

**ASTM E 1886 and ASTM E 1996
TEST REPORT**

Rendered to:

NORSE, INC.

**SERIES/MODEL: Flush Mount/Surface Mount
PRODUCT TYPE: Hurricane Shutter Fastening System**

This report contains in its entirety:

**Cover Page: 1 page
Report Body: 16 pages
Test Equipment: 1 page
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**Report No.: 92518.01-109-44
Revision 1: 09/21/09
Test Dates: 08/17/09
Through: 08/23/09
Report Date: 09/11/09
Expiration Date: 08/23/13**

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NORSE, INC.
100 South Road
Torrington, Connecticut 06790

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Project Summary: Architectural Testing, Inc. was contracted by Norse, Inc. to perform testing on three Series/Model Flush Mount and Series/Model Surface Mount, hurricane shutter fastening system. The samples tested met the performance requirements set forth in the referenced test procedures for a ± 2155 Pa (± 45.0 psf) Design Pressure with missile impacts corresponding to Missile Level D and Wind Zone 4. Test specimen description and results are reported herein. The samples were provided by the client.

Test Procedures: The test specimens were evaluated in accordance with the following:

ASTM E 330-02, Test Method for Structural Performance of Exterior Windows, Curtain Walls and Doors by Uniform Static Air Pressure Difference.

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

ASTM E 1996-05, Standard Specification for Performance of Exterior Windows, Glazed Curtain Walls, Doors and Storm Shutters Impacted by Wind Borne Debris in Hurricanes.

Test Specimen Description:

Test Specimen #1 through #3:

Series/Model: Flush Mount Fastening System

Product Type: Hurricane Shutter

Overall Size: 1829 mm (72") wide by 2032 mm (80") high

Rough Opening Size: 1829 mm (72") wide by 2032 mm (80") high

Test Specimen #4:

Series/Model: Surface Mount

Product Type: Hurricane Shutter Fastening System

Overall Size: 1902 mm (74-7/8") wide by 2073 mm (81-5/8") high

Rough Opening Size: 1829 mm (72") wide by 2032 mm (80") high

The following descriptions apply to all specimens.

Finish: All hardware had a mill finish. All plywood was natural.

Panel Construction: The shutter panels were constructed of two sheets of nominal 5/8" thick plywood sheathing. The two panels utilized a 6" wide by 3/4" thick piece of plywood at the center vertical joint. The 6" wide piece of plywood was secured to the exterior left plywood panel with #10 x 1-5/8" long pan head screws located at each end, and spaced 4-1/2" on center with a staggered spacing.

Test Buck Construction: The test bucks were constructed of C12 x 20.7 steel C-Channel wrap. The wrap utilized fully welded corners. The test buck utilized a solid poured concrete (3000 psi) sill, measuring 14" wide by 7-1/2" tall. Hollow 8" by 8" by 8" long grout-filled CMU half-block was laid up each jamb with nominal 1/4" mortar joints. A solid 8" by 8" continuous lintel was utilized at the top of the test wall. The grout-filled CMU block and the lintel was secured to the steel wrap with 1/4" x 1-1/2" long Tapcon anchors spaced 16" on center. The test bucks utilized 1" by 1" by 0.062" thick aluminum tubing inside the rough opening. The aluminum tubing was utilized to simulate an aluminum window/patio door frame. The tubing was secured to the test buck with 1/4" x 1-1/2" long Tapcon anchors spaced 12" on center. The surface mount utilized the tubing at the exterior edge of the opening and the flush mount utilized the tubing set back 5/8" from the exterior edge of the test buck.

Test Specimen Description: (Continued)

Installation Details:

Flush Mount Installation: The shutter system was installed into a concrete-masonry-unit (CMU) grout filled wall. Steel hooks, measuring 1-3/8" wide by 1" tall by 0.07" thick were secured to the lintel with two #10 x 2" long Tapcon concrete anchors, (Reference Norse drawing). The hooks were located on the lintel, 4" from each CMU jambs and spaced approximately 9" on center (eight total clips, four per panel). Receiving clips for the hooks were located on the plywood panel at each hook location. The receiving clips were secured with two #10 x 1" long machine bolts with nuts and washers.

Surface Mount Installation: The shutter system was installed onto the exterior surface of a concrete-masonry-unit (CMU) grout filled wall. Steel hooks, measuring 1-3/8" wide by 1" tall by 0.07" thick were secured to the lintel with two #10 x 2" long Tapcon concrete anchors, (Reference Norse drawing). The hooks were located on the lintel, 4" from each CMU jambs and spaced approximately 7" on center (ten total clips, five per panel). Receiving clips for the hooks were located on the plywood panel at each hook location. The receiving clips were secured with two #10 x 1" long machine bolts with nuts and washers.

*The following installation details apply to both
Flush Mount and Surface Mount test specimens.*

The left and right sides of the plywood were secured with a "keyed-hooking" system, (Reference Norse drawing). Four clips were utilized on each side, located 8" from the head and sill and spaced approximately 21-1/2" on center. The "keyed-hooks" were secured to the plywood sheathing with four #10 x 5/8" long pan head screws. The receiving clip for the "keyed-hooks" was secured to the CMU jambs with two #10 x 2" long Tapcon concrete anchors. The vertical joint four of the "keyed-hooks", located 8" from the head and sill and spaced approximately 21-1/2" on center. The "keyed-hooks" were secured to the plywood sheathing with four #10 x 5/8" long pan head screws. The receiving clip for the "keyed-hooks" was secured to the plywood sheathing with two #10 x 1" long machine bolts with nuts and washers.

The bottom of the plywood was secured with 0.12" thick steel L-shaped clips measuring 1-1/2" wide by 1" wide and tall. The clips were located 4" from each end and spaced approximately 13-1/2" on center. The clips were secured to the plywood with two #10 x 5/8" long pan head screws through the clips and into the plywood. The clip was also secured to the poured concrete sill with one #1/4 x 1-1/2" long hex head lag bolt with concrete anchor, (Reference Norse Drawing).

Test Results: The following results have been recorded:

Protocol ASTM E330-02, *Static Air Pressure Tests*

Test Unit #1 (Flush Mount)

Design Pressure: ± 45.0 psf

Title of Test	Results								
	Indicator Readings (inch)								
	#1	#2	#3	#4	#5	#6	#7	#8	#9
Structural Loads									
50% of Test Pressure (+33.75 psf)									
Maximum Deflection	0.17	1.61	0.14	0.17	0.15	0.15	0.25	0.32	0.25
Permanent Set	0.04	0.15	0.02	0.02	0.02	0.01	0.02	<0.01	<0.01
Design Pressure (+45.00 psf)									
Maximum Deflection	0.18	2.05	0.18	0.22	0.19	0.18	0.32	0.35	0.32
Permanent Set	0.03	0.19	0.03	0.02	0.01	<0.01	0.02	0.08	0.02
50% of Test Pressure (-33.75 psf)									
Maximum Deflection	0.57	2.00	0.30	0.45	0.34	0.28	0.39	0.55	0.41
Permanent Set	0.11	0.36	0.06	0.07	0.07	0.07	0.09	0.16	0.10
Design Pressure (-45.00 psf)									
Maximum Deflection	0.73	2.44	0.40	0.55	0.42	0.36	0.50	0.72	0.51
Permanent Set	0.16	0.43	0.05	0.11	0.10	0.10	0.13	0.22	0.13
Test Pressure (+67.50 psf)									
Maximum Deflection	0.39	3.20	0.28	0.39	0.37	0.38	0.59	0.83	0.51
Permanent Set	0.20	0.51	0.12	0.22	0.17	0.24	0.09	0.12	0.11
Test Pressure (-67.50 psf)									
Maximum Deflection	0.98	3.72	0.64	0.76	0.61	0.50	0.70	0.68	0.63
Permanent Set	0.39	0.64	0.07	0.34	0.26	0.23	0.05	0.10	0.16

Note: See Architectural Testing Sketch #1 for indicator locations.

Test Results: (Continued)

Protocol ASTM E330-02, Static Air Pressure Tests

Test Unit #4 (Surface Mount)

Design Pressure: ± 45.0 psf

Title of Test	Results								
	Indicator Readings (inch)								
Structural Loads	#1	#2	#3	#4	#5	#6	#7	#8	#9
50% of Test Pressure (+33.75 psf)									
Maximum Deflection	0.10	1.90	0.15	0.10	0.14	0.13	0.23	0.30	0.17
Permanent Set	0.02	0.16	0.03	0.02	0.02	0.02	0.03	0.04	0.03
Design Pressure (+45.00 psf)									
Maximum Deflection	0.13	2.35	0.20	0.11	0.18	0.15	0.26	0.36	0.20
Permanent Set	0.02	0.19	0.03	0.02	0.02	0.02	0.05	0.05	0.05
50% of Test Pressure (-33.75 psf)									
Maximum Deflection	0.48	2.51	0.38	0.43	0.38	0.28	0.36	0.47	0.38
Permanent Set	0.29	0.46	0.04	0.31	0.04	0.18	0.06	0.07	0.06
Design Pressure (-45.00 psf)									
Maximum Deflection	0.56	3.01	0.54	0.53	0.46	0.37	0.45	0.59	0.49
Permanent Set	0.38	0.54	0.07	0.39	0.31	0.25	0.09	0.10	0.08
Test Pressure (+67.50 psf)									
Maximum Deflection	0.53	3.65	0.32	0.54	0.49	0.42	0.36	0.52	0.32
Permanent Set	0.35	0.54	0.08	0.37	0.31	0.24	0.09	0.10	0.08
Test Pressure (-67.50 psf)									
Maximum Deflection	0.82	4.08	0.82	0.73	0.62	0.51	0.70	0.90	0.79
Permanent Set	0.51	0.62	0.11	0.51	0.43	0.37	0.19	0.21	0.19

Note: See Architectural Testing Sketch #1 for indicator locations.

