Architectural Testing

AEROSOL FOAM
PERFORMANCE TEST REPORT
According to AAMA 812-04

Rendered to:

HILTI, INC.

PRODUCT: CF 812
Insulating Foam Sealant with Hilti DS-1 Dispenser

Report No.: 57260.01-106-31
Report Date: 11/17/05
Expiration Date: 09/22/09

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AEROSOL FOAM PERFORMANCE TEST REPORT
According to AAMA 812-04

Rendered to:

HILTI, INC.
5400 South 122nd East Avenue
Tulsa, Oklahoma 74146

Report No.:	57260.01-106-31
Test Date:	08/08/05
Through:	09/22/05
Report Date:	11/17/05
Expiration Date:	09/22/09

Product: CF 812 Insulating Foam Sealant with Hilti DS-1 Dispenser

Project Summary: Architectural Testing, Inc. (ATI) was contracted by Hilti, Inc. to conduct evaluations of a Single Component, Aerosol Expanding Polyurethane Foam Sealant. The product was independently evaluated in accordance with AAMA 812-04, *Voluntary Practice for Assessment of Single Component Aerosol Expanding Polyurethane Foams for Sealing Rough Openings of Fenestration Installations*. This product conforms to AAMA 812-04 requirements with Dimensional Stability results ≤10% at a pressure build value of 0.7962 psi.

Results Summary

Average Peak Pressure Build (psi)	Actual Measured Peak Beam Deflection* (inches)	Calculated Theoretical Beam Deflection (inches)
0.7962	**0.0547**	**0.0159**

***Note**: Actual Measured Peak Beam Deflection is based on a five foot long by three inch wide by one inch thick aluminum beam (see Appendix A photographs) whose moment of inertia is 0.25 in^4. A user of this report, knowing the moment of inertia of the applicable window or door side jambs, can use the data to predict whether unacceptable jamb distortion is possible using the given product. Always ask for both the beam deflection data and the moment of inertia of the tested beam when comparing product data. The Calculated Theoretical Beam Deflection is the value used to predict the expected foam deflection.*

Results Summary

14 Day Dimensional Stability (%)					
40ºC / 90% R.H.		30ºC / 30% R.H.		-20ºC / Uncontrolled R.H.	
Average	Standard Deviation	Average	Standard Deviation	Average	Standard Deviation
-0.43	0.61	-0.32	0.68	-1.49	0.56

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Test Methods: The following paragraphs detail the procedures used to conduct the three tests of AAMA 812.

Pressure Build:
A 3-1/2" square piece of 3/4" thick untreated pine with a 2" diameter hole drilled through its center was secured to a piece of 4" square 3/8" thick plywood using four #6 by 1/2" long wood screws. This assembly was then conditioned at 70ºF ±2ºF and 50 ±5% R.H. for a period of at least 48 hours and subsequently cleaned of loose debris and checked for moisture content. Five such assemblies were made for each product evaluated.

At the conclusion of the conditioning period, a single assembly was placed under a load cell on an instrumented resistance frame. A 1-1/2" diameter mandrel was wrapped in a protective polyethylene sheet to prevent adhesion of the foam product to the mandrel.

The test product was dispensed into the cavity of the wooden assembly, struck off plane with the uppermost surface of the wood assembly and immediately placed in contact with the load sensing mandrel of the resistance frame. While ensuring the assembly was centered under the mandrel, leaving a 1/4" annular space for foam expulsion during expansion, the test was allowed to continue uninterrupted for a period extending at least one hour after the peak pressure had been achieved. The peak value for five replicate samples was recorded.

Beam Deflection:
Once the pressure build values were obtained, the average value was used to determine the calculated Moment of Inertia for a theoretical beam deflection of 0.0625". Based on the AAMA 812 procedure, 1/10 of the average pressure build force was then used, along with the newly calculated Moment of Inertia, to define the thickness of a beam whose length was 5' 0" and whose width was 3".

