

CONSTRUCTION TESTING CORPORATION

13873 N.W. 19th Avenue Miami, Florida 33054

Phone : 305-685-6657 Fax : 305-685-6659 Email : ctclab@bellsouth.net

Report No: 04-009 LE FBC

11 August 2004

Test Dates: 24 & 26 May, 1 & 3 June & 3 July 2004

Testing : Polycarbonate Hurricane Shutter Panels

Client:

Transparent Protection Systems, Inc.

6643 North 42nd Terrace

West Palm Beach, FL 33407

Phone: 888-447-8320 Fax: 561-844-2445

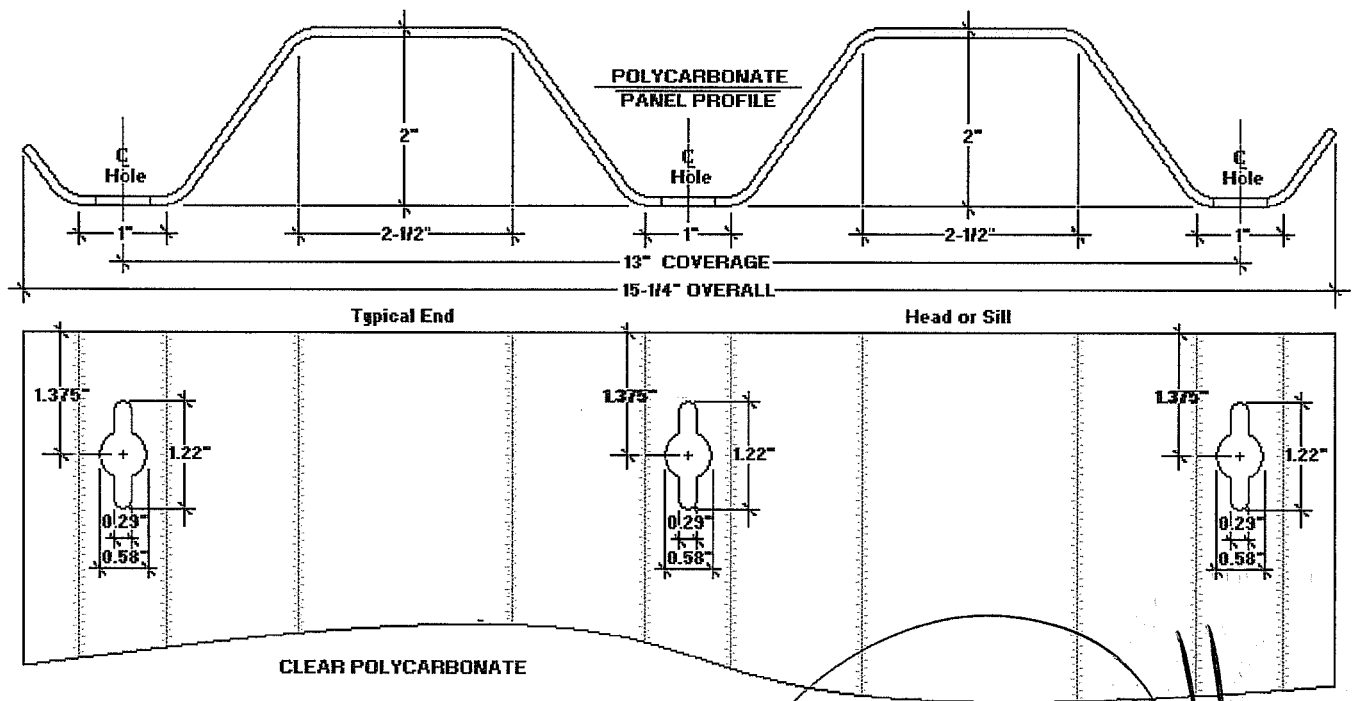
General: This test report incorporates into one document three testing activities. These are:

1. Uniform Static Air Pressure, per FBC 2001, TAS 202-94
2. Large Missile Impacts, per FBC 2001, TAS 201-94
3. Cyclic Wind Pressure Loading, per FBC 2001, TAS 203-94

Witness to Testing:

Yamil G. Kuri, P.E. : CTC Official Witness, Raina Williams, CTC Assistant & George Dotzler, CTC Test Engineer

Description of Specimens: Specimens were nominal 1/10" polycarbonate Storm Panels (Mic'd thickness varied across section from 0.0905" to 0.1185"). These panels were extruded into a two ribbed 2" x 13" section with a nominal coverage of 13" per panel manufactured by Transparent Protection Systems, Inc. of West Palm Beach, Florida. These panels utilized the a double key hole punch pattern at each end of the panels as shown in the diagram below. Specimen were all three panels wide (41 1/4") and 103" long. Specimen were mounted in a variety of fastenings these are detailed on the following page. Specimen were installed without intermediate supports to the panel overlaps. Detailed descriptions of each specimen are included immediately preceding the relevant test data together with section drawings.



