

**REHAU Construction LLC**  
**STRUCTURAL PERFORMANCE TEST**

NCTL-210-3741-1A



# NATIONAL CERTIFIED TESTING LABORATORIES

8350 PARKLINE BLVD. STE. 12 • ORLANDO, FLORIDA 32809 • TELEPHONE (407) 240-1356  
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**REHAU Construction LLC**  
**AAMA/WDMA/CSA 101/LS.2/A440-05**

*Report No: NCTL-210-3741-1A*  
*Expiration Date: 04/05/15*

## **Test Specimen**

*Manufacturer:*

*REHAU Construction LLC*

*Product Type:*

*Tilt and Turn uPVC Prime Window*

*Series/Model:*

*"Series 4500"*

*Primary Product Designation:*

*DAW-R65 1118 mm wide x 2032 mm high (44.0" x 80.0")*

*Optional Product Designation:*

*Not Applicable*

*Test Completion Date:*

*04/05/11*

*Reference should be made to Structural Performance Test Report Number NCTL-210-3741-1A complete specimen description and test data.*

## **NATIONAL CERTIFIED TESTING LABORATORIES**

*Mark Bennett*  
*Manager of Testing Services*



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## STRUCTURAL PERFORMANCE TEST REPORT

Report No: NCTL-210-3741-1A  
Test Date: 04/05/11  
Report Date: 04/28/11  
Expiration Date: 04/05/15

**Client:** REHAU Construction LLC  
1501 Edwards Ferry Road, NE  
Leesburg, Virginia 20176

**Test Specimen:** REHAU Construction LLC "Series 4500" Tilt and Turn uPVC Prime Window DAW-R65 1118 mm wide x 2032 mm high (44.0" x 80.0")

**Test Method:** AAMA/WDMA/CSA 101/I.S.2/A440-05, "Standard/Specification for Windows, Doors, and Unit Sky Lights." ASTM E1886-02/05 Performance of Exterior Windows, Curtain Walls, Doors and Storm Shutters Impacted by Missiles and Exposed to Cyclic Pressure Differentials. ASTM E1996-02/05 Performance of Exterior Windows, Glazed Curtain Walls, Doors and Storm Shutters Impacted by Windborne Debris in Hurricanes.

### TEST SPECIMEN DESCRIPTION

#### General:

The test specimen was a Tilt and Turn uPVC Prime Window, type X and had an overall measurement of 1118 mm wide x 2032 mm high (44.0" x 80.0"). The active sash had an overall measurement of 1041 mm wide x 1956 mm high (41" x 77.0") and had a daylight opening measurement of 876 mm wide x 1803 mm high (34.5" x 71.0"). The Dual Action (Tilt - Turn) window was constructed from rigid vinyl (uPVC). The tilt & turn window frame (Drawing # 601205) had an overall measurement of 83 mm wide x 68 mm high x 3 mm (3.25" x 2.68" x .100") (typical wall thickness). The frame was of welded corner construction.

#### Sash Construction:

The active sash (Drawing # 554051) was constructed from PVC and had an overall measurement of 60 mm wide x 80 mm high x 2 mm (2.36" x 3.15" x .060") (typical wall thickness). The operable sash was of welded corner construction.

#### Glazing:

The specimen employed an insulated glass makeup that had an overall measurement of 25 mm (1"). The insulated glass consisted from exterior to interior of 5 mm (.1875") clear tempered glass / 9 mm (.348") airspace created by an aluminum spacer / 5 mm (.1875") clear annealed glass / 2 mm (.090") SentryGlas Plus by Dupont / 5 mm (.1875") clear annealed glass.

#### Glazing Material:

The specimens were dry glazed using Weiss adhesive Cosmofen VKD 874 and employed a glazing spine (Drawing # 864992) on the exterior. The specimens also employed a glazing stop (Drawing # 560600) that had an overall measurement of 20 mm wide x 20 mm high (.768" x .768") and was employed on the interior.

**Weatherseals:** Two (2) strips of Fin weatherstrip (Drawing # 864952) had an overall measurement 8 mm wide x 10 mm high(.300" x .390") on each sash member.

