

**NEGATIVE WIND PRESSURE TEST ON EXTERIOR SIDING
FOR MANUFACTURED HOUSING APPLICATIONS:
NOVIK CEDAR ROUGHSAWN SIDING,
12.75-IN EXPOSURE, AND 0.105-IN NAIL FLANGE THICKNESS
DOUBLE, 2X4, STUD GRADE STUDS ON 16-IN. CENTERS
WITH 3/8-IN. 24/0 RATED, OSB SHEATHING
FOR 90-IN. TALL EXTERIOR WALLS
WIND ZONE III, CORNER**

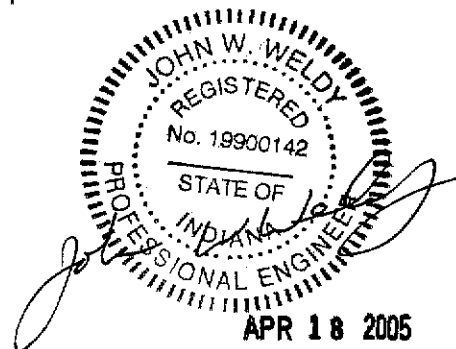
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Test Report: TL122104-4
Issued: December 21, 2004

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Reviewed By:
John Weldy P.E.
Test Engineer



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1. INTRODUCTION

NTA, Inc. conducted negative wind pressure load tests on Cedar Roughsawn exterior siding for Novik, Inc. of Quebec, Canada. The purpose of this evaluation is to assess the suitability of siding covered wall assemblies for use in manufactured home construction when subjected to simulated negative wind pressure in accordance with Section 3280.401(b) of the *Federal Manufactured Home Construction and Safety Standards* (FMHCSS). General test parameters and pass/fail criteria, in accordance with the FMHCSS, are summarized in Table 1, below. All tests were conducted at the NTA Test Laboratory located in Nappanee, Indiana.

Table 1: Test Parameters

Parameter	Value
FMHCSS Wind Zone	HUD Wind Zone III
Corner/Non-Corner	Corner
Design Pressure	58 psf
Deflection Limit	$L/180$
Clear Height, h	90
Specimen Width, w	48

2. TEST PROGRAM

2.1. DESCRIPTION OF TEST SPECIMENS

Three similar test assemblies were constructed from the sample siding material provided by the client.

All commonly available construction materials were obtained by NTA. A summary of the construction materials is provided in Table 2, with a summary of the attachment methods provided in Table 3. A construction diagram is provided in the Appendix (Figure 1). During construction an oversized polyethylene sheet (6 mil) was placed between the wall framing and the exterior sheathing. This sheeting will apply the uniform pressure for testing.

Table 2: Materials

Location	Material
Studs	Double, 2x4 Stud Graded SPF, 16-in. oc
Top Plate	Single, 1x4 Un-Graded SPF
Bottom Plate	Single, 1x4 Un-Graded SPF
Exterior Sheathing	3/8-in. OSB, 24/0 Rated, By Weyerhaeuser Structurwood.
Exterior Siding	Cedar Roughsawn Exterior Siding 12.75-in Exposure, 0.105-in. Average Nail Flange Thickness

Table 3: Fastening Schedule

Connection	Fastener	Quantity or Spacing
Top Plate-to-Studs	15 Ga. x 7/16-in. x 1-3/4-in. Staple	3
Bottom Plate-to-Studs	15 Ga. x 7/16-in. x 1-3/4-in. Staple	3
Exterior Sheathing	16 Ga. x 7/16-in. x 1-1/2-in. Staple	6,6
Exterior Siding	0.122 x 1-1/2-in. Galvanized Roofing Nail	1 in center hole, 5 evenly spaced

2.2. TEST PROCEDURE

The test procedure is based on ASTM E72², Section 11; however, the loading stages were modified to correspond with those required in the ultimate load test procedures found in Section 3280.401(b) of the Federal Manufactured Home Construction and Safety Standards. Accordingly, the test setup consists of a vacuum chamber with an open side slightly larger than the test assembly, as shown in Figure 2. A vacuum pump and manometer connection provide a means to apply and monitor the applied pressure. The samples are placed with the exterior sheathing facing inward, thereby placing a negative force on the exterior sheathing. The polyethylene sheeting is pleated to accommodate the specimen deflection and then sealed to the chamber.

Instrumentation consists of a water manometer and dial indicators. The water manometer has a resolution of 0.1 inches of water for pressures up to ± 72.0 inches of water. Dial indicators, with a resolution of 0.001-in., are positioned along selected studs to take deflection readings at midspan and at the supports. For specimens with studs spaced at 16-in. centers, the center two studs are gauged, using a total of six dial gauges. For studs spaced at 24-in. centers, only the middle stud is gauged, using a total of three gauges.