Test Results: (Continued)

ASTM E 1886, *Large Missile Impact*

Conditioning Temperature: 22°C (72°F)

Missile Weight: 4196 g (9.25 lbs)

Missile Length: 2.3 m (7' 8-1/2")

Muzzle Distance from Test Specimen: 5.2 m (17 ft.)

Test Unit #1 (Flush Mount)

Impact #1: Missile Velocity: 15.4 m/s (50.6 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Center of right panel

Observations: Missile hit target area, no penetration.

Deflection: 5.6 mm (0.22")

Results: Pass

Impact #2: Missile Velocity: 15.2 m/s (50.0 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Upper right corner of right panel

Observations: Missile hit target area, resulting in minor splitting of the plywood, no penetration.

Deflection: 3.3 mm (0.13")

Results: Pass

Impact #3: Missile Velocity: 15.4 m/s (50.6 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Midspan of vertical joint.

Observations: Missile hit target area, no penetration.

Deflection: 5.1 mm (0.20")

Results: Pass

Note: See Architectural Testing Sketch #2 for impact locations.

Test Results: (Continued)

ASTM E 1886, *Large Missile Impact*

Conditioning Temperature: 22°C (72°F)

Missile Weight: 4196 g (9.25 lbs)

Missile Length: 2.3 m (7' 8-1/2")

Muzzle Distance from Test Specimen: 5.2 m (17 ft.)

Test Unit #2 (Flush Mount)

Impact #1: Missile Velocity: 15.2 m/s (49.9 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Center of right panel

Observations: Missile hit target area, no penetration.

Deflection: 31.8 mm (1.25 ")

Results: Pass

Impact #2: Missile Velocity: 15.3 m/s (50.3 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Lower left corner of right panel

Observations: Missile hit target area, no penetration.

Deflection: 10.7 mm (0.42")

Results: Pass

Impact #3: Missile Velocity: 15.4 m/s (50.4 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Midspan of vertical joint.

Observations: Missile hit target area, cracked the plywood strip, joining the panels, no penetration.

Deflection: 10.2 mm (0.40")

Results: Pass

Note: See Architectural Testing Sketch #3 for impact locations.

Test Results: (Continued)

ASTM E 1886, *Large Missile Impact*

Conditioning Temperature: 22°C (72°F)

Missile Weight: 4196 g (9.25 lbs)

Missile Length: 2.3 m (7' 8-1/2")

Muzzle Distance from Test Specimen: 5.2 m (17 ft.)

Test Unit #3 (Flush Mount)

Impact #1: Missile Velocity: 15.2 m/s (49.9 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Center of right panel

Observations: Missile hit target area, resulting in full penetration of missile, 3" sphere cannot freely pass through penetration.

Deflection: N/A (transducer released upon impact)

Results: Pass

Impact #2: Missile Velocity: 15.2 m/s (49.9 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Upper right corner of right panel

Observations: Missile hit target area, resulting in full penetration of missile. 3" sphere cannot freely pass through penetration.

Deflection: N/A (transducer released upon impact)

Results: Pass

Impact #3: Missile Velocity: 15.4 m/s (50.4 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Midspan of vertical joint.

Observations: Missile hit target area, cracked the plywood strip, joining the panels, no penetration.

Deflection: 10.2 mm (0.40")

Results: Pass

Note: See Architectural Testing Sketch #4 for impact locations.

Test Results: (Continued)

ASTM E 1886, *Large Missile Impact*

Conditioning Temperature: 22°C (72°F)
Missile Weight: 4196 g (9.25 lbs)
Missile Length: 2.3 m (7' 8-1/2")
Muzzle Distance from Test Specimen: 5.2 m (17 ft.)

Test Unit #4 (Surface Mount)

Impact #1: Missile Velocity: 15.3 m/s (50.1 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Center of right panel
Observations: Missile hit target area, no penetration.
Deflection: 4.1 mm (0.16")
Results: Pass

Impact #2: Missile Velocity: 15.3 m/s (50.1 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Lower left corner of right panel
Observations: Missile hit target area, resulting in a full penetration of the missile, 3" sphere cannot freely pass through the penetration.
Deflection: N/A
Results: Pass

Impact #3: Missile Velocity: 15.3 m/s (50.3 fps); orientation within $\pm 5^\circ$ of vertical

Impact Area: Midspan of vertical joint.
Observations: Missile hit target area, no penetration.
Deflection: 12.2 mm (0.48")
Results: Pass

Note: See Architectural Testing Sketch #5 for impact locations.

Test Results: (Continued)

ASTM E 1886, Air Pressure Cycling

Test Unit #1 (Flush Mount)

Design Pressure: ±2155 Pa (±45.0 psf)

POSITIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
430 to 1077 (9.0 to 22.5)	3500	3.09	5.3 (0.21)	46.5 (1.83)	5.6 (0.22)	5.3 (0.21)	4.3 (0.17)	4.3 (0.17)	10.9 (0.43)	14.0 (0.55)	11.2 (0.44)
0 to 1293 (0 to 27.0)	300	3.64	5.3 (0.21)	51.0 (2.01)	5.6 (0.22)	5.3 (0.21)	4.3 (0.17)	4.8 (0.19)	11.4 (0.45)	14.7 (0.58)	11.4 (0.45)
1077 to 1724 (22.5 to 36.0)	600	2.97	5.3 (0.21)	63.2 (2.49)	5.6 (0.25)	6.4 (0.25)	4.3 (0.17)	6.9 (0.27)	13.2 (0.52)	17.0 (0.67)	13.5 (0.53)
646 to 2155 (13.5 to 45.0)	100	3.97	5.3 (0.21)	71.1 (2.80)	7.4 (0.29)	6.9 (0.27)	4.3 (0.17)	6.9 (0.27)	14.0 (0.55)	18.3 (0.72)	14.2 (0.56)
			Permanent Set								
			0.3 (0.01)	7.1 (0.28)	2.0 (0.08)	0.3 (0.01)	0.3 (0.01)	1.3 (0.05)	2.5 (0.10)	2.3 (0.09)	4.6 (0.18)

NEGATIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
646 to 2155 (13.5 to 45.0)	3500	4.24	13.7 (0.54)	73.2 (2.88)	18.3 (0.72)	10.4 (0.41)	23.6 (0.93)	9.9 (0.39)	17.3 (0.68)	18.0 (0.71)	13.7 (0.54)
1077 to 1724 (22.5 to 36.0)	300	3.12	10.9 (0.43)	63.8 (2.51)	17.5 (0.69)	9.9 (0.39)	22.9 (0.90)	9.4 (0.37)	15.5 (0.61)	17.0 (0.70)	13.0 (0.51)
0 to 1293 (0 to 27.0)	600	4.56	10.7 (0.42)	52.8 (2.08)	12.4 (0.49)	7.1 (0.28)	5.8 (0.23)	5.3 (0.21)	10.9 (0.43)	11.7 (0.46)	5.8 (0.23)
430 to 1077 (9.0 to 22.5)	100	2.86	10.2 (0.40)	48.5 (1.91)	13.2 (0.52)	8.9 (0.35)	4.8 (0.19)	5.6 (0.22)	10.7 (0.42)	10.9 (0.43)	5.1 (0.20)
			Permanent Set								
			0.5 (0.02)	5.3 (0.21)	4.8 (0.19)	3.6 (0.14)	4.6 (0.18)	1.8 (0.07)	1.5 (0.06)	1.0 (0.04)	0.3 (0.01)

Observations: No additional damage was observed.

Result: Pass

Note: See Architectural Testing Sketch #1 for indicator locations.