**Hardware:** A Multi-point Roto-Tilt and Turn hardware was employed on the specimen. Four (4) keepers were located on the lock stile at approximately 114 mm(4.5"), 597 mm(23.5"), 1270 mm(50.0") & 1829 mm(72.0") from the head. One(1) keeper was located on the head at approximately 114 mm(4.5") from the lockstile. Three (3) keepers were located on the hinge stile located at approximately 114 mm(4.5"), 71 mm(28.0") & 1308 mm(51.5") from the head. Two (2) keepers were located on the sill at approximately 114 mm(4.5") & 521 mm(20.5") from the edge of the frame.

**Weep Holes:** Three (3) weep holes were located on the sill at approximately 121 mm(4.75") from each end and at approximately mid-span of the sill.

**Insect Screen:** None

**Sealant** Silicone was used to seal the screws holes and seal the specimen to the wooden test buck.

**Reinforcement:**

**All Specimens:** All frame members employed a hollow reinforcement (Drawing# 237091) of 35 mm wide x 28 mm high(1.38" x 1.10"). All sash members employed a U-shaped reinforcement (Drawing # 244536) that had an overall measurement of 35 mm wide x 28 mm high(1.38" x 1.10").

**Installation: All Specimens:** The specimens were installed into a 51 mm(2") x 254 mm(10") wood test buck using twenty (20) #10 x 38 mm(1.5") Phillips pan-head screws. Four (4) #10 x 38 mm(1.5") Phillips pan-head screws were located on the head and sill at approximately 102 mm(4") from each end and approximately 305 mm(12") on center thereafter. Six (6) #10 x 38 mm(1.5") Phillips pan-head screws were located on each jamb at approximately 102 mm(4") from each end and approximately 368 mm(14.5") on center thereafter.

**Interior & Exterior Surface Finish:** White Vinyl (PVC)

**TEST RESULTS**

**AAMA/WDMA/CSA 101/I.S.2/ A440-05**

"Standard/ Specification for Windows, Doors, and Unit Sky Lights."

<u>Par. No.</u>	<u>Title of Test &amp; Method</u>	<u>Measured</u>	<u>Allowed</u>
5.3.1.1.3	Latching Devices	68 N (15.0lbf)	100 N (22.5lbf)
5.3.2	Air Infiltration - ASTM E283		
	Air at 1.57 psf	.004 cfm/ft <sup>2</sup>	0.3cfm/ft <sup>2</sup>
	Air at 6.24 psf	.004 cfm/ft <sup>2</sup>	0.3cfm/ft <sup>2</sup>
5.3.3 *	Water Resistance - ASTM E547		
	3.4 L/ (min•min <sup>2</sup> ) (5.0 gph/ft)		
	WTP =140 Pa (2.9 psf)	No Leakage	No Leakage

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**TEST RESULTS(Cont.)**

<u>Par. No.</u>	<u>Title of Test &amp; Method</u>	<u>Measured</u>	<u>Allowed</u>
5.3.4.2 **	Uniform Load Structural - ASTM E330		
		<u>Measured</u>	<u>Allowed</u>
		<u>Deflection</u>	<u>Perm. Set</u>
	<b>3120 Pa (65.0 psf) Exterior</b>		
	Loc #1	3.83 mm (.151")	.660 mm (.026")
	Loc #2	5.84 mm (.230")	.203 mm (.008")
	<b>3120 Pa (65.0 psf) Interior</b>		
	Loc #1	4.78 mm (.188")	.152 mm (.006")
	Loc #2	6.63 mm (.261")	.203 mm (.008")
5.3.5	Forced Entry Resistance - ASTM F588 Level 10 (See Appendix A for test results)		Meets As Stated
5.3.6.2	Thermoplastic Corner Weld Test		Meets As Stated
5.3.6.4.4	Sash/Leaf Concentrated Load Test on Latch Rail (Horizontal Load 135 N (30 lbf))	1.1 mm (.043")	1.5 mm (0.06")
5.3.6.6.3	Stabilizing Arm Load Test (Top Rail At Center 445 N (100 lbf)(10 Second Hold))		Meets as Stated
5.3.3 *	Water Resistance - ASTM E547 & 331 3.4 L/(min•min <sup>2</sup> ) (5.0 gph/ft) WTP =468 Pa (9.75 psf)	No Leakage	No Leakage
5.3.4.2 **	Uniform Load Structural - ASTM E330		
	<b>Specimen # 1</b>	<u>Measured</u>	<u>Allowed</u>
		<u>Perm. Set</u>	<u>Perm. Set</u>
	<b>4680 Pa (97.5 psf) Exterior</b>		
	Loc #1	1.98 mm (.078")	4.17 mm (.164")
	Loc #2	2.31 mm (.091")	7.82 mm (.308")
	<b>4680 Pa (97.5 psf) Interior</b>		
	Loc #1	.813 mm (.032")	4.17 mm (.164")
	Loc #2	.356 mm (.014")	7.82 mm (.308")