For testing, each specimen is loaded monotonically at approximate 1/4 live load pressure increments. Upon reaching each loading stage, applied load is maintained for not less than 10 minutes prior to reading the dial indicators. Once the dial indicators have been read, the pressure is increased to the next loading stage. This procedure is followed through pressure corresponding to 1.25 times live load. After which, the dial gauges are removed and the pressure is increased to 2.5 times live load. Once this pressure had been maintained for not less than 10 minutes, the pressure is further increased to ultimate. At ultimate, the peak pressure and mode of failure are noted. Ultimate is taken as the point where the specimen exhibits rupture, fracture, or excessive yielding. Any failure or observations at any point during the test are duly noted.

The applied pressure, in inches of water, is converted to pounds per square foot (psf) using the following conversion: 1 inch of water column = 5.2 psf.

3. TEST RESULTS

A total of three specimens were tested using the procedure outlined herein. The ultimate loads and service load deflections for each specimen are presented in Table 4, below. This table also provides the average assembly strength and compares it with the required pass/fail criteria.

Table 4: Test Results

Specimen	Ultimate Pressure (psf)	Service Load Deflection (in.)	Failure Mode at Ultimate
1998	158	0.266	Sheathing Fastener Failure
1999	154	0.262	Top Plate Failure
2000	188	0.285	Top Plate Failure
Average	167	0.271	--
Evaluation Criteria ^a	145	0.500	--
Overall Result	<i>Pass</i>	<i>Pass</i>	--

^a As required by the FMHCSS, which requires a factor of safety of 2.5 against failure and L/180 deflection limit under service level loads.


5. CONCLUSION

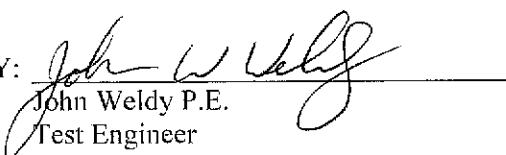
Three similar assemblies were tested and assessed in accordance with the ultimate load test procedures of the FMHCSS. The conditions of test and overall findings are summarized in Table 5, below.

It must be noted that NTA, Inc. did not oversee or verify the sampling procedure used by the client when selecting the sample material. The data provided herein were obtained and assessed in accordance with FMHCSS test procedures and criteria and should not be used for other types of construction. For use in manufactured housing, these findings and results are subject to DAPIA review and approval.

Table 5: Conclusion

Specimen	Test Conditions	Overall Result
Cedar Roughsawn Siding, 12.75-in Exposure, and 0.105-in Nail Flange Thickness Fastened and constructed as detailed herein	Wind Zone III Corner	<i>Pass</i>

TEST PERFORMED BY: 
 Dale Arter
 Director of Testing

REPORT REVIEWED BY: 
 John Weldy P.E.
 Test Engineer

REFERENCES



1. Department of Housing and Urban Development (HUD). *Manufactured Home Construction and Safety Standards & Interpretive Bulletins to the Standards April 1, 1995. 24 Code of Federal Regulations Part 3280.* Office of Assistant Secretary for Housing, Federal Housing Commissioner, Department of Housing and Urban Development.
2. American Society for Testing and Materials (ASTM). *Standard Test Methods of Conducting Strength Tests of Panels for Building Construction.* ASTM E 72-02. ASTM, Philadelphia, PA, 2002. 11 pp.

