

**NEGATIVE WIND PRESSURE TEST ON EXTERIOR SIDING
FOR MANUFACTURED HOUSING APPLICATIONS:
DOUBLE, 2X4, STUD GRADE STUDS ON 16-IN. CENTERS
WITH 3/8, 24/0 RATED, OSB SHEATHING
FOR 90-IN. TALL EXTERIOR WALLS
WITH NOVIK HAND-LAID BRICK (0.090) SIDING FOR
WIND ZONE III, CORNER**

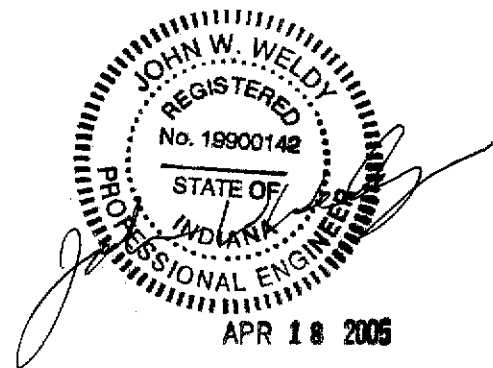
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Test Report: TL081704-41
Issued: September 13, 2004

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Test Engineer



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1. INTRODUCTION

NTA, Inc. conducted negative uniform wind pressure load tests on Hand-Laid Brick (0.09-in. x 19-in. x 48-in.) exterior siding for Novik, Inc. of St-Augustin-de-Desmaures, Québec, Canada. The purpose of this evaluation is to assess the suitability of Novik exterior siding, subjected to simulated negative wind pressure in accordance with Section 3280.305 of the *Federal Manufactured Home Construction and Safety Standards* (FMHCSS), for use in manufactured home construction. 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	III
Corner/Non-Corner	Corner
Design Pressure	58 psf
Deflection Limit	L/180
Clear Height, h	90-in.
Specimen Width, w	48-in.

2. TEST PROGRAM

2.1. DESCRIPTION OF TEST SPECIMENS

Three similar test assemblies were constructed from the sample siding material provided by the client. Spacing of the fasteners consisted in one fastener in the middle of the siding using the hole provided and 5 more fasteners using the slots provided evenly spaced across each section of siding. All the siding was fastened in accordance with the manufacturer's installation instructions. Fasteners were also installed with at least 1/32 of space between the fastener and the siding also described in the manufacturer's instructions manual.

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). A sample diagram of the siding is provided in the Appendix (Figure 2). 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	Single, 2x4 SPF Stud Grade, 16-in. oc.
Top Plate	Single, 1x4 SPF Un-Graded
Bottom Plate	Single, 1x4 SPF Un-Graded
Exterior Sheathing	3/8-in. OSB, 24/0 Rated, By Weyerhaeuser Structurwood.
Exterior Siding	Hand-Laid Brick Exterior (0.090) Siding

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 3. 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 $\frac{1}{4}$ 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 to the required pass/fail criteria.

Table 4: Test Results

Specimen	Ultimate Pressure (psf)	Service Load Deflection (in.)	Failure Mode at Ultimate
1338	193	0.254	Failure at Top Plate
1339	197	0.271	Left Stud failure at Top Plate
1340	222	0.266	Middle Right Stud Failed at Top Plate
Average Ultimate	204	0.263	--
Evaluation Criteria	145	0.500	--
Overall Result	<i>Pass</i>	<i>Pass</i>	--

^a As required by the FMHCSS¹, 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

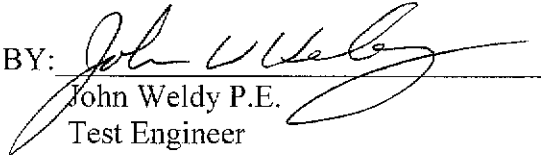
Specimen	Test Conditions	Overall Result
Novik, Hand-Laid Brick (0.090) Siding Fastened and constructed as detailed herein	Wind Zone III Corner	<i>Pass</i>