Test Results: (Continued)

ASTM E 1886, Air Pressure Cycling

Test Unit #2 (Flush Mount)

Design Pressure: ± 2155 Pa (± 45.0 psf)

POSITIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
430 to 1077 (9.0 to 22.5)	3500	2.82	7.4 (0.29)	47.8 (1.88)	10.9 (0.43)	3.6 (0.14)	6.6 (0.26)	6.9 (0.27)	13.7 (0.54)	17.0 (0.67)	16.3 (0.64)
0 to 1293 (0 to 27.0)	300	4.79	7.6 (0.30)	53.1 (2.09)	11.4 (0.45)	3.6 (0.14)	6.6 (0.26)	7.1 (0.28)	14.0 (0.55)	17.8 (0.70)	17.0 (0.67)
1077 to 1724 (22.5 to 36.0)	600	2.95	9.9 (0.39)	67.1 (2.64)	13.0 (0.51)	4.6 (0.18)	8.1 (0.32)	8.6 (0.34)	16.3 (0.64)	20.6 (0.81)	19.3 (0.76)
646 to 2155 (13.5 to 45.0)	100	5.08	9.9 (0.39)	73.4 (2.89)	13.7 (0.54)	4.6 (0.18)	8.4 (0.33)	8.6 (0.34)	16.8 (0.66)	21.3 (0.84)	20.1 (0.79)
			Permanent Set								
			2.5 (0.10)	10.9 (0.43)	6.6 (0.26)	1.8 (0.07)	3.1 (0.15)	4.1 (0.16)	8.9 (0.35)	11.2 (0.44)	10.2 (0.40)

NEGATIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
646 to 2155 (13.5 to 45.0)	3500	4.34	39.4 (1.55)	96.3 (3.79)	31.2 (1.23)	15.2 (0.60)	17.8 (0.70)	17.3 (0.68)	21.8 (0.86)	26.7 (1.05)	24.9 (0.98)
1077 to 1724 (22.5 to 36.0)	300	2.68	39.4 (1.55)	90.2 (3.55)	30.7 (1.21)	15.2 (0.60)	17.5 (0.69)	17.3 (0.68)	21.8 (0.86)	26.4 (1.04)	24.4 (0.96)
0 to 1293 (0 to 27.0)	600	5.78	35.8 (1.41)	75.9 (2.99)	27.7 (1.09)	14.7 (0.58)	17.0 (0.67)	18.5 (0.73)	18.5 (0.73)	22.1 (0.87)	20.8 (0.82)
430 to 1077 (9.0 to 22.5)	100	2.81	34.3 (1.35)	71.4 (2.81)	26.7 (1.05)	14.7 (0.58)	17.0 (0.67)	17.3 (0.68)	17.8 (0.70)	21.1 (0.83)	19.8 (0.78)
			Permanent Set								
			25.4 (1.00)	28.4 (1.12)	15.2 (0.60)	13.0 (0.51)	14.7 (0.58)	15.2 (0.60)	12.4 (0.49)	14.7 (0.58)	14.8 (0.56)

Observations: No additional damage was observed.

Result: Pass

Note: See Architectural Testing Sketch #1 for indicator locations.

Test Results: (Continued)

ASTM E 1886, Air Pressure Cycling

Test Unit #3 (Flush Mount)

Design Pressure: ± 2155 Pa (± 45.0 psf)

POSITIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
430 to 1077 (9.0 to 22.5)	3500	2.58	10.67 (0.42)	44.45 (1.75)	5.33 (0.21)	8.13 (0.32)	9.14 (0.36)	9.14 (0.36)	11.94 (0.47)	12.95 (0.51)	11.68 (0.46)
0 to 1293 (0 to 27.0)	300	4.28	11.18 (0.44)	45.97 (1.81)	5.84 (0.23)	8.38 (0.33)	9.40 (0.37)	9.40 (0.37)	12.19 (0.48)	13.21 (0.52)	12.19 (0.48)
1077 to 1724 (22.5 to 36.0)	600	3.50	13.21 (0.52)	61.47 (2.42)	7.87 (0.31)	10.67 (0.42)	11.43 (0.45)	11.43 (0.45)	14.73 (0.58)	16.00 (0.63)	14.22 (0.56)
646 to 2155 (13.5 to 45.0)	100	3.91	13.72 (0.54)	66.80 (2.63)	8.64 (0.34)	11.18 (0.44)	12.19 (0.48)	11.94 (0.47)	15.75 (0.62)	17.02 (0.67)	14.99 (0.59)
			Permanent Set								
			6.86 (0.27)	10.67 (0.42)	3.56 (0.14)	5.33 (0.21)	5.84 (0.23)	4.83 (0.19)	6.35 (0.25)	7.37 (0.29)	5.84 (0.23)

NEGATIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
646 to 2155 (13.5 to 45.0)	3500	3.92	22.86 (0.90)	71.37 (2.81)	16.51 (0.65)	15.24 (0.60)	13.21 (0.52)	10.92 (0.43)	17.78 (0.70)	20.83 (0.82)	18.29 (0.72)
1077 to 1724 (22.5 to 36.0)	300	2.49	22.10 (0.87)	65.53 (2.58)	15.24 (0.60)	14.48 (0.57)	12.45 (0.49)	10.16 (0.40)	16.26 (0.64)	19.30 (0.76)	16.51 (0.65)
0 to 1293 (0 to 27.0)	600	4.70	21.34 (0.84)	59.18 (2.33)	13.72 (0.54)	14.48 (0.57)	12.45 (0.49)	9.91 (0.39)	14.99 (0.59)	17.53 (0.69)	14.99 (0.59)
430 to 1077 (9.0 to 22.5)	100	2.89	20.07 (0.79)	54.36 (2.14)	12.95 (0.51)	14.22 (0.56)	11.94 (0.47)	9.91 (0.39)	14.48 (0.57)	17.02 (0.67)	14.48 (0.57)
			Permanent Set								
			6.60 (0.26)	17.78 (0.70)	4.32 (0.17)	9.91 (0.39)	9.65 (0.38)	4.57 (0.18)	8.38 (0.33)	7.87 (0.31)	8.64 (0.34)

Observations: No additional damage was observed.

Result: Pass

Note: See Architectural Testing Sketch #1 for indicator locations.

Test Results: (Continued)

ASTM E 1886, Air Pressure Cycling

Test Unit #3 (Flush Mount)

Design Pressure: ± 2155 Pa (± 45.0 psf)

POSITIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
430 to 1077 (9.0 to 22.5)	3500	2.84	7.6 (0.30)	58.7 (2.31)	4.6 (0.18)	3.8 (0.15)	4.3 (0.17)	3.8 (0.15)	2.5 (0.10)	1.3 (0.05)	1.5 (0.06)
0 to 1293 (0 to 27.0)	300	4.79	7.9 (0.31)	66.0 (2.60)	4.6 (0.18)	3.8 (0.15)	4.3 (0.17)	4.1 (0.16)	2.8 (0.11)	1.3 (0.05)	2.0 (0.08)
1077 to 1724 (22.5 to 36.0)	600	2.79	8.4 (0.33)	72.6 (2.86)	5.1 (0.20)	4.1 (0.16)	5.1 (0.20)	4.6 (0.18)	3.0 (0.12)	1.5 (0.06)	2.3 (0.09)
646 to 2155 (13.5 to 45.0)	100	4.62	8.9 (0.35)	87.1 (3.43)	6.4 (0.25)	4.6 (0.18)	5.3 (0.21)	4.6 (0.18)	3.6 (0.14)	1.8 (0.07)	2.3 (0.09)
			Permanent Set								
			1.0 (0.04)	3.8 (0.15)	1.5 (0.06)	3.3 (0.13)	1.8 (0.07)	3.0 (0.12)	1.5 (0.06)	1.3 (0.05)	1.0 (0.04)

NEGATIVE PRESSURE

Pressure Range Pa (psf)	Number of Cycles	Average Cycle Time (seconds)	Maximum Deflection at Indicator mm (inch)								
			#1	#2	#3	#4	#5	#6	#7	#8	#9
646 to 2155 (13.5 to 45.0)	3500	4.39	15.2 (0.60)	79.0 (3.11)	16.0 (0.63)	11.7 (0.44)	12.2 (0.48)	5.8 (0.23)	18.0 (0.71)	19.8 (0.78)	19.1 (0.75)
1077 to 1724 (22.5 to 36.0)	300	2.44	19.6 (0.77)	76.7 (3.02)	16.8 (0.66)	18.5 (0.73)	17.5 (0.69)	17.8 (0.70)	18.0 (0.71)	19.8 (0.78)	19.1 (0.75)
0 to 1293 (0 to 27.0)	600	4.63	22.3 (0.88)	70.4 (2.77)	15.7 (0.62)	19.8 (0.78)	17.8 (0.70)	17.5 (0.69)	16.3 (0.64)	17.8 (0.70)	16.8 (0.66)
430 to 1077 (9.0 to 22.5)	100	2.39	22.3 (0.88)	65.8 (2.59)	16.5 (0.65)	36.1 (1.42)	17.3 (0.68)	16.5 (0.65)	15.7 (0.62)	17.3 (0.68)	16.0 (0.63)
			Permanent Set								
			21.3 (0.84)	4.8 (0.19)	2.5 (0.10)	23.9 (0.94)	6.1 (0.24)	5.3 (0.21)	3.0 (0.12)	2.8 (0.11)	2.8 (0.11)

Observations: No additional damage or deglazing was observed.

Result: Pass

Note: See Architectural Testing Sketch #1 for indicator locations.

General Note: Upon completion of testing, the specimens met the requirements of Section 7 of ASTM E 1996.

Test Equipment: (See Appendix A)

Canon: Constructed from steel piping utilizing compressed air to propel the missile

Missile: 2x4 Southern Pine

Timing Device: Electronic Beam Type

Cycling Mechanism: Computer controlled centrifugal blower with electronic pressure measuring device

Deflection Measuring Device: Linear transducers

Tape and film were used to seal against air leakage during structural testing. In our opinion, the tape and film did not influence the results of the test.

Drawing Reference: The test specimen drawings have been reviewed by Architectural Testing and are representative of the test specimen reported herein.