FIGURES

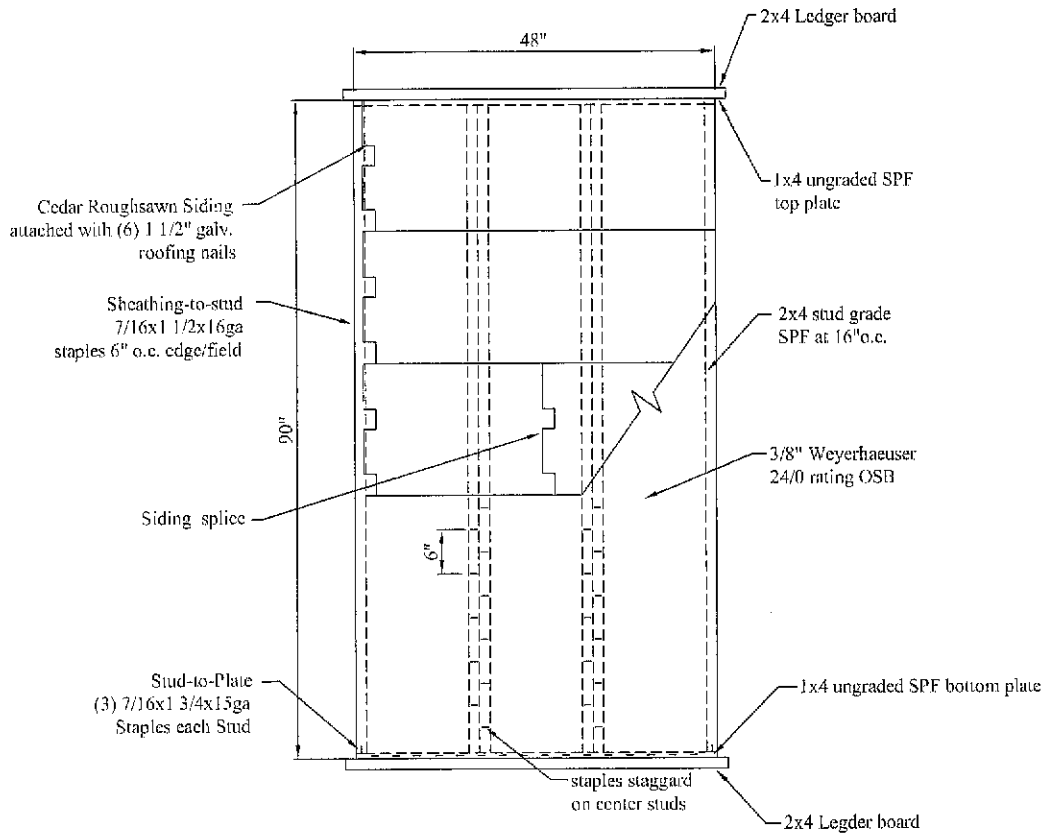


Figure 1: Specimen Construction

FIGURES

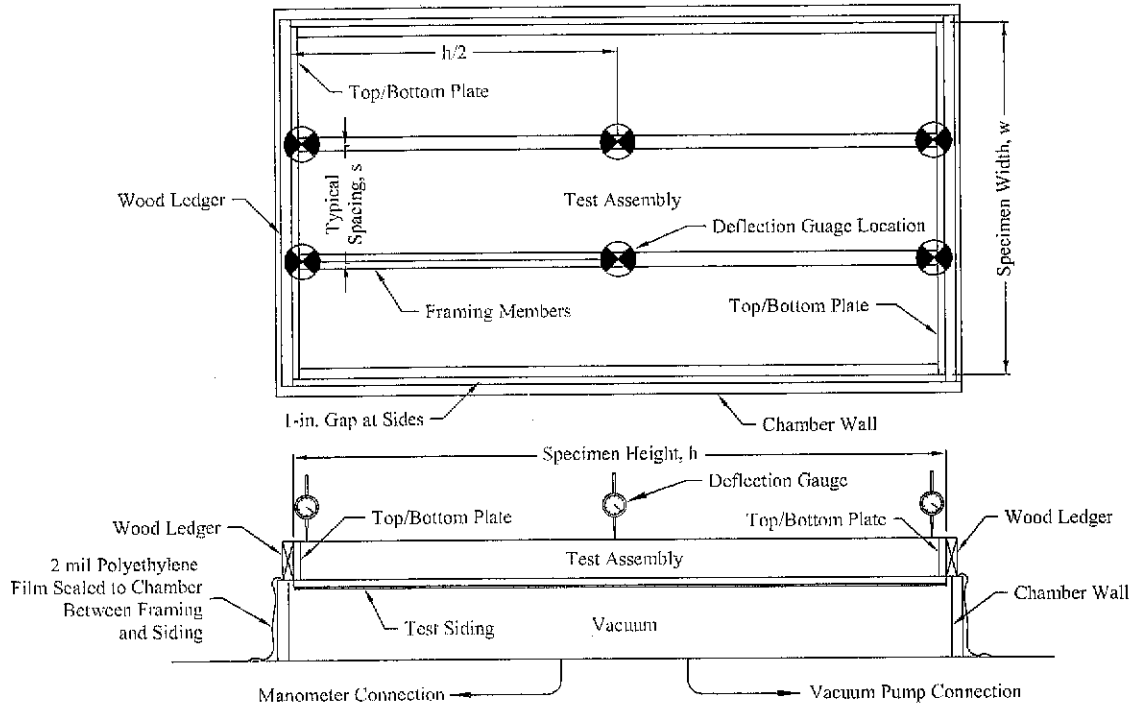


Figure 2: Test Setup

APPENDIX



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Out

NTA, Inc.