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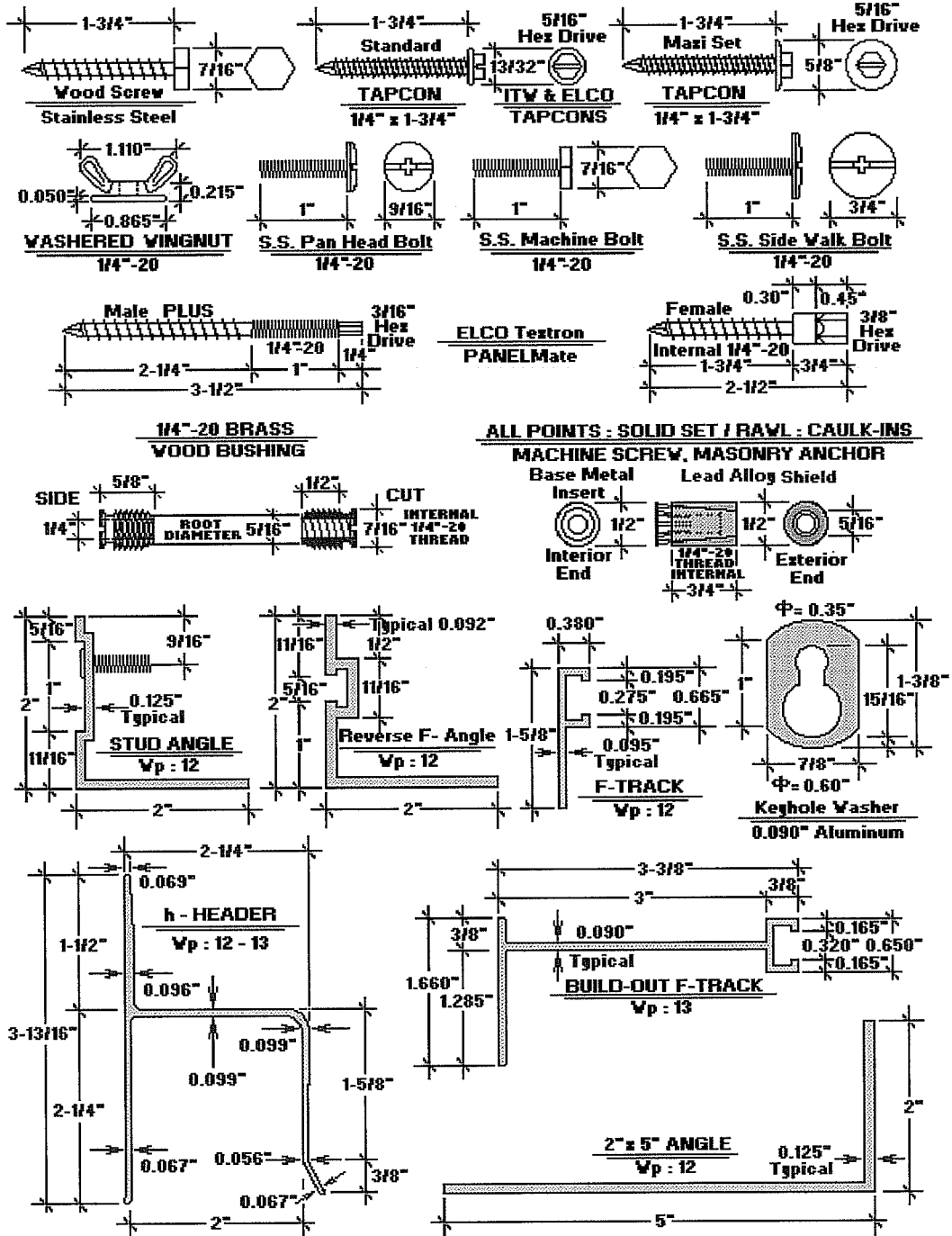
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DETAILS: Test specimens were installed with the following fasteners and aluminum extrusion:



A "Webster" gauge was utilized to determine the material hardness of aluminum components. These readings are indicated (w: 13) for example where the gauge registered a 13 hardness taken off of a mill finish extrusion. Where gauge readings are taken off of a painted aluminum component, readings are indicated (Wp: 11.5) for example. Where a number of similar aluminum components were sampled and a range of readings were found these are shown as (w: 11.5-13) or as (Wp:10-12) for example.

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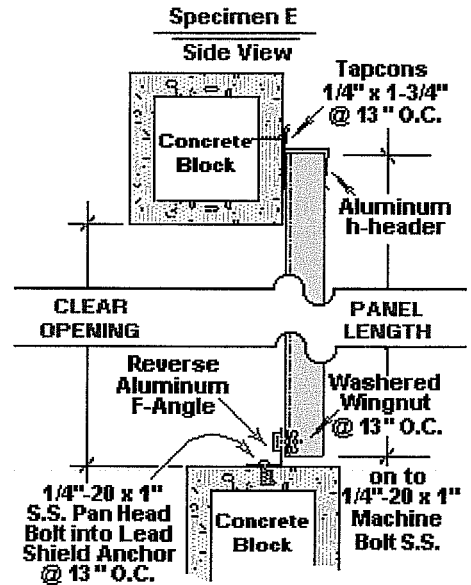
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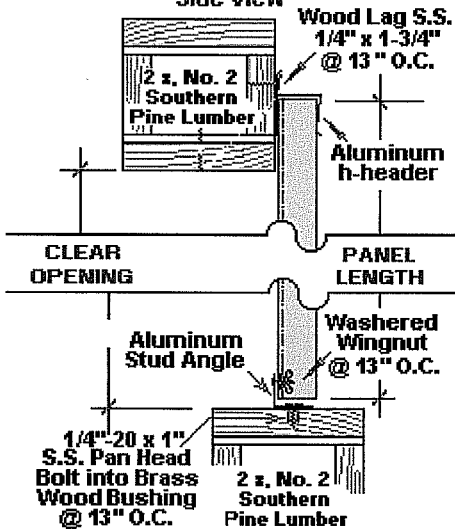
Specimen E : Wall / Floor, Mount : 103" Panels : 99" C.O. Impacts & Cyclic Wind Loading

Head: Panels were mounted into an aluminum h-header extrusion. This extrusion was secured to a concrete block beam at 13" on center with ITW Maxi Set 1/4" x 1-3/4" Tapcon masonry screws. **Sill:** Panels were mounted at 13" on center with washered wing nuts onto stainless steel, 1/4"-20 x 1" machine bolts trapped into an aluminum reverse f-track. This reverse f-angle was secured to a concrete block beam at 13" on center with stainless steel, 1/4"-20 x 1" pan head bolts (9/16" head and combination slot & Phillips drive) into All Point, Solid Set, machine bolt, masonry anchors.



Specimen F

Side View

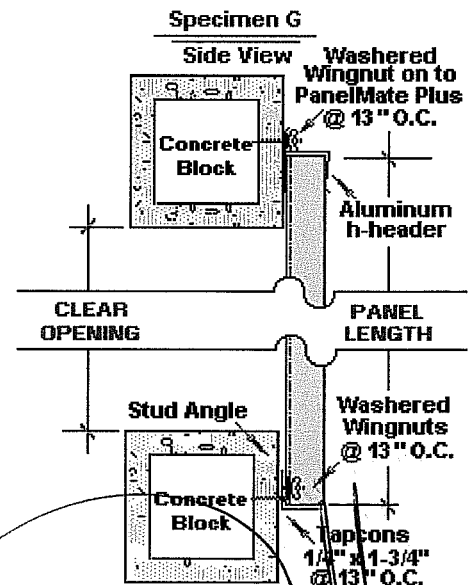


Specimen F : Build Out / Floor, Mount : 103" Panels : 99" C.O. Impacts & Cyclic Wind Loading

Head: Panels were mounted into an aluminum h-header extrusion. This extrusion was secured to a No: 2 Southern Pine lumber beam at 13 on center with S.S. 1/4" x 1-3/4" wood lags. **Sill:** Panels were mounted at 13" on center with washered wing nuts onto a studded aluminum angle. This angle was secured at 13" on center with stainless steel 1/4"-20 x 1" pan head bolts (9/16" head and combination slot & phillips drive) into All Points, brass wood bushings secured into a No: 2 Southern Pine lumber beam.