List of Official Observers:

<u>Name</u>	<u>Company</u>
Chris Langer	Norse, Inc.
Alfred C. Langer	Norse, Inc.
Aaron M. Shultz	Architectural Testing, Inc.
Tim J. McGill	Architectural Testing, Inc.
Michael D. Stremmel, P.E.	Architectural Testing, Inc.
Eric M. Brennan	Architectural Testing, Inc.

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

For ARCHITECTURAL TESTING, INC.

Eric M. Brennan
Technician

Michael D. Stremmel, P.E.
Senior Project Engineer

EMB:dem

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

- Appendix-A: Test Equipment (1)
- Appendix-B: Sketches (5)
- Appendix-C: Photograph (1)
- Appendix-D: Drawings (7)

Revision Log

<u>Rev. #</u>	<u>Date</u>	<u>Page(s)</u>	<u>Revision(s)</u>
0	09/11/09	N/A	Original report issue
1	09/21/09	Cover Page, Page 15, and Appendix D	Revised drawing packet to include missed drawings.

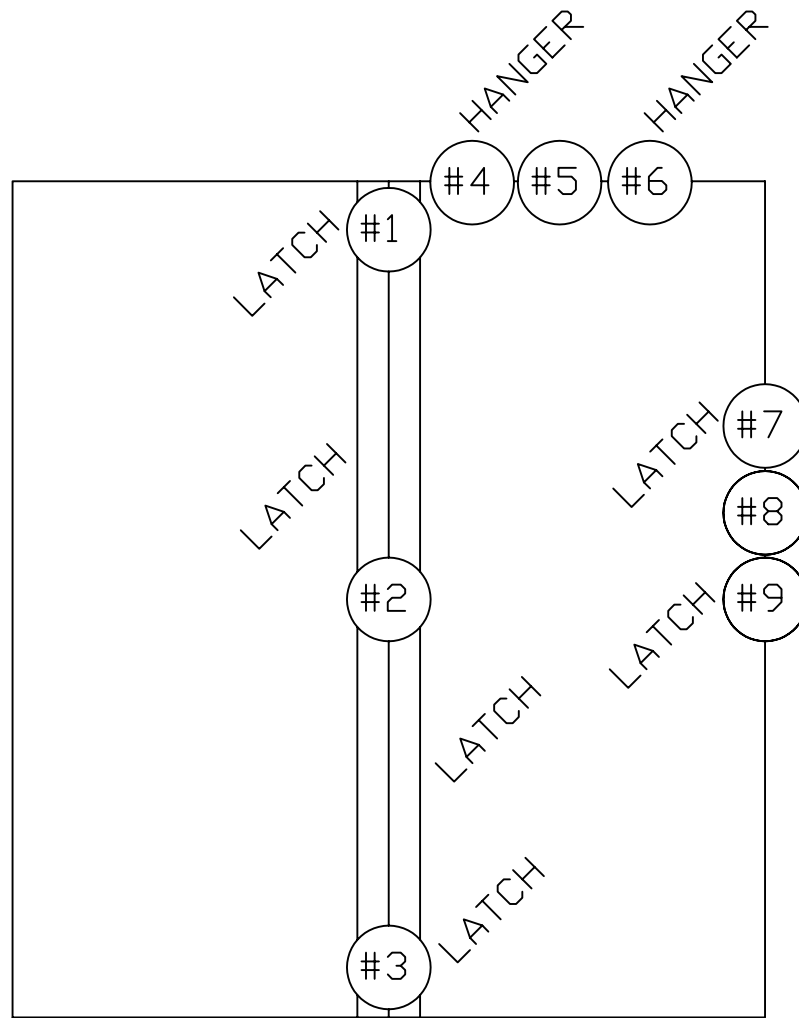
Appendix A
Test Equipment

Instrument	Manufacturer	Asset #
20" Linear Transducer	Celesco	Y002774
20" Linear Transducer	Celesco	62186
20" Linear Transducer	Celesco	62183
20" Linear Transducer	Celesco	003624
20" Linear Transducer	Celesco	Y003027
20" Linear Transducer	Celesco	003439
20" Linear Transducer	Celesco	62184
40" Linear Transducer	Celesco	62261-1
40" Linear Transducer	Celesco	62261-2
Control Panel (Blower)	Architectural Testing, Inc.	3232
Control Panel (Blower)	Architectural Testing, Inc.	5406
Cannon	Architectural Testing, Inc.	005118

Appendix B

Sketches

REV	DATE	DESCRIPTION	BY



INDICATOR LOCATIONS

PROJECT NO.
92518.01
109-44

PROJECT NAME: Shutters- ASTM E1886/E1996
CLIENT: Norse, Inc.



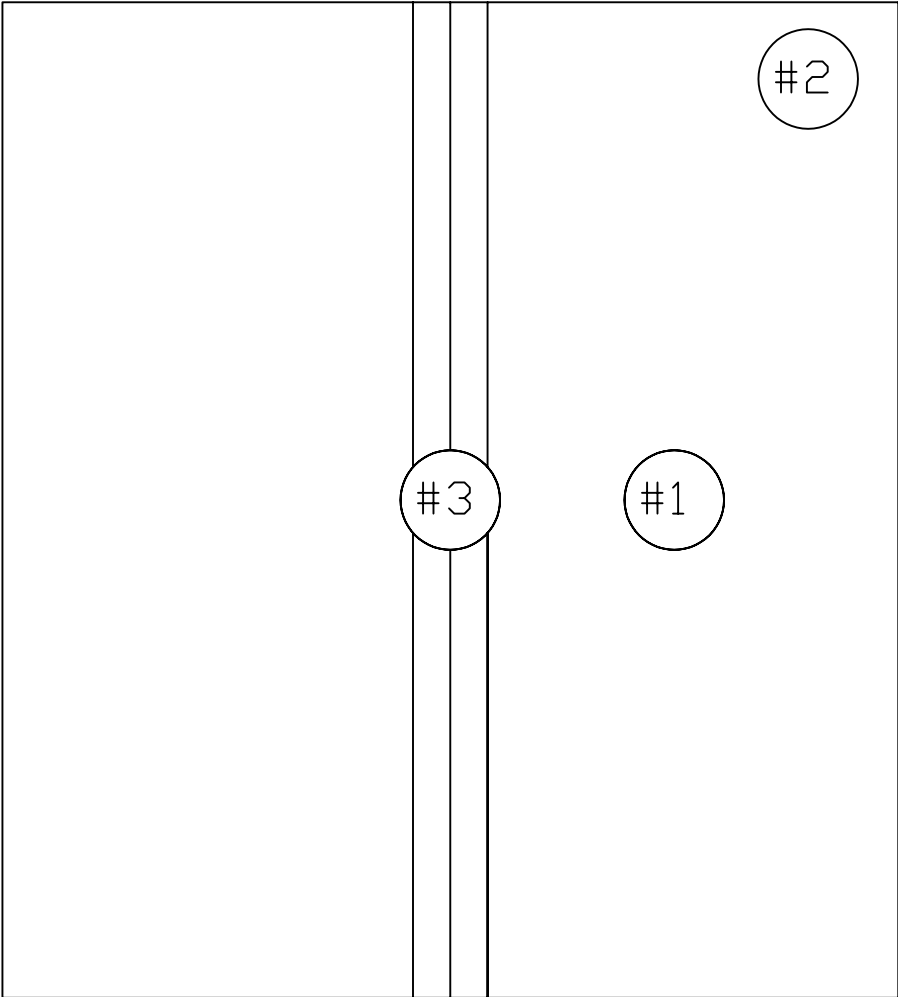
DRAWING
Sketch #1(Indicators)