Loc # 1 Mid-Span of Top Rail

Loc # 1 Maximum Allowable Perm. Set (0.04% of 1041 mm (41.0") Length of span) = 4.17 mm (.164")

Loc # 2 Mid-Span Lockstile

Loc # 2 Maximum Allowable Perm. Set (0.04% of 1956 mm (77.0") Length of span) = 7.82 mm (.308")

\* Tested with and without screen

\*\* No glass breakage or permanent damage causing the unit to be inoperable

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11/2/11

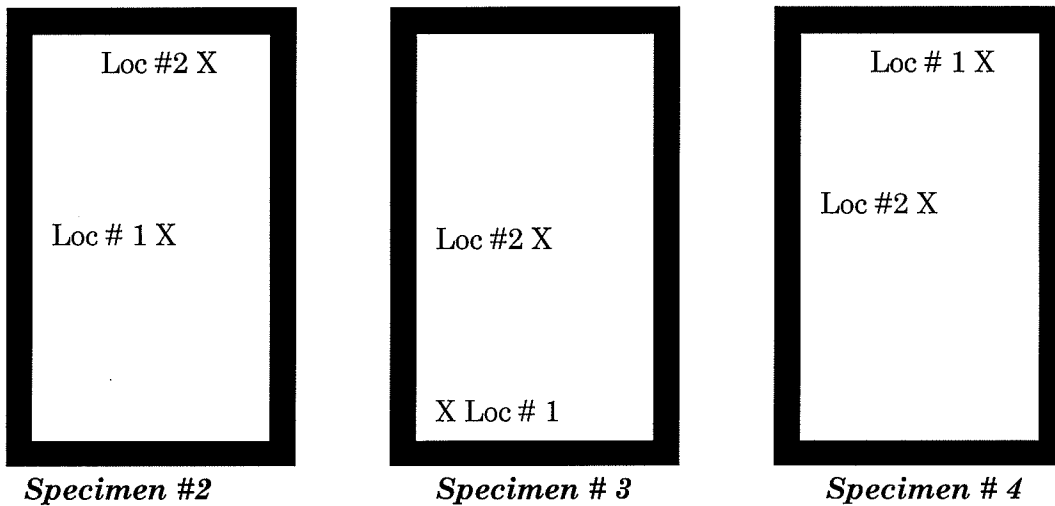
**LARGE MISSILE IMPACT PERFORMANCE TEST  
TEST PARAMETERS**

The appropriate missile to be used for impact tests was selected in accordance with section 6 of ASTM E1996 based on the following criteria:

Level of Protection:	Basic Protection
Wind Zone:	Wind Zone 4 - greater than 140 mph
Assembly Height Above Ground Level:	Less than or equal to 30 feet

**IMPACT PERFORMANCE TEST RESULTS**

Large missile impact tests were conducted using a #2 Southern Yellow Pine 2 x 4 measuring 92" in length and weighing 9.25 lbs (Missile D) as shown in Table 2 of ASTM E 1996. Missile speeds and locations were in accordance with section 5.3 and Table 2 ASTM E1996. For pass/fail criteria, no penetration is defined as no tear longer than 5 inches in length and 1/16" wide pass per section 7 of ASTM E 1996. All specimens were conditioned at 70° F ± 15° F prior to testing. Missile orientation at impact complies with section 11.2.2 of ASTM E1886.



- Specimens # 2**      *Impact location # 1: Mid-Span of Active Sash*  
                           *Impact location # 2: Top Right Corner of Active Sash*
  
- Specimens # 3**      *Impact location # 1: Bottom Left Corner of Active Sash*  
                           *Impact location # 2: Mid-Span of Fixed Active Sash*
  
- Specimens # 4**      *Impact location # 1: Top Right Corner of Active Sash*  
                           *Impact location # 2: Mid-Span of Fixed Active Sash*

Description of specimen after cycle test: None of the impacts penetrated the specimen.

**NOTES:** All impacts rejected without penetration. Upon completion of testing the specimen met the requirements for ASTM E 1996-02/05.

