile weight prior to testing was 9 lbs. Nominal impact speed set at 50 feet per second. Nine (9) Large Missile Impacts were performed on the mock-up, for impact locations and speeds see **Large Missile Impact Location Diagram, Appendix C.**

9.2. The specimen was Small Missile impacted with ten (10) 2-gram solid steel 5/16 diameter balls. Small Missile Impact locations on the mock-up were to the glazing only. Eighteen (18) Small Missile Impacts were performed on the mock-up, for impact locations see **Small Missile Impact Location Diagram, Appendix C.**

10. ASTM E 1886-05 UNIFORM LOAD CYCLIC TESTING RESULTS

Design Load: 90.0 psf **/ Load Direction:** Positive							
Sequence	**Range**	**Average Cycle Time**	**Cycles**	**Indicator Max Deflection**			
				#2	**#3**	**#4**	**#5**
Cycle 1	0.2 P to 0.5 P	5 seconds	3500	.76"	.16"	.12"	.10"
Cycle 2	0 to 0.6 P	5 seconds	300	.85"	.19"	.15"	.13"
Cycle 3	0.5 P to 0.8 P	4 seconds	600	.92"	.20"	.17"	.22"
Cycle 4	0.3 P to 1.0 P	6 seconds	100	1.15"	.22"	.19"	.15"

Design Load: 90.0 psf **/ Load Direction:** Negative							
Sequence	**Range**	**Average Cycle Time**	**Cycles**	**Indicator Max Deflection**			
				#2	**#7**	**#12**	**#17**
Cycle 1	0.3 P to 1.0 P	6 seconds	50	1.20"	.24"	.21"	.16"
Cycle 2	0.5 to 0.8 P	4 seconds	1050	.98".	.21"	.19"	.14"
Cycle 3	0 to 0.6 P	5 seconds	50	.83"	.19"	.17"	.12"
Cycle 4	0.2 P to 0.5 P	5 seconds	3350	.78"	.17"	.15"	.10"

11. DISCLAIMER

The mock-up performed within the specified criteria. This report does not constitute certification of this product. The results contained within this document apply only to the tested specimen.

Respectfully submitted,

CONSTRUCTION CONSULTING LABORATORY, *INTERNATIONAL*

WESLEY WILSON
LABORATORY MANAGER

JEFFREY CRUMP
TESTING MANAGER

APPENDIX A

C. R. LAURENCE CO., INC. RELIANCE STORMMAX DRAWINGS

Sheet	Details	Date
1	Elevation and Test Procedure	8/8/11
2-4	Horizontals	3/15/11
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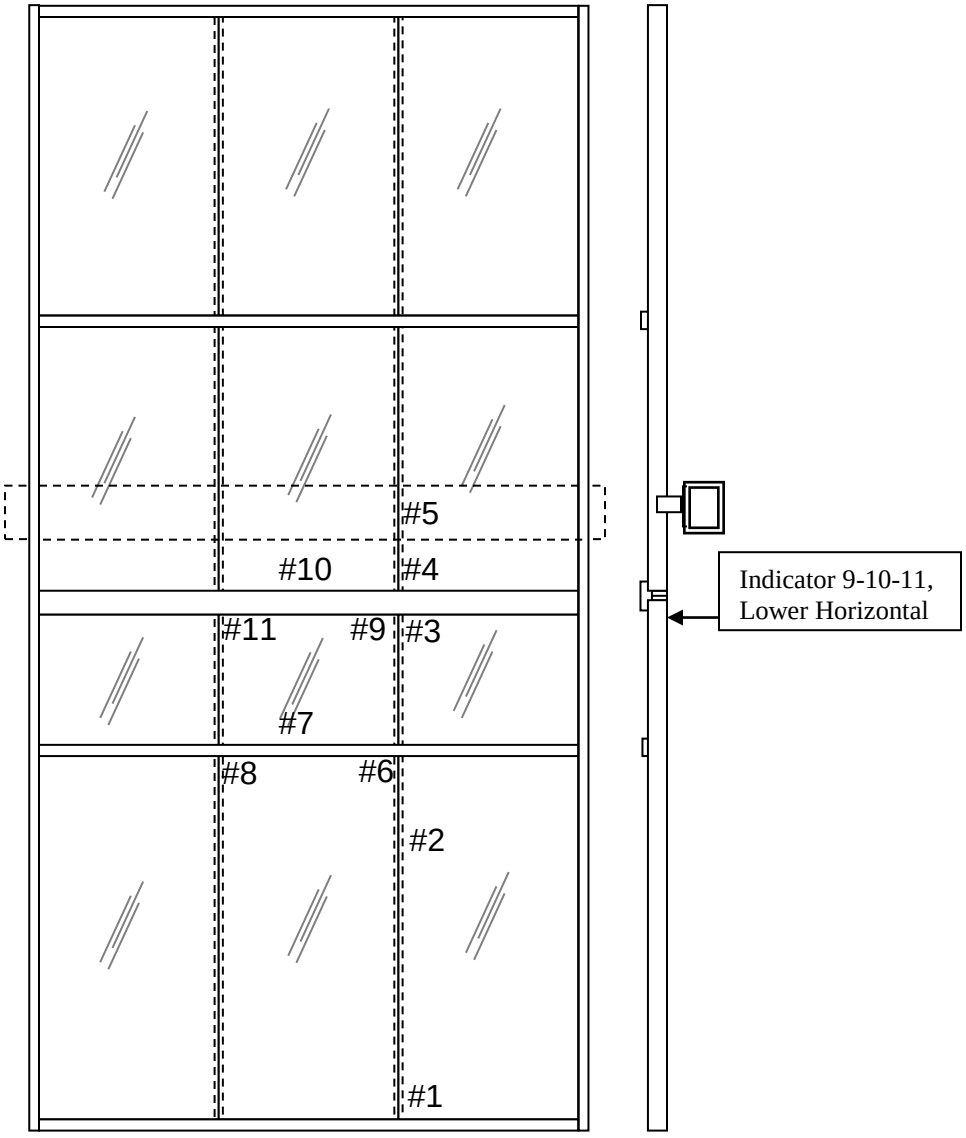
13 & 14	Fabricated Parts	3/15/11
15 & 16	Bill of Materials	3/15/11