**Negative Wind Test for Wall Assemblies to be used in Manufactured Homes:
Specimen 1**

Client: Novic Inc.
Job Number: TL122104-4
Test Method: *FMHCSS, Section 3280.401(b), Ultimate Load Test Procedure*

Performed By: Gregg Tompos
Witnessed By: Dale Arter

General:	Apparatus:	Asset No.	Ambient Conditions:
Received: 12/1/2004	Length Measure: 00307		Ambient Temp.: 71.1 deg. F
Fabrication Date: 12/6/2004	Vacuum Table: 00023		Ambient R.H.: 46%
Test Date: 12/9/2004	Manometer: 00337		Senor Asset No.: 00201
Test Location: NTA, Test Facility Nappance, IN	Moisture Meter: 00173		

Specimen Description:	Loading Conditions:
Specimen No.: 01998	HUD Wind Zone: Zone 3 (corner)
Clear Span: 90-in.	Design Pressure: 58 psf
Width: 48-in.	Deflection Limit (L/180): 0.5-in.
Framing: (2) 2x4 stud SPF 16-in. oc	
Ext. Sheathing: 3/8" 24/0 Structural sheathing 0.375 OSB	
16 ga x 7/16 x 1 1/2-in. Staple 6/6-in. oc edge/field	
Ext. Siding: Cedar Roughsawn Polypropylene(0.105-in. flange thick.)	
6d x 1.5-in. Nails 6 total evenly spaced-in. oc	
Int. Sheathing: none	
Wood MC: 9% - 17.5%	

Specimen 1 Ultimate Load Test Deflection Data

Load Stages	Applied Pressure (psf)	Left Stud Deflection (in.)			Right Stud Deflection (in.)		
		Top Support	Mid Span	Bottom Support	Top Support	Mid Span	Bottom Support
0 (REF)	0.0	0.000	0.000	0.000	0.000	0.000	0.000
1/4LL	14.6	0.026	0.093	0.034	0.027	0.105	0.035
1/2LL	29.1	0.043	0.179	0.057	0.046	0.198	0.155
3/4LL	43.7	0.062	0.271	0.078	0.068	0.300	0.174
LL	58.2	0.080	0.362	0.097	0.088	0.399	0.192
5/4LL	72.8	0.099	0.460	0.116	0.109	0.507	0.212
5/2LL	144.6	--	--	--	--	--	--

Net LL Deflection: 0.266-in. at 58 psf
Ultimate Uniform Load: 158 psf
Failure Mode: *Fasteners pulled out of studs and pulled through top plate at center right stud*

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Reviewed & Approved By: Dale Arter

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NTA, Inc.

**Negative Wind Test for Wall Assemblies to be used in Manufactured Homes:
Specimen 2**

Client: Novic Inc.
Job Number: TL122104-4
Test Method: *FMHCSS, Section 3280.401(b), Ultimate Load Test Procedure*

Performed By: Gregg Tompos
Witnessed By: Dale Arter

General:	Apparatus:	Asset No.	Ambient Conditions:
Received: 12/1/2004	Length Measure:	00307	Ambient Temp.: 70.9 deg. F
Fabrication Date: 12/6/2004	Vacuum Table:	00023	Ambient R.H.: 47%
Test Date: 12/9/2004	Manometer:	00023	Senor Asset No.: 00201
Test Location: NTA, Test Facility Nappanee, IN	Moisture Meter:	00173	

Specimen Description:	Loading Conditions:
Specimen No.: 01999	HUD Wind Zone: Zone 3 (corner)
Clear Span: 90-in.	Design Pressure: 58 psf
Width: 48-in.	Deflection Limit (L/180): 0.5-in.
Framing: (2) 2x4 stud SPF 16-in. oc	
Ext. Sheathing: 3/8" 24/0 Structural sheathing 0.375 OSB 16 ga x 7/16 x 1 1/2-in. Staple 6/6-in. oc edge/field	
Ext. Siding: Cedar Roughsawn Polypropylene(0.105-in. flange thick.) 6d x 1.5-in. Nails 6 total evenly spaced-in. oc	
Int. Sheathing: none	
Wood MC: 9% - 17.5%	

Specimen 2 Ultimate Load Test Deflection Data

Load Stages	Applied Pressure (psf)	Left Stud Deflection (in.)			Right Stud Deflection (in.)		
		Top Support	Mid Span	Bottom Support	Top Support	Mid Span	Bottom Support
		00064	00253	00147	00081	00252	00079
0 (REF)	0.0	0.000	0.000	0.000	0.000	0.000	0.000
1/4LL	14.6	0.024	0.082	0.026	0.025	0.090	0.029
1/2LL	29.1	0.053	0.166	0.053	0.052	0.191	0.057
3/4LL	43.7	0.080	0.256	0.080	0.078	0.294	0.085
LL	58.2	0.105	0.344	0.109	0.103	0.397	0.116
5/4LL	72.8	0.132	0.440	0.144	0.132	0.505	0.152
5/2LL	144.6	--	--	--	--	--	--

Net LL Deflection: 0.262-in. at 58 psf
Ultimate Uniform Load: 154 psf
Failure Mode: Top plate broke from left to right

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NTA, Inc.