Specimen G : Wall Mount : 103" Panels : 96" C.O. Impacts & Cyclic Wind Loading

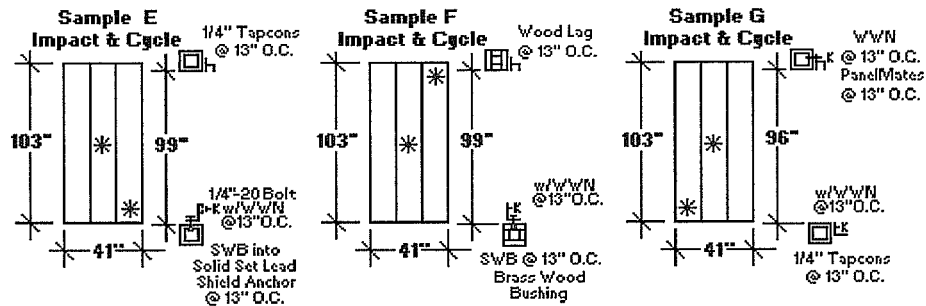
Head: Panels were mounted into an aluminum h-header extrusion. This extrusion was secured to a concrete block beam at 13" on center with washered wing nuts onto ELCO PanelMate, Male, masonry anchors. **Sill:** Panels were mounted at 13" on center with washered wing nuts onto a studded aluminum angle. This angle was secured at 13" on center with standard 1/4" x 1-3/4" ELCO Tapcon masonry screws.



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Impact and Cyclic Wind Loading / Manner of Testing: In accordance with the **FLORIDA BUILDING CODE 2001, TESTING APPLICATIONS STANDARD (TAS) 201-94, IMPACT TEST PROCEDURES** and **TESTING APPLICATIONS STANDARD (TAS) 203-94, CRITERIA FOR TESTING PRODUCTS SUBJECT TO CYCLIC WIND PRESSURE LOADING.**

The specimens, **E, F & G**, as previously described, were impacted (as shown in the diagram above) with a 9.02 lb, 96" long, S4S, 2x4, of No. 2 Southern Pine lumber, in locations as directed by the client consulting engineer.

ID	Size	Location Rt(in), Up(in) {1}	Location Description {2}	Velocity Ft/Sec {3}	Deflection Inches {4}	Permanent Set Inches {5}
E	41" x 103"	21, 50	Center Panel 2 / 3	49.6	8.00	0.00
E	41" x 103"	34, 8	Lower Right Corner	50.2	5.00	0.38
F	41" x 103"	21, 50	Center Panel 2 / 3	49.7	8.50	0.00
F	41" x 103"	34, 96	Upper Right Corner	49.6	4.75	0.00
G	41" x 103"	21, 51	Center Panel 2 / 3	49.2	8.25	0.00
G	41" x 103"	7, 10	Lower Left Corner	49.3	6.50	0.50

- (1) : Impact location given on Cartesian grid, right and up from lower left hand corner.
- (2) : The location description relative to the product assembly.
- (3) : Impact velocity measured with an Oehler Chronometer model 35P, verified by the video method.
- (4) : Deflections recorded by the change in height of a collapsed aluminum foil cylinder.
- (5) : Set readings made from the deformed product to a reference plane with a steel ruler.