The conditioning temperature of the specimens were 72.2°.

Missile orientation at impact complies with Section 11.2.2 of ASTM E1886-02/05.

**PRESSURE CYCLING TEST RESULTS**

After completion of the impact tests, the specimens were pressure cycled in accordance with Table 1 of ASTM E1996. The duration of each air pressure cycle was between 1 and 5 seconds. Where required, two (2) mil plastic film was used to obtain cycle loads. The film did not affect the performance of the specimen or influence the results of the test. For pass/fail criteria, no opening is defined as no tear longer than 5 inches in length and 1/16" wide or no opening through which a 3" diameter solid sphere can freely pass per section 7 of ASTM E 1996.

**Specimen# 2****D/P + 65.0psf - 65.0psf***Positive Load*

<i>Range of Test</i>	<i>Actual</i>	<i># of Cycles</i>	<i>Cycles/Min</i>
+0.2 - +0.5	13.0 psf - 32.5 psf	3,500	40
+0.0 - +0.6	0.00 psf - 39.0 psf	300	40
+0.5 - +0.8	32.5 psf - 52.0 psf	600	40
+0.3 - +1.0	19.5 psf - 65.0 psf	100	40

*Negative Loads*

<i>Range of Test</i>	<i>Actual</i>	<i># of Cycles</i>	<i>Cycles/Min</i>
-0.3 - -1.0	19.5 psf - 65.0 psf	50	40
-0.5 - -0.8	32.5 psf - 52.0 psf	1,050	40
-0.0 - -0.6	0.00 psf - 39.0 psf	50	40
-0.2 - -0.5	13.0 psf - 32.5 psf	3,350	40

9000 cycles completed

Description of specimen after cycle test: Specimen showed no resultant failure or duress after cycle test. No failure of fasteners or separation of glass from the frame.

**Specimen# 3****D/P + 65.0psf - 65.0psf***Positive Load*

<i>Range of Test</i>	<i>Actual</i>	<i># of Cycles</i>	<i>Cycles/Min</i>
+0.2 - +0.5	13.0 psf - 32.5 psf	3,500	40
+0.0 - +0.6	0.00 psf - 39.0 psf	300	40
+0.5 - +0.8	32.5 psf - 52.0 psf	600	40
+0.3 - +1.0	19.5 psf - 65.0 psf	100	40

*Negative Loads*

<i>Range of Test</i>	<i>Actual</i>	<i># of Cycles</i>	<i>Cycles/Min</i>
-0.3 - -1.0	19.5 psf - 65.0 psf	50	40
-0.5 - -0.8	32.5 psf - 52.0 psf	1,050	40
-0.0 - -0.6	0.00 psf - 39.0 psf	50	40
-0.2 - -0.5	13.0 psf - 32.5 psf	3,350	40

9000 cycles completed

Description of specimen after cycle test: Specimen showed no resultant failure or duress after cycle test. No failure of fasteners or separation of glass from the frame.

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**PRESSURE CYCLING TEST RESULTS(Cont.)****Specimen# 4****D/P + 65.0psf - 65.0psf***Positive Load*

<i>Range of Test</i>	<i>Actual</i>	<i># of Cycles</i>	<i>Cycles/Min</i>
+0.2 - +0.5	13.0 psf - 32.5 psf	3,500	40
+0.0 - +0.6	0.00 psf - 39.0 psf	300	40
+0.5 - +0.8	32.5 psf - 52.0 psf	600	40
+0.3 - +1.0	19.5 psf - 65.0 psf	100	40

*Negative Loads*

<i>Range of Test</i>	<i>Actual</i>	<i># of Cycles</i>	<i>Cycles/Min</i>
-0.3 - -1.0	19.5 psf - 65.0 psf	50	40
-0.5 - -0.8	32.5 psf - 52.0 psf	1,050	40
-0.0 - -0.6	0.00 psf - 39.0 psf	50	40
-0.2 - -0.5	13.0 psf - 32.5 psf	3,350	40

*9000 cycles completed**Description of specimen after cycle test: Specimen showed no resultant failure or duress after cycle test. No failure of fasteners or separation of glass from the frame.*\* *No glass breakage or permanent damage causing the unit to be inoperable**Note: A 2 mil. Polyethylene film was used on the cycle tests and it is the opinion of the undersigned that they had no influence on the results of these tests.**Criteria 7.2.1 With no tear formed longer than 5" or no opening formed through which a 3" diameter solid sphere can freely pass.**The listed results were secured by using the ASTM E1886 test method and indicate compliance with the performance requirements of ASTM E1996 for the listed test parameters at the following design pressures:*