DWG. BY:
TJM
DATE:
09/10/09

SHEET
1 OF
1

REV	DATE	DESCRIPTION	BY

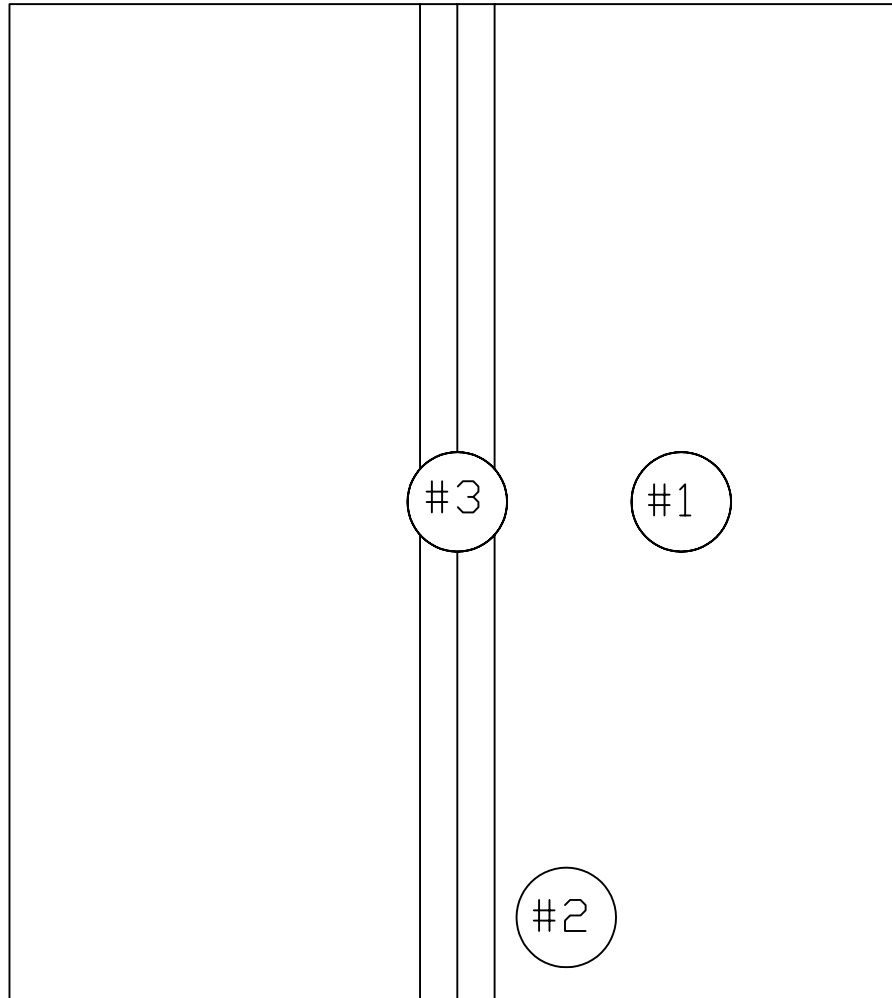
UNIT #1



IMPACT LOCATIONS

REV	DATE	DESCRIPTION	BY

UNIT #2



IMPACT LOCATIONS

PROJECT NO.
92518.01
109-44

PROJECT NAME: Shutters- ASTM E1886/E1996
CLIENT: Norse, Inc.



DRAWING

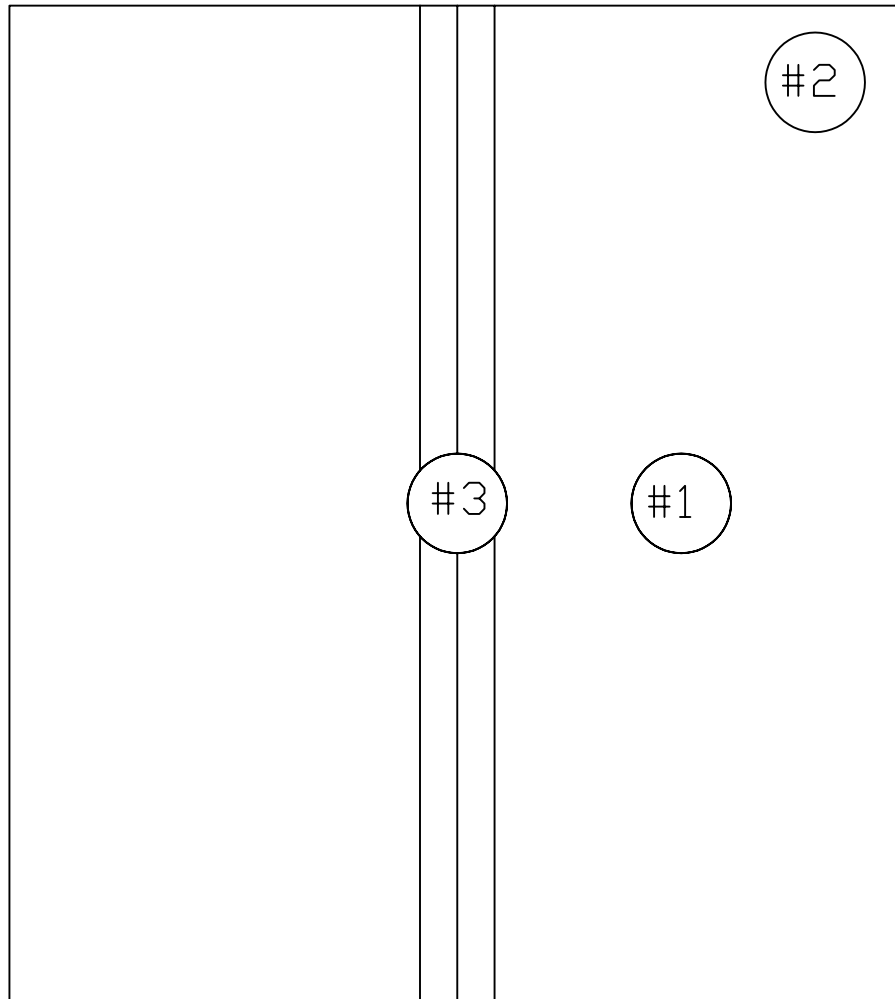
Sketch #3 (Unit #2)

DWG. BY:
TJM
DATE:
09/10/09

SHEET
1 OF
1

REV	DATE	DESCRIPTION	BY

UNIT #3



IMPACT LOCATIONS

PROJECT NO.
92518.01
109-44

PROJECT NAME: Shutters- ASTM E1886/E1996
CLIENT: Norse, Inc.



DRAWING

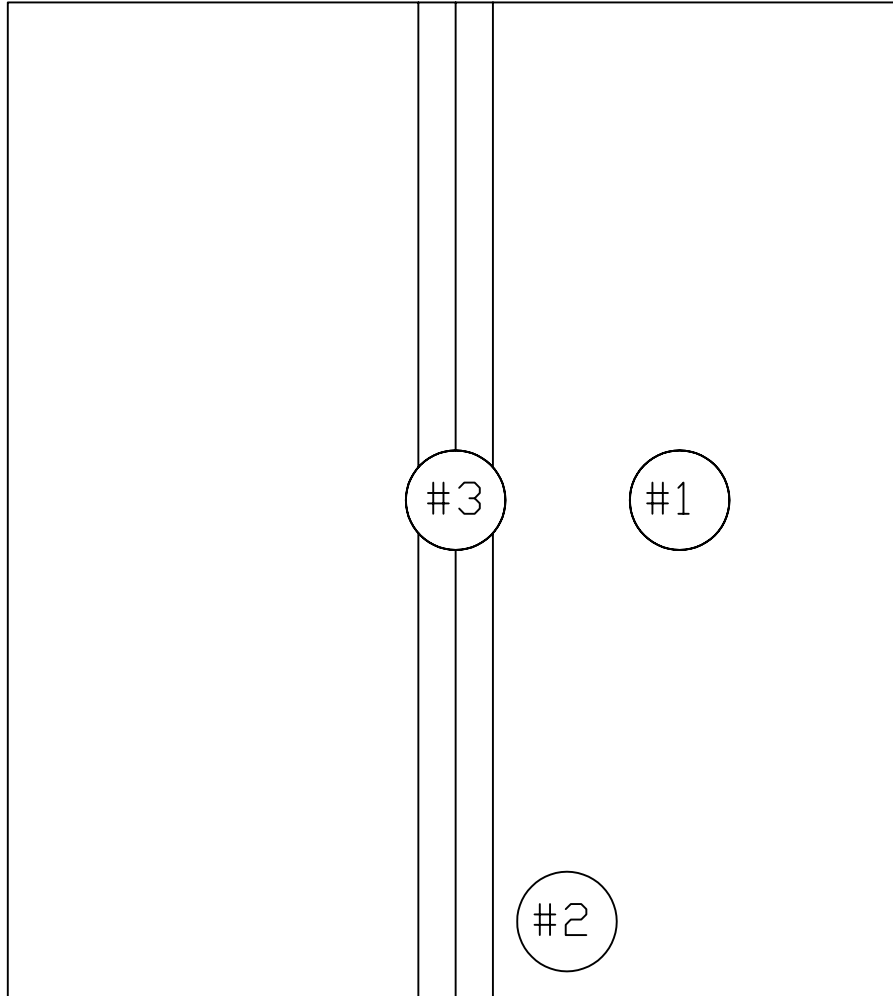
Sketch #4 (Unit #3)

DWG. BY:
TJM
DATE:
09/10/09

SHEET
1 OF
1

REV	DATE	DESCRIPTION	BY

UNIT #4



IMPACT LOCATIONS

PROJECT NO.
92518.01
109-44

PROJECT NAME: Shutters- ASTM E1886/E1996
CLIENT: Norse, Inc.