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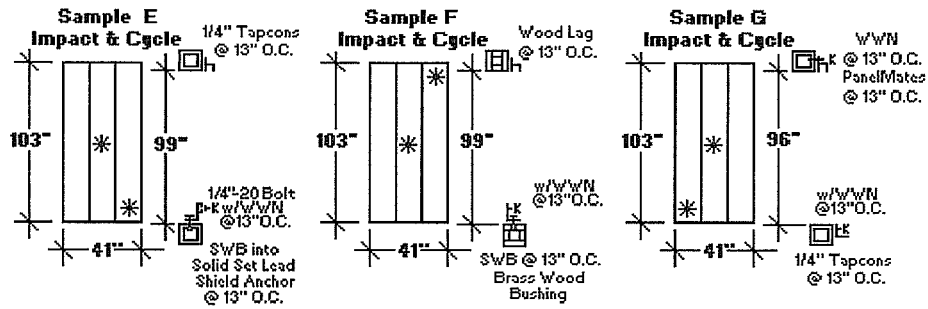
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Following impacts, specimens E, F & G were cyclic wind loaded as directed by the **FBC 2001, TAS 203-94, CRITERIA FOR TESTING PRODUCTS SUBJECT TO CYCLIC WIND PRESSURE LOADING**, in accordance with **Table 1625.4 : Fatigue Loading Sequence**, located in chapter 16, **FBC 2001**. In general, numerous static air pressure cycles are applied to the specimen at varying load levels based upon the positive and negative design load levels. Polyethylene film (2 mil) and tape were used to seal air leakage during loads and were used in a manner that did not influence the results. A detailed account of the cyclic wind loads applied and resulting deflections at the centerline of the specimen's primary span follows:

No. Cycles	Range	Design PSF	Load PSF	Defl'ns E Inches	Defl'ns F Inches	Defl'ns G Inches
0				0.000	0.000	0.000
600	0% to 50% Pos. DL	17.3	8.7	2.125	2.313	1.750
70	0% to 60% Pos. DL	17.3	10.4	2.500	2.563	2.000
1	0% to 130% Pos. DL	17.3	22.5	6.500	6.563	5.750
0	At Rest			0.313	0.375	0.125
0				0.000	0.000	0.000
600	0% to 50% Neg. DL	(17.3)	(8.7)	2.750	2.625	0.000
70	0% to 60% Neg. DL	(17.3)	(10.4)	3.250	3.188	2.500
1	0% to 130% Neg. DL	(17.3)	(22.5)	6.500	6.188	5.875
0	At Rest			0.375	0.313	0.125
1342	Total Cycles					

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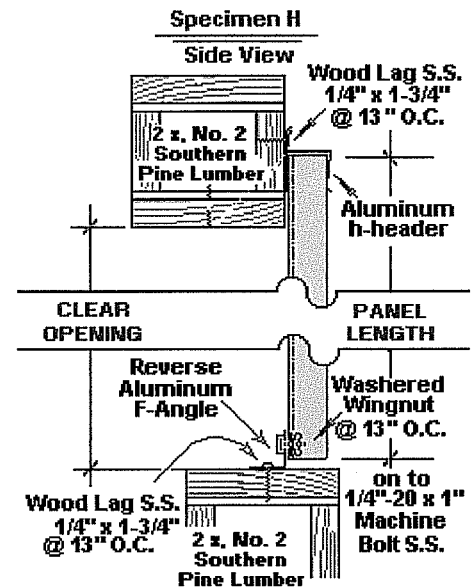
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Specimen H1 : Wall / Floor, Mount : 103" Panels : 99" C.O. : -Wind

Specimen H4 : Wall / Floor, Mount : 93" Panels : 89" C.O. : -Wind

Head: Panels were mounted into an aluminum h-header extrusion. This extrusion was secured to a No: 2 Southern Pine lumber beam at 13" on center with S.S. 1/4" x 1-3/4" wood lags. **Sill:** Panels were mounted at 13" on center with washered wing nuts onto stainless steel, 1/4"-20 x 1" machine bolts trapped into an aluminum reverse f-track. This reverse f-angle was secured to a No: 2 Southern Pine lumber beam at 13" on center with S.S. 1/4" x 1-3/4" wood lags.

Static Wind Loading / Manner of Testing: In accordance with FBC 2001, TAS 202-94, **CRITERIA FOR TESTING IMPACT & NON IMPACT RESISTANT BUILDING ENVELOPE COMPONENTS USING UNIFORM STATIC AIR PRESSURE :** Loads were applied to the specimen (30 second duration) at levels specified by the client's Consulting Engineer. Polyethylene film (2 mil) and tape were used to seal air leakage during loads these were used in a manner that did not influence the results. Gauges were mounted along the centerline of the specimen's primary span to record deflections. Deflection readings follow:



Wind Load Data : Specimen H1

Load	Load	Top		Center		Bottom		NET	Gross	Percent	Percent
		Defl'n	Defl'n	Defl'n	Defl'n	Defl'n	Defl'n				
PSF	in H2O	at Load	at Load	at Load	at Load	at Load	at Load	at Load	at Load	Recovery	Recovery
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NA	NA
(5.2)	1.0	0.094	0.000	1.500	0.000	0.063	0.000	1.422	0.000	100.0%	100.0%
(10.4)	2.0	0.250	0.000	3.313	0.125	0.219	0.000	3.078	0.125	95.9%	96.2%
(15.6)	3.0	0.563	0.000	5.438	0.375	0.281	0.125	5.016	0.313	93.8%	93.1%
(20.8)	4.0	1.000	0.063	7.688	0.500	0.313	0.250	7.031	0.344	95.1%	93.5%
(31.2)	5.0	1.500	0.125	10.000	0.750	0.500	0.375	9.000	0.500	94.4%	92.5%
(31.2)	6.0	NR	NR	NR	NR	NR	NR				

At ~5-1/4" H2O Load, panels pulled out of header.

Wind Load Data : Specimen H4

Load	Load	Top		Center		Bottom		NET	Gross	Percent	Percent
		Defl'n	Defl'n	Defl'n	Defl'n	Defl'n	Defl'n				
PSF	in H2O	at Load	at Load	at Load	at Load	at Load	at Load	at Load	at Load	Recovery	Recovery
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NA	NA
(10.4)	2.0	0.250	0.000	2.313	0.125	0.125	0.000	2.125	0.125	94.1%	94.6%
(20.8)	4.0	0.813	0.000	4.813	0.375	0.563	0.000	4.125	0.375	90.9%	92.2%
(31.2)	6.0	1.125	0.063	7.500	0.500	0.750	0.094	6.563	0.422	93.6%	93.3%
(36.4)	7.0	1.375	0.125	9.000	0.750	0.969	0.250	7.828	0.563	92.8%	91.7%
(41.6)	8.0	NR	NR	NR	NR	NR	NR				

At ~7-3/4" H2O Load, panels pulled out of header.

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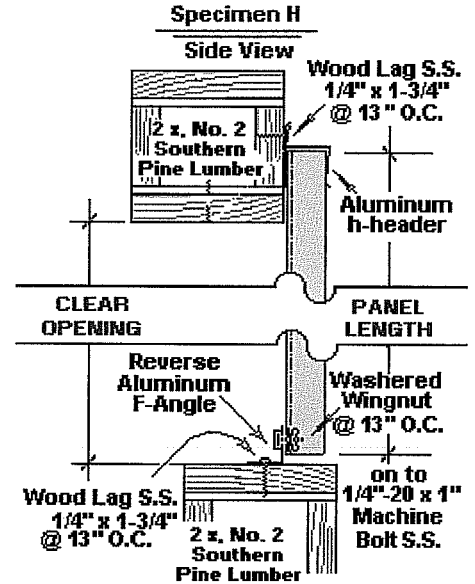
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Specimen H2 : Wall / Floor, Mount : 84" Panels : 80" C.O. : -Wind
Specimen H5 : Wall / Floor, Mount : 72" Panels : 68" C.O. : -Wind

Head: Panels were mounted into an aluminum h-header extrusion. This extrusion was secured to a No: 2 Southern Pine lumber beam at 13" on center with S.S. 1/4" x 1-3/4" wood lags. **Sill:** Panels were mounted at 13" on center with washered wing nuts onto stainless steel, 1/4"-20 x 1" machine bolts trapped into an aluminum reverse f-track. This reverse f-angle was secured to a No: 2 Southern Pine lumber beam at 13" on center with S.S. 1/4" x 1-3/4" wood lags.

Static Wind Loading / Manner of Testing: In accordance with FBC 2001, TAS 202-94, **CRITERIA FOR TESTING IMPACT & NON IMPACT RESISTANT BUILDING ENVELOPE COMPONENTS USING UNIFORM STATIC AIR PRESSURE :** Loads were applied to the specimen (30 second duration) at levels specified by the client's Consulting Engineer. Polyethylene film (2 mil) and tape were used to seal air leakage during loads these were used in a manner that did not influence the results. Gauges were mounted along the centerline of the specimen's primary span to record deflections. Deflection readings follow:



Wind Load Data : Specimen H2

Load PSF	Load in H2O	Top		Center		Bottom		NET Defl'n at Load	NET Defl'n at Load	Percent Recovery	Gross Percent Recovery
		Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load				
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NA	NA
(10.4)	2.0	0.188	0.000	1.438	0.000	0.031	0.000	1.328	0.000	100.0%	100.0%
(20.8)	4.0	0.375	0.000	3.063	0.000	0.063	0.000	2.844	0.000	100.0%	100.0%
(31.2)	6.0	0.563	0.000	4.563	0.125	0.094	0.000	4.234	0.125	97.0%	97.3%
(41.6)	8.0	0.813	0.000	5.813	0.250	0.125	0.000	5.344	0.250	95.3%	95.7%
(46.8)	9.0	1.000	0.063	7.188	0.438	0.313	0.063	6.531	0.375	94.3%	93.9%
(52.0)	10.0	1.188	0.125	9.063	0.688	0.563	0.188	8.188	0.531	93.5%	92.4%
(57.2)	11.0	NR	NR	NR	NR	NR	NR				

Wind Load Data : Specimen H5

Load PSF	Load in H2O	Top		Center		Bottom		NET Defl'n at Load	NET Defl'n at Load	Percent Recovery	Gross Percent Recovery
		Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load				
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NA	NA
(20.8)	4.0	0.250	0.000	1.906	0.000	0.188	0.000	1.688	0.000	100.0%	100.0%
(41.6)	8.0	0.563	0.000	3.938	0.063	0.500	0.000	3.406	0.063	98.2%	98.4%
(52.0)	10.0	0.813	0.063	5.063	0.188	0.563	0.031	4.375	0.141	96.8%	96.3%
(57.2)	11.0	0.938	0.125	6.125	0.313	0.688	0.094	5.313	0.203	96.2%	94.9%
(62.4)	12.0	1.063	0.250	7.438	0.438	0.813	0.188	6.500	0.219	96.6%	94.1%
(67.6)	13.0	NR	NR	NR	NR	NR	NR				

Panels released from header at ~12-3/4" H2O.

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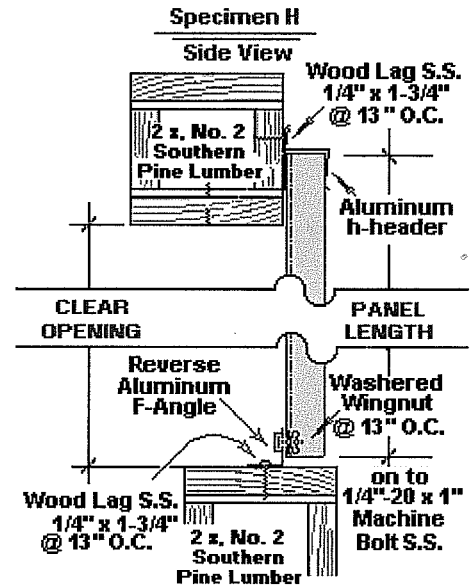
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Specimen H3 : Wall / Floor, Mount : 60" Panels : 54" C.O. : -Wind

Specimen H3 : Wall / Floor, Mount : 48" Panels : 44" C.O. : -Wind

Head: Panels were mounted into an aluminum h-header extrusion. This extrusion was secured to a No: 2 Southern Pine lumber beam at 13" on center with S.S. 1/4" x 1-3/4" wood lags. **Sill:** Panels were mounted at 13" on center with washered wingnuts onto stainless steel, 1/4"-20 x 1" machine bolts trapped into an aluminum reverse f-track. This reverse f-angle was secured to a No: 2 Southern Pine lumber beam at 13" on center with S.S. 1/4" x 1-3/4" wood lags.

Static Wind Loading / Manner of Testing: In accordance with FBC 2001, TAS 202-94, **CRITERIA FOR TESTING IMPACT & NON IMPACT RESISTANT BUILDING ENVELOPE COMPONENTS USING UNIFORM STATIC AIR PRESSURE :** Loads were applied to the specimen (30 second duration) at levels specified by the client's Consulting Engineer. Polyethylene film (2 mil) and tape were used to seal air leakage during loads these were used in a manner that did not influence the results. Gauges were mounted along the centerline of the specimen's primary span to record deflections. Deflection readings follow:



Wind Load Data : Specimen H3

Load PSF	Load in H2O	Top		Center		Bottom		Defl'n at Load	NET Defl'n at Load	Percent Recovery	Gross Percent Recovery
		Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load				
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NA	NA
(20.8)	4.0	0.125	0.000	1.188	0.000	0.125	0.000	1.063	0.000	100.0%	100.0%
(41.6)	8.0	0.313	0.000	2.313	0.000	0.313	0.000	2.000	0.000	100.0%	100.0%
(62.4)	12.0	0.563	0.000	3.500	0.063	0.438	0.063	3.000	0.031	99.0%	98.2%
(72.8)	14.0	0.813	0.000	5.250	0.125	0.813	0.125	4.438	0.063	98.6%	97.6%
(78.0)	15.0	0.938	0.063	6.188	0.375	0.750	0.188	5.344	0.250	95.3%	93.9%
(83.2)	16.0	1.188	0.125	7.875	0.500	1.000	0.250	6.781	0.313	95.4%	93.7%
(88.4)	17.0	NR	NR	NR	NR	NR	NR				

Center line moment failure at ~16-1/2" H2O

Wind Load Data : Specimen H6

Load PSF	Load in H2O	Top		Center		Bottom		Defl'n at Load	NET Defl'n at Load	Percent Recovery	Gross Percent Recovery
		Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load	Defl'n at Load				
0.0	0.0	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	NA	NA
(31.2)	6.0	0.094	0.000	1.750	0.000	0.094	0.000	1.656	0.000	100.0%	100.0%
(62.4)	12.0	0.125	0.000	1.500	0.000	0.125	0.000	1.406	0.000	100.0%	100.0%
(93.6)	18.0	0.188	0.031	2.313	0.063	0.188	0.031	2.188	0.031	98.6%	97.3%
(124.8)	24.0	0.313	0.063	3.125	0.125	0.250	0.063	2.938	0.063	97.9%	96.0%
(156.0)	30.0	0.500	0.094	4.000	0.250	0.438	0.094	3.719	0.156	95.8%	93.8%
(171.6)	33.0	NR	NR	NR	NR	NR	NR				

Center line moment failure at ~31-1/2" H2O

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Report No: 04-009 LE FBC

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Test Dates: 24 & 26 May, 1 & 3 June, 3 July, 10 & 11 August 2004

Test Summary : Polycarbonate Hurricane Shutter Panels

Client:

**Transparent Protection
Systems, Inc.**

6643 North 42nd Terrace
West Palm Beach, FL 33407

Phone: 888-447-8320

Fax: 561-844-2445

IMPACTS : Specimens E, F & G were impacted in accordance with FBC 2001 TAS 201-94. None failed as a result of large missile impacts.

CYCLIC WIND LOADS : Specimens E, F & G were subjected to cyclic wind loads in accordance with FBC 2001 TAS 203-94. All specimen successfully completed the cyclic wind loads to verified a **Design Load of +/- 17.33 PSF.**

WIND LOADS : Specimen H1, H4, H2, H5, H3 & H6 were subjected to static wind loads in accordance with FBC 2001 TAS 202-94. Specimen were tested to failure, these failures are described following the relevant data. **Specimen H1** successfully completed wind loads to verify a **Design Load of -17.33 PSF** on a 103" panel with a 99" clear opening, **Specimen H4** successfully completed wind loads to verify a **Design Load of -24.27 PSF** on a 93" panel with a 89" clear opening, **Specimen H2** successfully completed wind loads to verify a **Design Load of -34.67 PSF** on a 84" panel with a 80" clear opening, **Specimen H5** successfully completed wind loads to verify a **Design Load of -41.6 PSF** on a 72" panel with a 68" clear opening **Specimen H3** successfully completed the wind loads to verify a **Design Load of -55.47 PSF** on a 60" panel with a 56" clear opening and **Specimen H6** successfully completed wind loads to verify a **Design Load of -104.0 PSF** on a 48" panel with a 44" clear opening.

CONCLUSION: Following testing all specimen were disassembled. No failures were observed in the shutters, the fastenings or anchorages, except as noted in specimen deliberately tested to failure, descriptions of these follow the relevant data. The shutter product was tested in accordance with and meets the requirements to comply with Florida Building Code 2001, Sections 1606, 1619 & 1626.

Respectfully submitted, CONSTRUCTION TESTING CORPORATION
(Miami-Dade Certification # 01-0924.04)

Report by George Dotzler:

Test witnessed & report reviewed
By Yamil G. Kuri, P.E.:

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