A 1" thick aluminum beam was obtained and an assembly was created to physically evaluate the deflection potential of the beam due to the pressure of the expanding foam in the following construction. The AAMA calculation found in Section 10.2, was used to determine the expected deflection of the foam material under a 1" thick beam. The calculated theoretical beam deflection was then compared to the actual measured beam deflection.

Test Methods: (Continued)

The beam deflection assembly consisted of the following:
A 5' 0" long by 3" wide rigid three sided wooden frame with a rigid wooden floor panel was pin-connected to the ends of the designed beam such that a 1/2" wide cavity between the 3" by 5' 0" face of the beam and the 3" by 5' 0" face of the floor panel of the assembly was created (see photo of assembly). A 1" by 0.0001" movement indicator was placed in contact with the top exposed surface of the beam. The cavity was then filled with the foam product using approximately four passes with the applicator system. Once the cavity was filled, all excess foam was struck off flush with the open face of the cavity. The product was allowed to expand freely at ambient conditions of 70ºF ±2ºF and 50 ±5% R.H. for a period of 24 hours and the peak deflection value recorded.

Dimensional Stability:
Nine specimens were prepared in accordance with the AAMA procedure as follows:

Two pieces of 8" by 4" by 3/8" thick AC grade plywood were sandwiched over two release liner covered wood spacers whose dimensions were 6" in length x 2" by 3/4". The spacers were located at the ends of the 8" dimension resulting in an open area between the spacers of 4" by 4" by 3/4". A diagram of this construction and photographs is included at the end of this report. This cavity was filled with the product and allowed to set for 24 hours. At the end of the 24 hour cure period, the clamps were removed and the excess foam cut cleanly from the assembly flush with the edges of the plywood.

The inner plywood to plywood dimensions were then measured for each sample and three samples per aging condition were exposed to the following:

40ºC ±2ºC (140ºF ±4ºF) / 90% ±5% relative humidity
30ºC ±2ºC (86ºF ±4ºF) / 30% ±5% relative humidity
-20ºC ±2ºC (-4ºF ±4ºF) / Uncontrolled relative humidity

At the completion of Day 7, the samples were removed from their respective conditions, stored at 70ºF and 50% ±5% R.H. for a period of at least two hours and again measured for the inner plywood to plywood dimension, first at the corners as near as possible to the interior foam surface and if that was not possible, at the exact middle of the edges where the spacers had been prior to their removal. The samples were then placed back into the conditions for another 7 Day period and the conditioning and measurement process repeated.

Test Results: The following tables contain the data collected for each test.

Pressure Build

Conditioning Start Date: 08/12/05
Conditioning End Date: 08/14/05
Conditioning Temperature: 72°F
Conditioning RH: 50%

Sample #	1	2	3	4	5
Pressure Build Construct Moisture Content	8.9%	8.4%	8.6%	8.5%	8.0%

Sample #	Peak Time to Pressure Build (minutes)	Peak Pressure Build (psi)
1	45	1.3644
2	35	0.7260
3	40	0.7470
4	65	0.5257
5	45	0.6180
Average	**46**	**0.7962**

Test Results: (Continued)

Measured Beam Deflection

Sample #	Peak Deflection (inches)
1	0.0340
2	0.0665
3	0.0635
Average	**0.0547**

Calculated Deflection [1]

Peak Deflection (inches)
0.0159

The calculated deflection is based on the following formula:

$$deflection = \frac{5WL^3}{384EI}$$, at the center of the beam

where,

W is the average pressure build / 10 (psi) multiplied by 60 (beam length in inches) multiplied by 3 (beam width in inches)

L is the length of the beam to be evaluated (this value was 60 in.)