DRAWING
Sketch #5 (Unit #4)

DWG. BY:
TJM
DATE:
09/10/09

SHEET
1 OF
1

Appendix C
Photograph



Product Overview

Appendix D

Drawings

NORSE LATCHING COMPONENTS, SHUTTER PLYWOOD, & HARDWARE USED FOR SURFACE MOUNTING TEST

ITEM	QUANTITY
#10 x 1 1/4" PHWS/BATTEN	20
*#10 x 3/4" PHWS	64
#10-32 x 1/4" PHMS W/NUTS & WASHERS	4
1/4" x 1 1/2" LAG. BOLTS W/ANCHORS	6
'TAPCON' SCREWS 3/4" x 1 3/4"	36
#10-32 x 1 1/4" FHMS (10 x 2) W/NUTS & WASHERS	20

NORSE HARDWARE

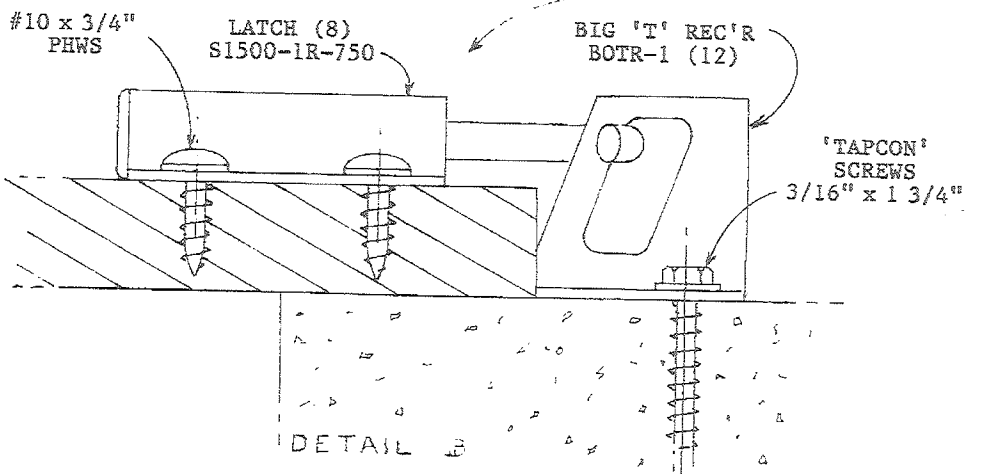
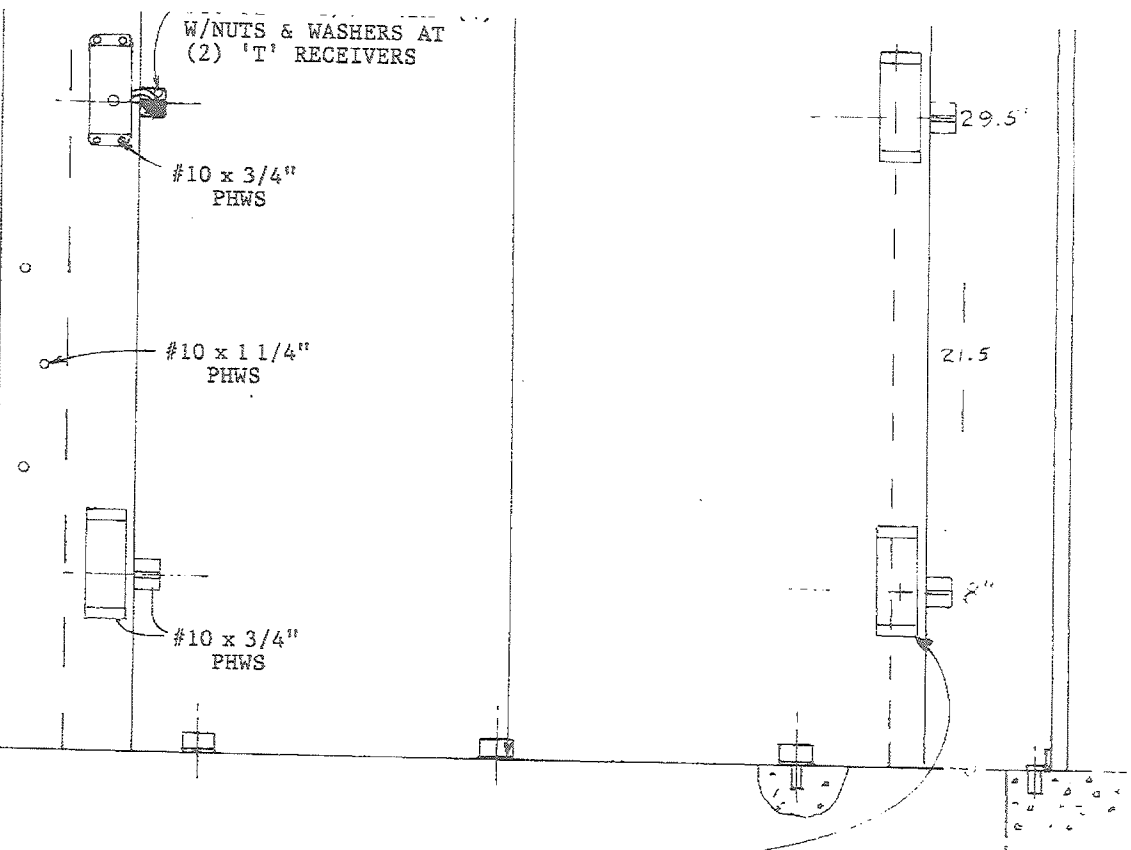
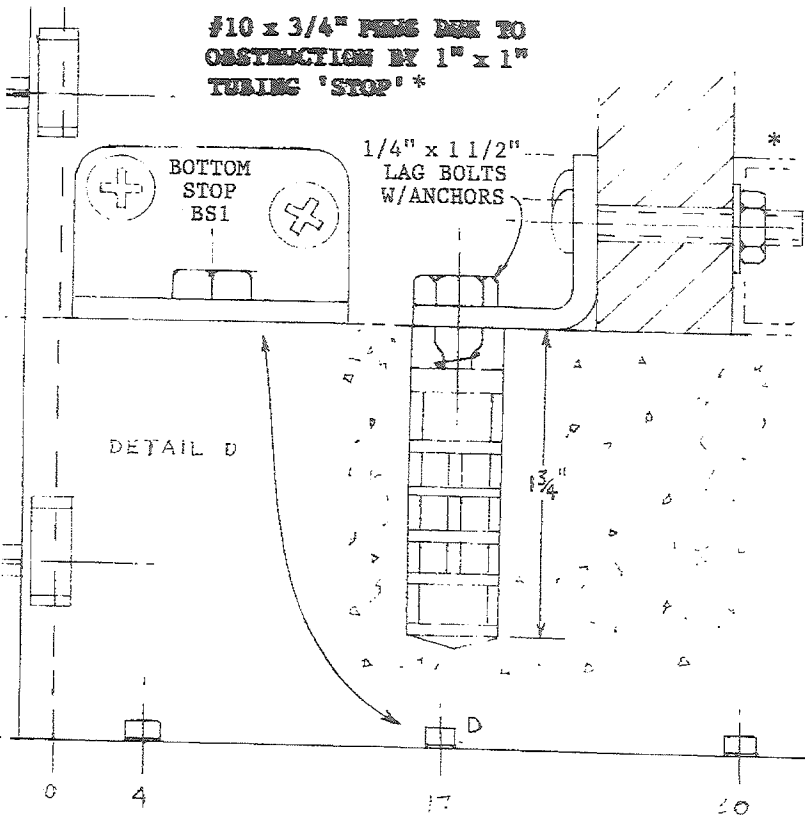
HOOKS (HK/S2)	10
HANGERS (HNG/S2)	10
BIG 'T' RECEIVERS (BOTR-1)/BATTEN	12
TYPE 1R LATCH (RH-S1500-1R-750)	8
TYPE 1L LATCH (LH-S1500-1L-750)	4
BOTTOM STOP (BS1)	6
PLYWOOD SHUTTERS (5/8" x 37 1/2" X 81 1/2")	2
BATTEN PLYWOOD (5/8" x 6" x 81 1/2")	1
<u>*#10 x 3/4" PHWS:</u>	
LATCHES (12 x 4)	48
BOTTOM STOPS (6 x 2)	12
BIG 'T' AT BATTEN (2 x 2)	4
TOTAL	64

REF: DWG. B101,293B

**TEST CONDUCTED AT ARCHITECTURAL TESTING
INC, YORK PA THE WEEK OF AUGUST 17, 2009.**

Architectural Testing

Architectural Testing
Test sample complies with these details.
Deviations are noted.
Report# 92518.01-109-44
Date 9/9/09 Tech Banner