December 29, 2011

APPENDIX B

DIAL INDICATOR LOCATION DIAGRAM



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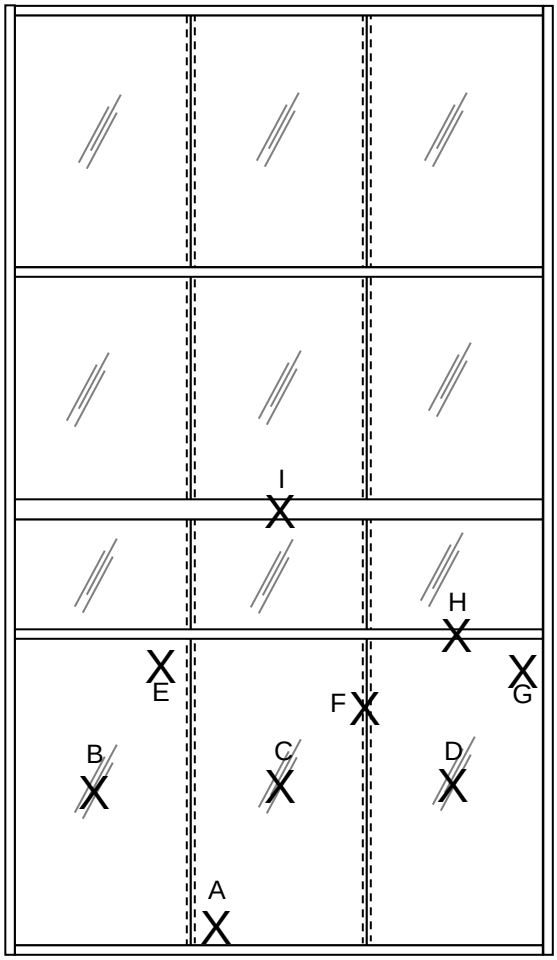
APPENDIX C

LARGE MISSILE IMPACT LOCATIONS
Nine (9) X-LARGE MISSILE



Impact	Speed Ft per Second	Note
A	52.0	Pass
B	51.8	Pass
C	51.3	Pass
D	50.9	Pass
E	50.4	Pass
F	50.0	Pass
G	50.8	Pass
H	51.1	Pass
I	50.9	Pass

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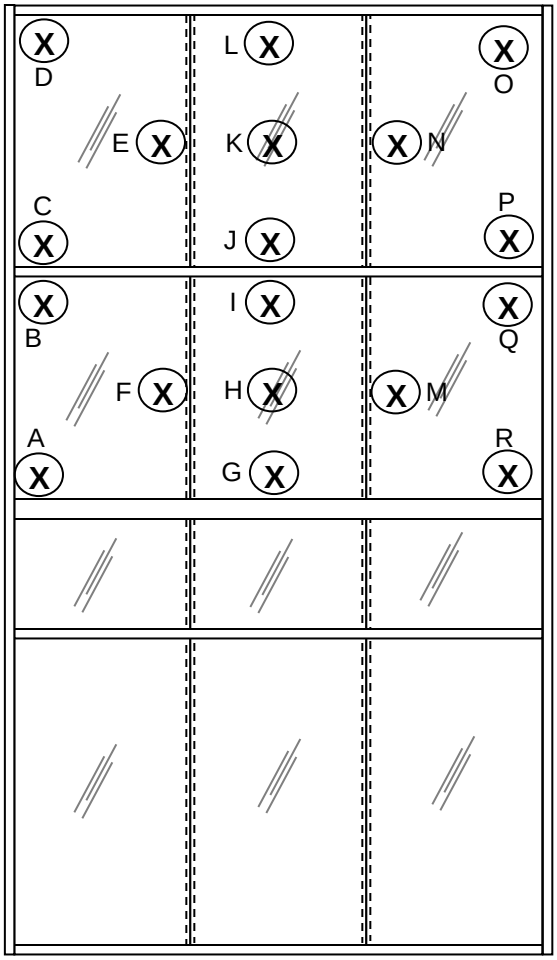
SMALL MISSILE IMPACT LOCATIONS
Eighteen (18) (X) - SMALL MISSILE



Impact	Speed Ft per Second	Note
A	131.0	Pass
B	130.6	Pass
C	128.9	Pass
D	132.8	Pass
E	130.3	Pass
F	130.1	Pass
G	130.0	Pass
H	129.2	Pass
I	129.0	Pass
J	130.2	Pass
K	131.3	Pass
L	132.6	Pass
M	131.0	Pass
N	131.5	Pass
O	129.8	Pass
P	132.1	Pass
Q	129.5	Pass
R	130.2	Pass

Note: In all cases, the sacrificial lite was broken after the 1st impact to the glass unit. **CCLI** cleared all broken glass from the field prior to the 2nd impact to each glass unit.

- END OF REPORT -

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