E is the Modulus of Elasticity for the beam material to be used (an aluminum beam was used and has a value of 10,100,000 psi)

I is the Moment of Inertia of the beam to be used (the 1" thick standard beam provided by ATI has a Moment of Inertia of 0.25 in.^{4})

[1] *Based on the pressure build results.*

Test Results: (Continued)

Dimensional Stability
40ºC ±2ºC (140ºF ±4ºF) / 90% ±5% Relative Humidity

Sample #	Reading #	Measurement (inches)		
		Initial	7 Days	14 Days
1	1	0.782	0.783	0.784
	2	0.780	0.779	0.777
	3	0.782	0.781	0.781
	4	0.782	0.780	0.779
2	1	0.774	0.771	0.765
	2	0.782	0.780	0.778
	3	0.777	0.775	0.773
	4	0.775	0.771	0.760
3	1	0.772	0.771	0.771
	2	0.772	0.771	0.771
	3	0.776	0.775	0.773
	4	0.783	0.784	0.785

Sample #	Average Change (%)		Standard Deviation (%)	
	7 Day	14 Day	7 Day	14 Day
1	-0.096	-0.160	0.161	0.302
2	-0.354	-1.031	0.124	0.676
3	-0.065	-0.098	0.129	0.265
Overall	**-0.17**	**-0.43**	**0.18**	**0.61**

Test Results: (Continued)

Dimensional Stability
30ºC ±2ºC (86ºF ±4ºF) / 30% ±5% Relative Humidity

Sample #	Reading #	Measurement (inches)		
		Initial	7 Days	14 Days
1	1	0.776	0.775	0.774
	2	0.775	0.775	0.770
	3	0.771	0.773	0.773
	4	0.774	0.772	0.775
2	1	0.785	0.780	0.771
	2	0.770	0.771	0.768
	3	0.788	0.793	0.789
	4	0.793	0.792	0.790
3	1	0.777	0.782	0.781
	2	0.782	0.784	0.784
	3	0.761	0.756	0.757
	4	0.755	0.746	0.745

Sample #	Average Change (%)		Standard Deviation	
	7 Day	14 Day	7 Day	14 Day
1	-0.032	-0.129	0.221	0.408
2	0.000	-0.574	0.529	0.835
3	-0.237	-0.270	0.838	0.831
Overall	**-0.09**	**-0.32**	**0.54**	**0.68**

Test Results: (Continued)

Dimensional Stability
-20ºC ±2ºC (-4ºF ±4ºF) / Uncontrolled Relative Humidity

Sample #	Reading #	Measurement (inches)		
		Initial	7 Days	14 Days
1	1	0.785	0.781	0.777
	2	0.770	0.762	0.755
	3	0.776	0.770	0.768
	4	0.780	0.774	0.771
2	1	0.789	0.770	0.770
	2	0.779	0.764	0.764
	3	0.774	0.761	0.761
	4	0.776	0.765	0.768
3	1	0.762	0.749	0.751
	2	0.777	0.770	0.770
	3	0.741	0.732	0.734
	4	0.761	0.743	0.743

Sample #	Average Change (%)		Standard Deviation	
	7 Day	14 Day	7 Day	14 Day
1	-0.773	-1.288	0.216	0.444
2	-1.858	-1.761	0.422	0.573
3	-1.547	-1.414	0.638	0.681
Overall	**-1.39**	**-1.49**	**0.63**	**0.56**

Dimensional Stability Calculation

The calculated dimensional stability is based on the formula:

$$d = \left(\frac{b}{c} \times 100\%\right) - 100\%$$

where,

b is the measured width of the gap at either the fours corners or the two edges after exposure to the test conditions

c is the measured width of the gap at either the fours corners or the two edges prior to exposure to the test conditions

A copy of this report will be retained by ATI for a period of four years from the original test date. This report is the exclusive property of the client so named herein, and is applicable to the samples evaluated. The results presented in this report are obtained values and do not constitute an opinion nor endorsement by this laboratory or any of its representatives. This report may not be reproduced, except in full, without the express written permission of Architectural Testing, Inc.