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

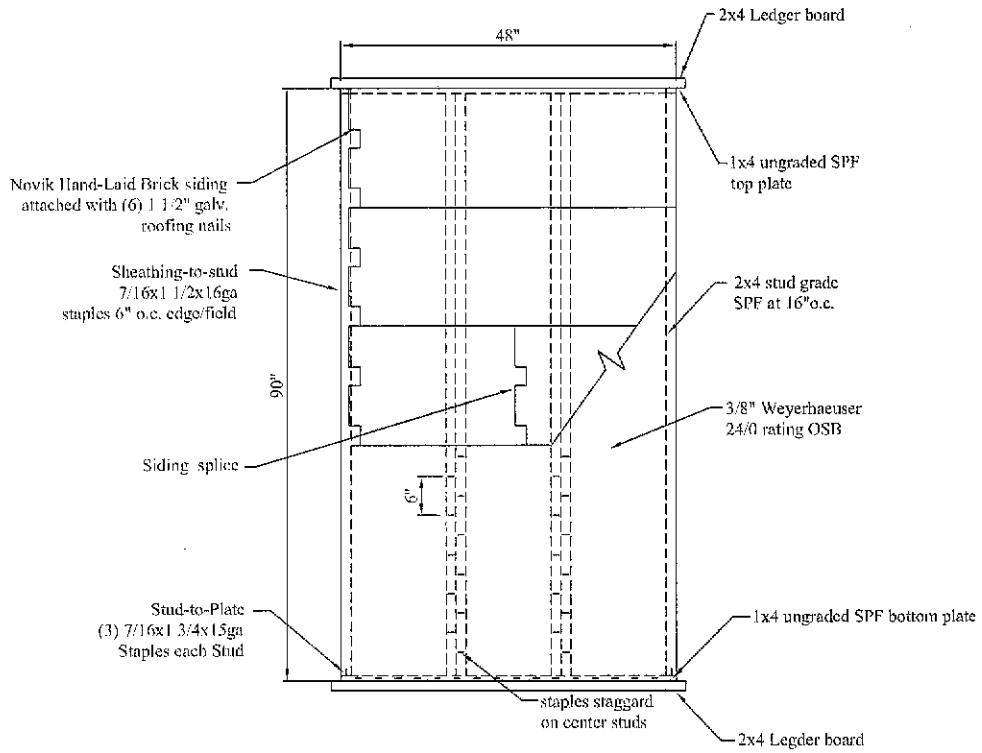


Figure 1: Specimen Construction

FIGURES

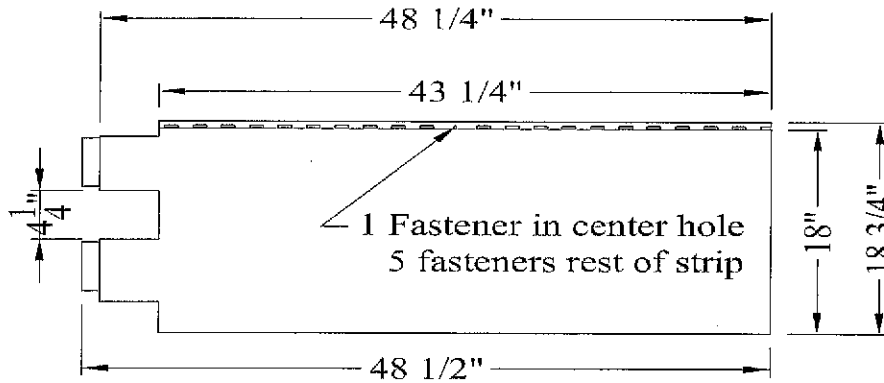


Figure 2: Siding Specimen

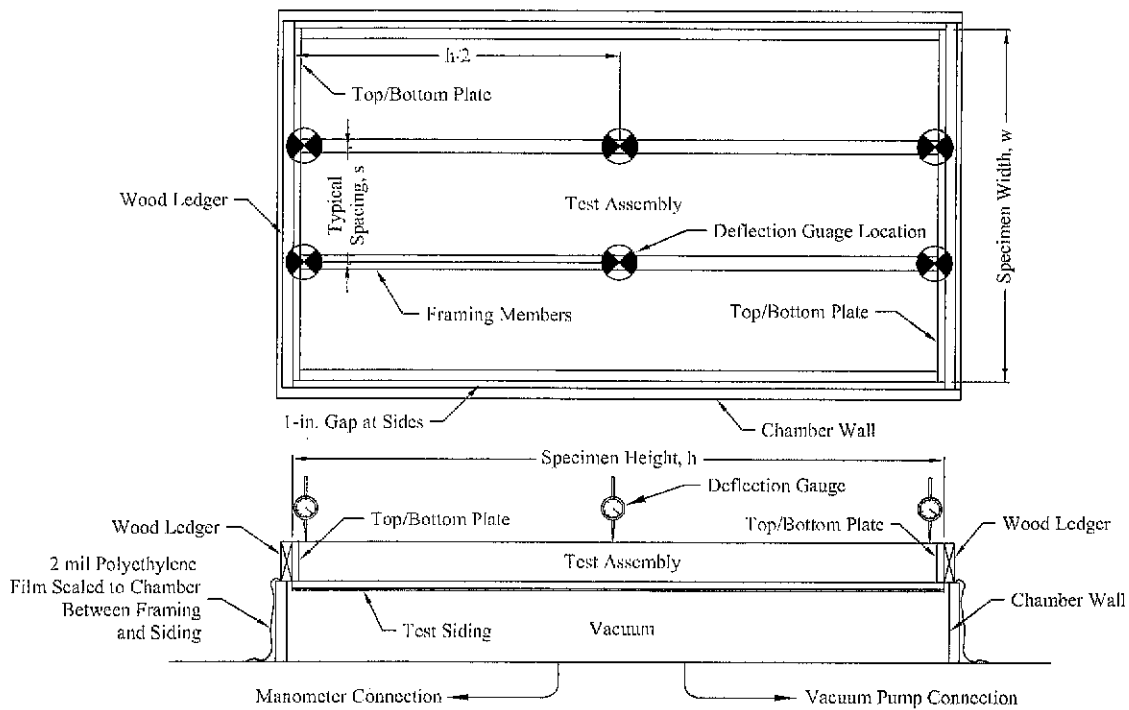


Figure 3: Test Setup

APPENDIX

TL081704-41 HUD Data sheets.xls
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NTA, Inc.

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

Specimen 1

Client: Novik
Job Number: TL081704-41
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: 8/17/2004	Length Measure:	00306	Ambient Temp.: 71.8 deg. F
Fabrication Date: 9/1/2004	Vacuum Table:	00023	Ambient R.H.: 53%
Test Date: 9/3/2004	Manometer:	00337	Senor Asset No.: 00200
Test Location: NTA, Test Facility Nappanee, IN	Moisture Meter:	00173	

Specimen Description:	Loading Conditions:
Specimen No.: 01338	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 o/c-in. oc	
Ext. Sheathing: Weverhaenscr 0.375 OSB	
16 ga x 7/16 x 1 1/2-in. staple 6/6-in. oc edge/field	
Ext. Siding: Novik Hand-Laid Brick Polypropylene(0.0918666666666667-in. flange thick.)	
(6) 4d x 1.5-in. Roofing nails random-in. oc	
Int. Sheathing: none	
Wood MC: 10.2% - 14.9%	

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	0.024	0.079	0.029	0.033	0.083	0.024
1/2LL	29.1	0.046	0.162	0.053	0.055	0.171	0.049
3/4LL	43.7	0.071	0.240	0.072	0.079	0.261	0.070
LL	58.2	0.095	0.339	0.095	0.103	0.362	0.094
5/4LL	72.8	0.117	0.430	0.116	0.126	0.460	0.118
5/2LL	144.6	--	--	--	--	--	--

Net LL Deflection: 0.254-in. at 58 psf
Ultimate Uniform Load: 193 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: Specimen 2

Client: Novik
Job Number: TL081704-41
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: 8/17/2004	Length Measure:	00306	Ambient Temp.: 72.2 deg. F
Fabrication Date: 9/1/2004	Vacuum Table:	00023	Ambient R.H.: 49%
Test Date: 9/2/2004	Manometer:	00023	Senor Asset No.: 00200
Test Location: NTA, Test Facility Nappanee, IN	Moisture Meter:	00173	