**Negative Wind Test for Wall Assemblies to be used in Manufactured Homes:
Specimen 3**

Client: Novic Inc. Performed By: Gregg Tompos
Job Number: TL122104-4 Witnessed By: Dale Arter
Test Method: *FMHCSS, Section 3280.401(h), Ultimate Load Test Procedure*

General:	Apparatus:	Asset No.	Ambient Conditions:
Received: 12/1/2004	Length Measure: 00307		Ambient Temp.: 71.5 deg. F
Fabrication Date: 12/6/2004	Vacuum Table: 00023		Ambient R.H.: 45%
Test Date: 12/8/2004	Manometer: 00023		Senor Asset No.: 00201
Test Location: NTA, Test Facility Nappanee, IN	Moisture Meter: 00173		

Specimen Description:	Loading Conditions:
Specimen No.: 02000	HUD Wind Zone: Zone 3 (corner)
Clear Span: 90-in.	Design Pressure: 58 psf
Width: 48-in.	Deflection Limit (L/180): 0.5-in.
Framing: (2) 2x4 stud SPF 16-in. oc	
Ext. Sheathing: 3/8" 24/0 Structural sheathing 0.375 OSB	
16 ga x 7/16 x 1 1/2-in. Staple 6/6-in. oc edge/field	
Ext. Siding: Cedar Roughsawn Polypropylene(0.105-in. flange thick.)	
6d x 1.5-in. Nails 6 total evenly spaced-in. oc	
Int. Sheathing: none	
Wood MC: 9% - 17.5%	

Specimen 3 Ultimate Load Test Deflection Data

Load Stages	Applied Pressure (psf)	Left Stud Deflection (in.)			Right Stud Deflection (in.)		
		Top Support	Mid Span	Bottom Support	Top Support	Mid Span	Bottom Support
0 (REF)	0.0	0.000	0.000	0.000	0.000	0.000	0.000
1/4LL	14.6	0.021	0.097	0.036	0.027	0.092	0.038
1/2LL	29.1	0.044	0.194	0.058	0.047	0.176	0.056
3/4LL	43.7	0.069	0.296	0.081	0.070	0.265	0.076
LL	58.2	0.094	0.406	0.103	0.093	0.358	0.097
5/4LL	72.8	0.116	0.509	0.124	0.115	0.448	0.116
5/2LL	144.6	--	--	--	--	--	--

Net LL Deflection: 0.285-in. at 58 psf
Ultimate Uniform Load: 188 psf
Failure Mode: Top plate broke

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Reviewed & Approved By: Dale Arter

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NTA, Inc.

**Negative Wind Test for Wall Assemblies to be used in Manufactured Homes:
Results Summary**

Client: Novic Inc.
Job Number: TL122104-4
Test Method: *FAMHCSS, Section 3.280.401(b), Ultimate Load Test Procedure*

Performed By: Gregg Tompos
Witnessed By: Dale Arter

Specimen Description:

Clear Span: 90-in.
Width: 48-in.

Loading Conditions:

HUD Wind Zone: Zone 3 (corner)
Design Pressure: 58 psf
Deflection Limit (L/180): 0.5-in.

Framing: (2) 2x4 stud SPF 16-in. oc
Ext. Sheathing: *3/8: 24/0 Structural sheathing 0.375 OSB
16 ga x 7/16 x 1 1/2-in. Staple 6/6-in. oc edge/field*
Ext. Siding: *Cedar Roughsawn Polypropylene(0.105-in. flange thick.)
6d x 1.5-in. Nails 6 total evenly spaced-in. oc*
Int. Sheathing: *none*

Wood MC: 9% - 17.5%

Overall Test Results

Specimen	Specimen No.	Ultimate Pressure (psf)	Service Deflection (in.)
1	01998	158	0.266
2	01999	154	0.262
3	02000	188	0.285

Average Ultimate Pressure: 167 psf, Pass (58 psf x 2.5 = 145 psf min.)
Average Midspan Deflection*: 0.271-in., Pass (L/180 = 0.5-in.)

* Midspan deflection less the average of the support deflections.

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