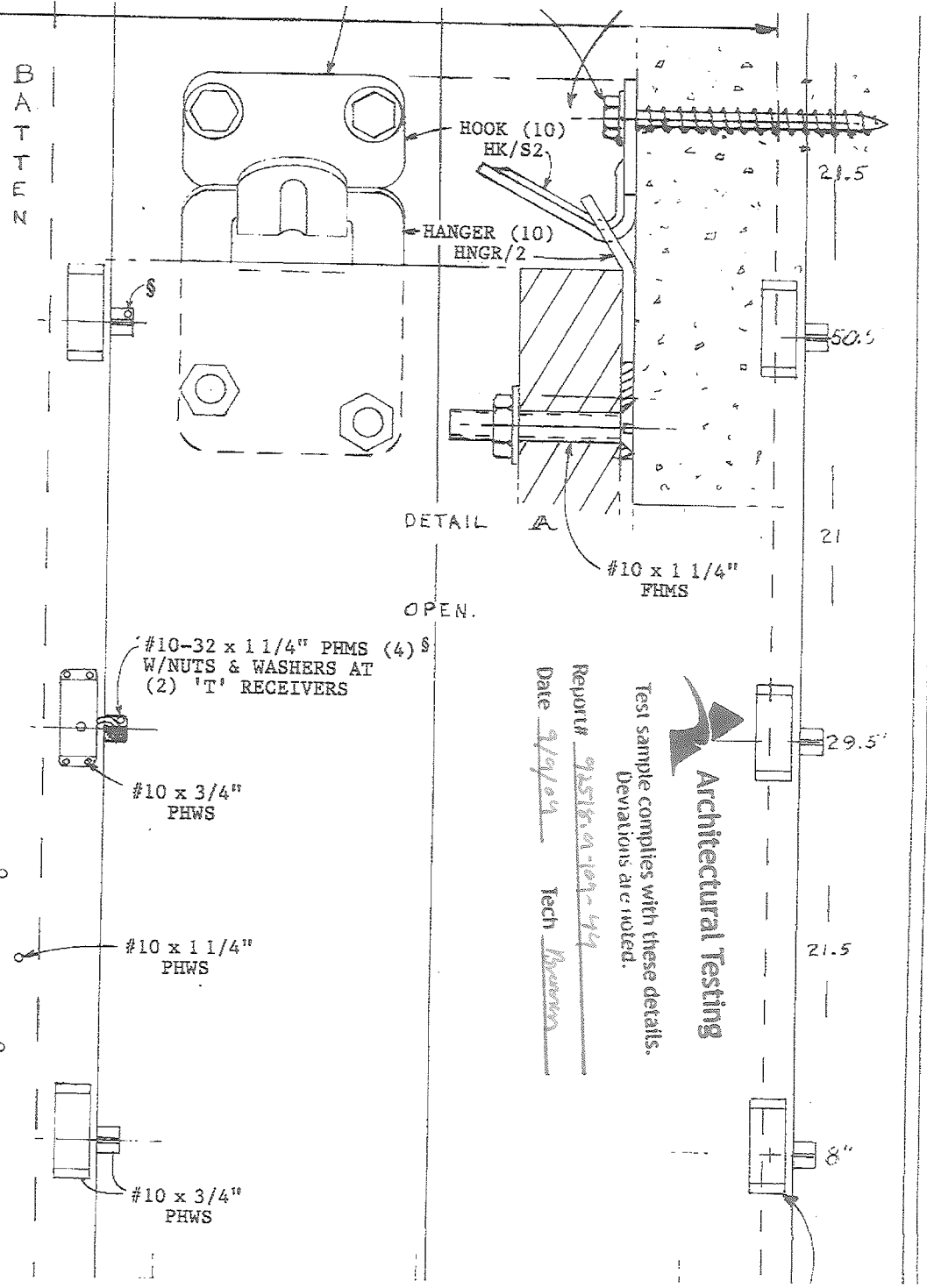
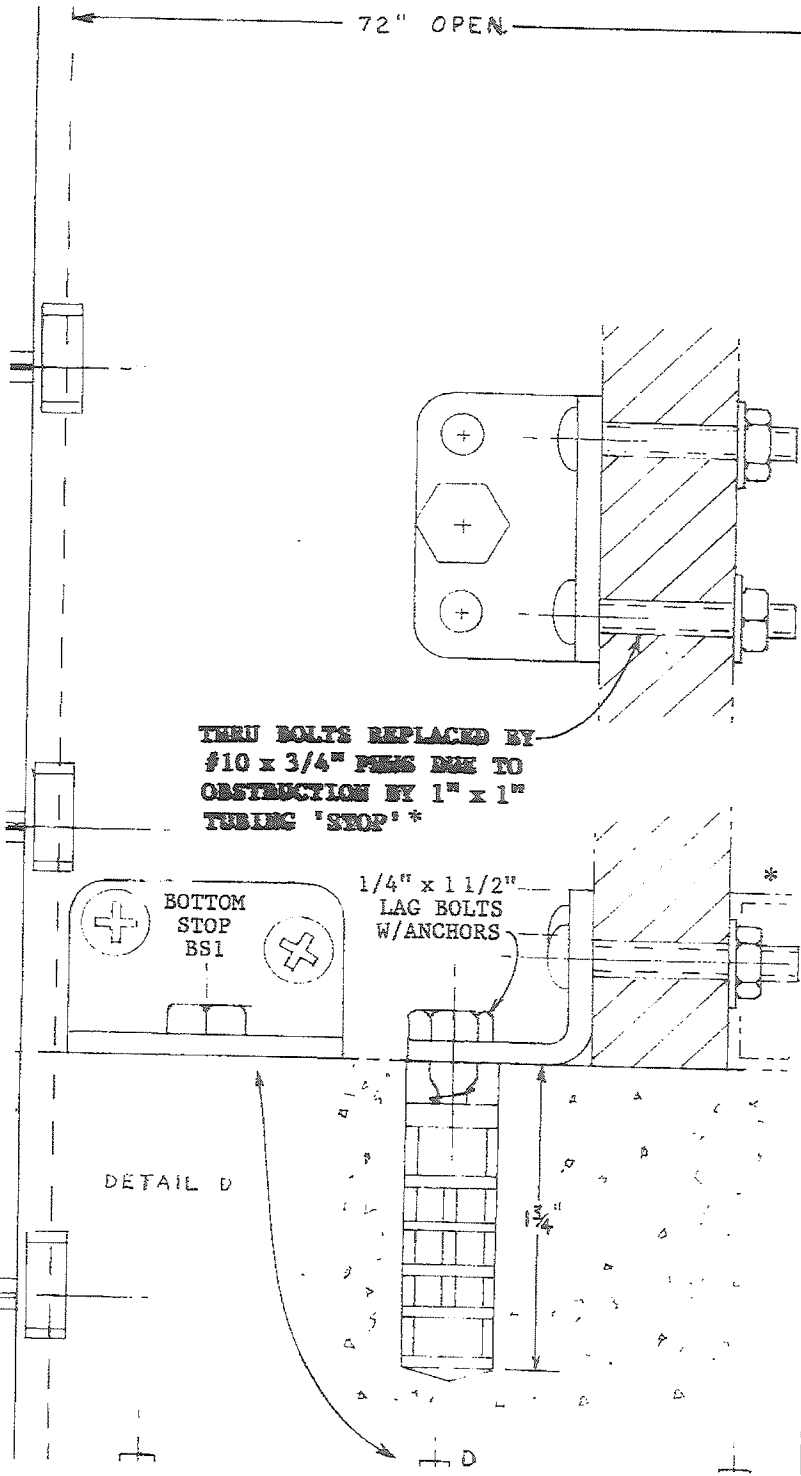


Architectural Testing

Test sample complies with these details. Deviations are noted.

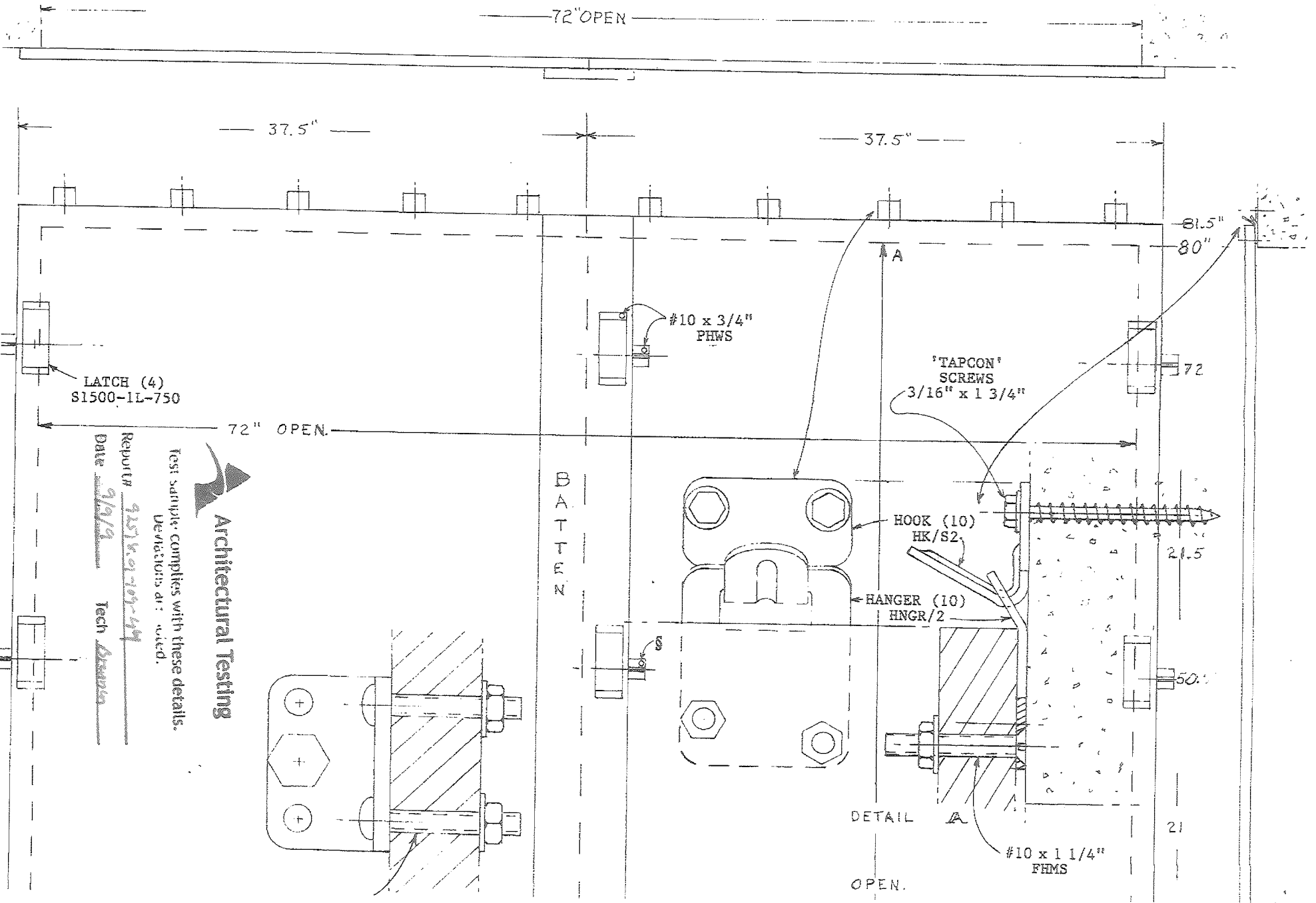
Report: 92516-01-07-44
 Date: 9/9/09
 Tech: *Banner*

NORSE <small>1180</small>	
72" x 80" TWO PANEL SURFACE MOUNTING HARDWARE CEMENT TEST BUCK	
SIZE B	CODE IDENT. NO. B101, 293 B
SCALE 1/8" = 1" 26 AUG 09 SHEET	




Architectural Testing
 Test sample complies with these details.
 Deviations are noted.