Specimen Description:	Loading Conditions:
Specimen No.: 01339	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 o/c-in. oc	
Ext. Sheathing: Weverhaeuser 0.375 OSB 16 ga x 7/16 x 1 1/2-in. staple 6/6-in. oc edge/field	
Ext. Siding: Novik Hand-Laid Brick Polypropylene(0.0918666666666667-in. flange thick.) (6) 4d x 1.5-in. Roofing nails random-in. oc	
Int. Sheathing: none	
Wood MC: 10.2% - 14.9%	

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
0 (REF)	0.0	0.000	0.000	0.000	0.000	0.000	0.000
1/4LL	14.6	0.036	0.091	0.028	0.035	0.091	0.021
1/2LL	29.1	0.059	0.176	0.056	0.058	0.177	0.043
3/4LL	43.7	0.083	0.273	0.083	0.081	0.277	0.069
LL	58.2	0.106	0.369	0.106	0.102	0.375	0.092
5/4LL	72.8	0.132	0.473	0.131	0.128	0.485	0.117
5/2LL	144.6	--	--	--	--	--	--

Net LL Deflection: 0.271-in. at 58 psf
Ultimate Uniform Load: 197 psf
Failure Mode: Left stud disengaged from top plate

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NTA, Inc.

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

Client: Novik
Job Number: TL081704-41
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: 8/17/2004	Length Measure: 00306	00306	Ambient Temp.: 74.2 deg. F
Fabrication Date: 9/1/2004	Vacuum Table: 00023	00023	Ambient R.H.: 51%
Test Date: 9/2/2004	Manometer: 00023	00023	Senor Asset No.: 00200
Test Location: NTA, Test Facility Nappanee, IN	Moisture Meter: 00173	00173	

Specimen Description:	Loading Conditions:
Specimen No.: 01340	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 o/c-in. oc	
Ext. Sheathing: Weverhaeuser 0.375 OSB	
16 ga x 7/16 x 1 1/2-in. staple 6/6-in. oc edge/field	
Ext. Siding: Novik Hand-Laid Brick Polypropylene(0.0918666666666667-in. flange thick.)	
(6) 4d x 1.5-in. Roofing nails random-in. oc	
Int. Sheathing: none	
Wood MC: 10.2% - 14.9%	

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
		00246	00254	00245	00081	00253	00077
0 (REF)	0.0	0.000	0.000	0.000	0.000	0.000	0.000
1/4LL	15.6	0.038	0.122	0.062	0.036	0.110	0.061
1/2LL	29.1	0.059	0.203	0.089	0.057	0.192	0.095
3/4LL	43.7	0.081	0.298	0.112	0.079	0.277	0.117
LL	58.2	0.101	0.401	0.133	0.100	0.368	0.140
5/4LL	72.8	0.122	0.506	0.154	0.121	0.460	0.163
5/2LL	144.6	--	--	--	--	--	--

Net LL Deflection: 0.266-in. at 58 psf
Ultimate Uniform Load: 222 psf
Failure Mode: middle right stud failed from top plate

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NTA, Inc.

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

Client: Novik
Job Number: TL081704-41
Test Method: *FMHCSS, Section 3280.401(b), Ultimate Load Test Procedure*

Performed By: Gregg Tompos
Witnessed By: Dale Arter

Specimen Description:

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

Framing: (2) 2x4 stud SPF 16 o/c-in. oc
Ext. Sheathing: *Weverhaeuser 0.375 OSB*
16 ga x 7/16 x 1 1/2-in. staple 6/6-in. oc edge/field
Ext. Siding: *Novik Hand-Laid Brick Polypropylene(0.091866666666667-in. flange thick.)*
(6) 4d x 1.5-in. Roofing nails random-in. oc
Int. Sheathing: *none*

Wood MC: 10.2% - 14.9%

Loading Conditions:

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

Overall Test Results

Specimen	Specimen No.	Ultimate Pressure (psf)	Service Deflection (in.)
1	01338	193	0.254
2	01339	197	0.271
3	01340	222	0.266

Average Ultimate Pressure: 204 psf, Pass (58 psf x 2.5 = 145 psf min.)
Average Midspan Deflection*: 0.263-in., Pass (L/180 = 0.5-in.)

* Midspan deflection less the average of the support deflections.

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Reviewed & Approved By: Dale Arter

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