*Specimens # 2-4: Positive Design Pressure: + 65.0 psf*  
*Negative Design Pressure: - 65.0 psf*

*Sampling: The sampling of the product(s) in this test report was accomplished by the client in accordance with the specification(s) the sample was tested to.***TEST COMPLETED 12/15/09***The tested specimen meets (or exceeds) the performance levels specified in AAMA/WDMA/CSA101/I.S.2/ A440-05 for air infiltration. The listed results were secured by using the designated test methods and indicate compliance with the performance requirements of the referenced specification paragraphs of AAMA/WDMA/CSA 101/I.S.2/A440-05 for the DAW-R65 1118 mm wide x 2032 mm high (44.0" x 80.0") product designation.**Detailed drawings were available for laboratory records and compared to the test specimens at the time of this report. A copy of this report along with representative sections of the test specimens will be retained by NCTL for a period of four (4) years. The results obtained apply only to the specimens tested. No conclusions of any kind regarding the adequacy or inadequacy of the glass in the test specimens may be drawn from this test. This report does not constitute certification of the product, which may only be granted by a certification program validator.*


*[Signature]*  
5/13/11



**Testing Observed by:** Mr. Mark Bennett (NCTL)  
 Mr. Miguel Nieves (NCTL)  
 Mr. Rick Moffet (NCTL)  
 Mr. Kenneth Hill (REHAU Construction LLC)  
 Mr. Gerry Ferrara (P.E)

**NATIONAL CERTIFIED TESTING LABORATORIES**



Mark Bennett  
 Manager of Testing Services

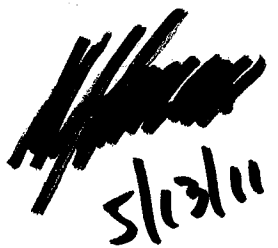


CHRISTOPHER BENNETT

Christopher Bennett  
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**APPENDIX A**  
*Forced Entry Resistance Test Results*

**Test Method:** ASTM F588-04, "Standard Test Methods for Measuring the Forced Entry Resistance of Window Assemblies, Excluding Glazing Impact".

**TEST RESULTS**

<u>Paragraph No.</u>	<u>Loads</u>	<u>Duration</u>	<u>Measured</u>	<u>Allowed</u>
10.1-Lock Manipulation		5 Minutes	No Entry	No Entry
10.2.2.1-Test B1	L2= 75 lbf	1 Minute	No Entry	No Entry
10.2.2.2-Test B2	L1=150 lbf L2= 75 lbf	1 Minute	No Entry	No Entry
10.2.2.3-Test B3	L1=150 lbf L2= 75 lbf	1 Minute	No Entry	No Entry
10.2.2.4 Lock Manipulation		5 Minutes	No Entry	No Entry

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**APPENDIX B***Estimated Uncertainty of Measurements*

*As required by Section 5.10.3 of ISO 17025, "General Requirements for the Competence of Testing and Calibration Laboratories," listed below is the estimated expanded uncertainties for the applicable measurements in this report:*

<i>Operating Force:</i>	$\pm 2.7 \text{ N } (\pm 0.6 \text{ lbf})$
<i>Test Pressures:</i>	$\pm 10 \text{ Pa } (\pm 0.2 \text{ psf})$
<i>Air Leakage:</i>	$\pm 0.06/A \text{ L/ (sec} \bullet \text{ m}^2) (\pm 0.12/A \text{ cfm/ft}^2)$ <i>where A is the area of the test specimen</i>
<i>Deflection Measurements:</i>	$\pm 0.05 \text{ mm } (\pm 0.002 \text{ inches})$
<i>Deglazing Force:</i>	$\pm 3.1 \text{ N } (\pm 0.7 \text{ lbf})$
<i>Forced Entry Loads:</i>	$\pm 3.1 \text{ N } (\pm 0.7 \text{ lbf})$

*All of the above expanded uncertainties are determined from combined standard uncertainties and a coverage factor  $k = 2.00$  based on a normal distribution, and define an interval estimated to have a level of confidence of 95%.*



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*5/2/10*

**APPENDIX C**

*List of Component Drawings Reviewed for Product Verification*

*See Attached Bill of Materials*

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