Report# 92518.01-01-44
 Date 9/9/04 Tech Matthew



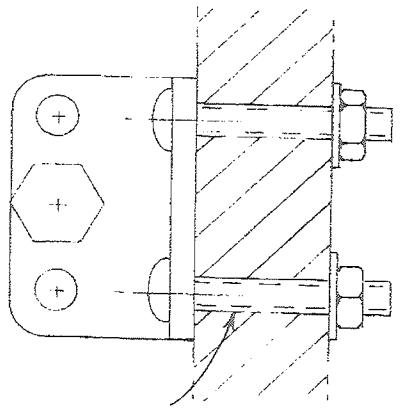
Architectural Testing

Test sample complies with these details.
Manufacturer: noted.

Report # 92576-01-109-449

Date 9/9/19

Tech Asst



NORSE LATCHING COMPONENTS, SHUTTER PLYWOOD, & HARDWARE USED FOR FLUSH MOUNTING TEST

ITEM	QUANTITY
#10 x 1 1/4" PHWS/BATTEN	20
*#10 x 3/4" PHWS	80
#10-32 x 1 1/4" PHMS W/NUTS & WASHERS	4
1/4" x 1 1/2" LAG. BOLTS W/ANCHORS	6
'TAPCON' SCREWS 3/4" x 1 3/4"	32

NORSE HARDWARE

HOOKS (HK/S2)	8
HANGERS (HNG/S2)	8
BIG 'T' RECEIVERS (BOTR-1)/BATTEN	4
SMALL 'T' RECEIVER (OTR187-1)	4
TYPE 1R LATCH (RH-S1500-1R-750)	8
TYPE 1L LATCH (LH-S1500-1L-750)	4
BOTTOM STOP (BS1)	6
PLYWOOD SHUTTERS (5/8" x 36" x 80")	2
BATTEN PLYWOOD (5/8" x 6" x 80")	1
<u>*#10 x 3/4" PHWS:</u>	
LATCHES (12 x 4)	48
BOTTOM STOPS (6 x 2)	12
BIG 'T' AT BATTEN (2 x 2)	4
HANGERS (8 x 2)	16
TOTAL	80



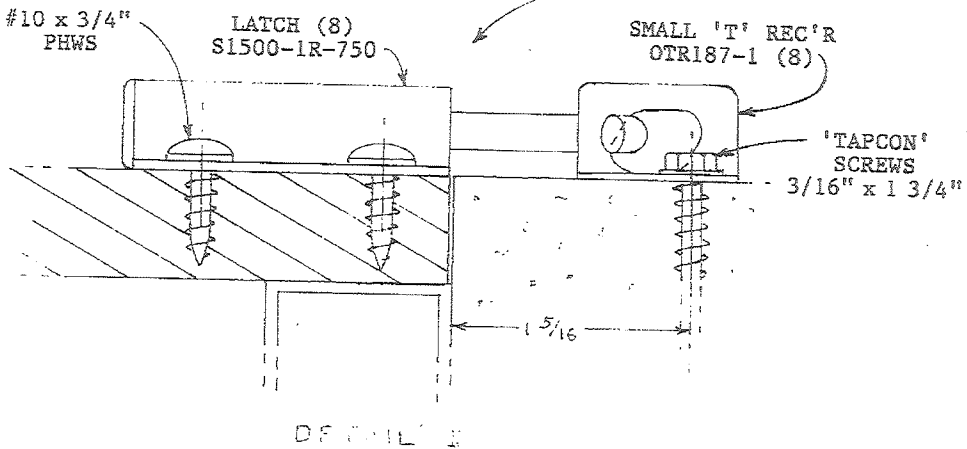
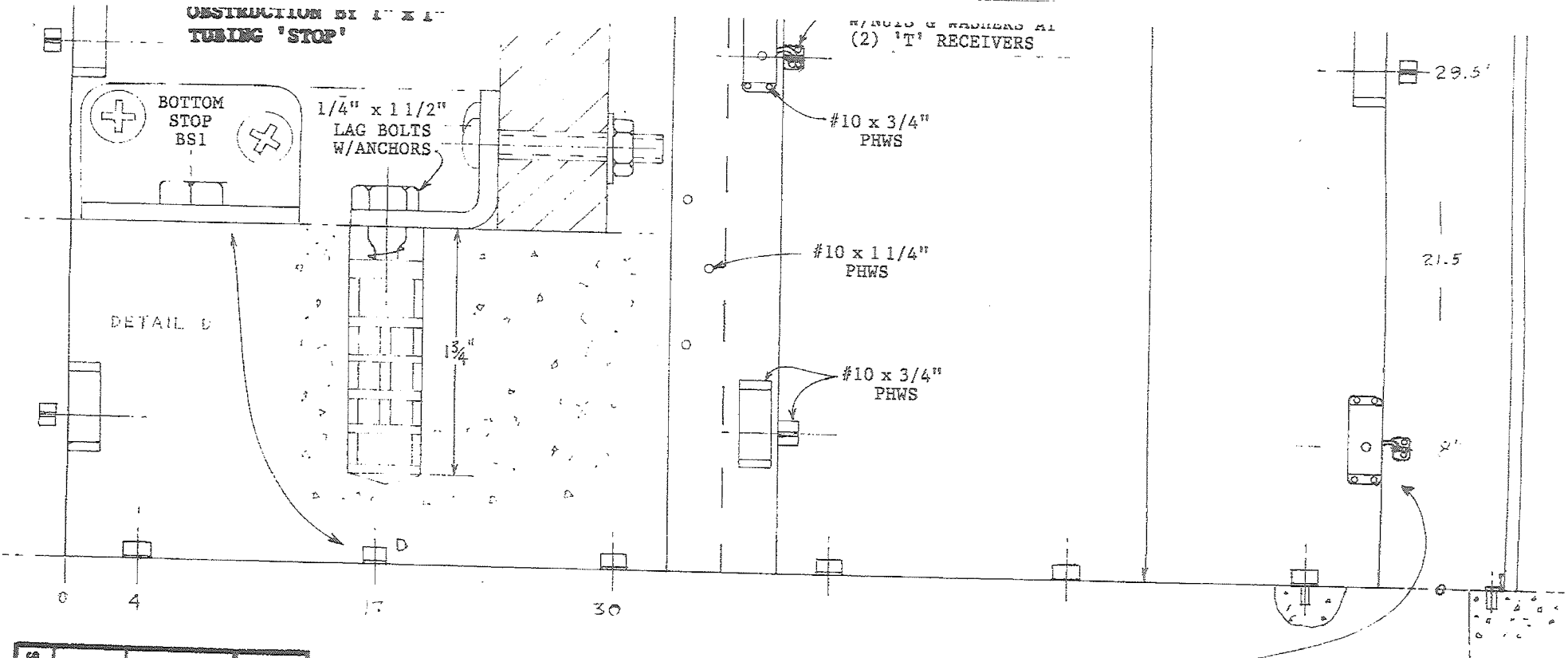
Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report # 92518. 08-109-99
Date 9/9/9 Tech Brennan

REF: DWG. B101,294

**TEST CONDUCTED AT ARCHITECTURAL TESTING
INC, YORK PA THE WEEK OF AUGUST 17, 2009.**



Architectural Testing

Test sample complies with these details.
Deviations are noted.

Report: 92518-9-109-914
Date: 9/4/9 Tech: *Bowers*

<p>NORSE INC.</p>		<p>72" x 80" TWO PANEL FLUSH MOUNTING HARDWARE</p>	
		<p>CEMENT TEST BUCK</p>	
<p>SCALE 1/8" = 1"</p>	<p>SIZE B</p>	<p>CODE IDENT. NO.</p>	<p>B101,294</p>
<p>26 AUG 09</p>	<p>SHEET</p>		



THRU BOLTS REPLACED BY

Architectural Testing

Test sample complies with these details. Deviations are noted.

Report# 92516 of 109-44
Date 9/9/99
Tech. Drawing

72" OPEN

80"

72"

'TAPCON' SCREWS
3/16" x 1 3/4"

#10 x 3/4"
PHWS

HOOK (8)
HK/S2

HANGER (8)
HNGR/2

#10 x 3/4"
PHWS

B
A
T
T
E
N

DETAIL A

80" OPEN

21.5

50.5

21