For ARCHITECTURAL TESTING, INC:

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Joseph M. Brickner
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Attachments (pages)
- Appendix A - Photographs (8)
- Appendix B - Moment of Inertia Table (1)

Revision Log

Rev. #	Date	Page(s)	Revision(s)
0	11/17/05	N/A	Original report issue

APPENDIX A

Photographs

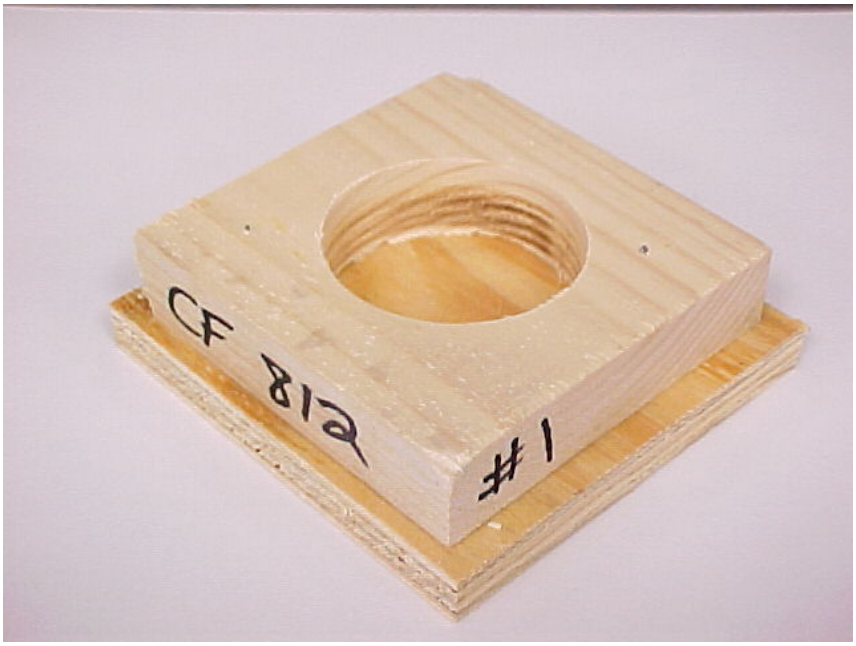

Photo No. 1
Pressure Build Construct - Empty

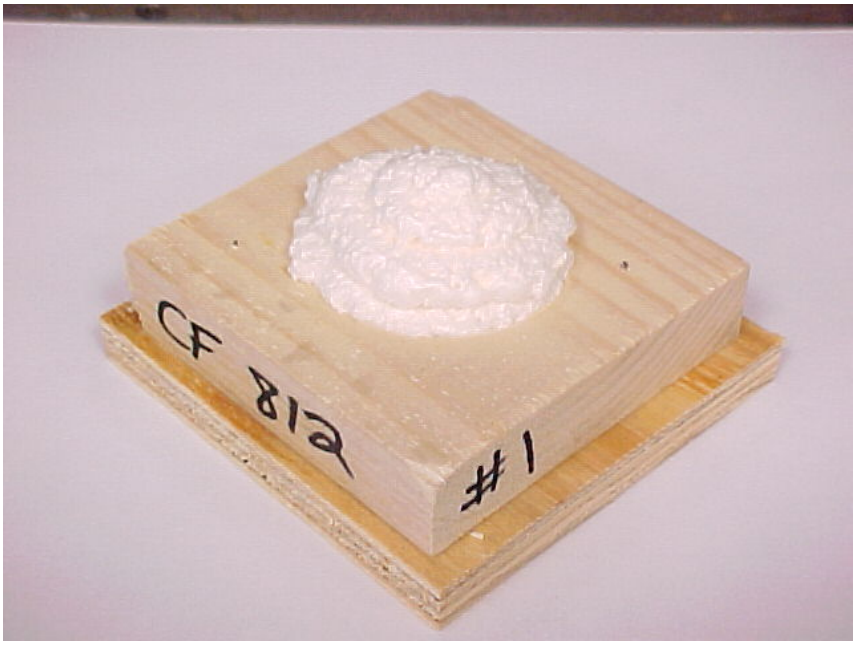

Photo No. 2
Pressure Build Construct - Filled

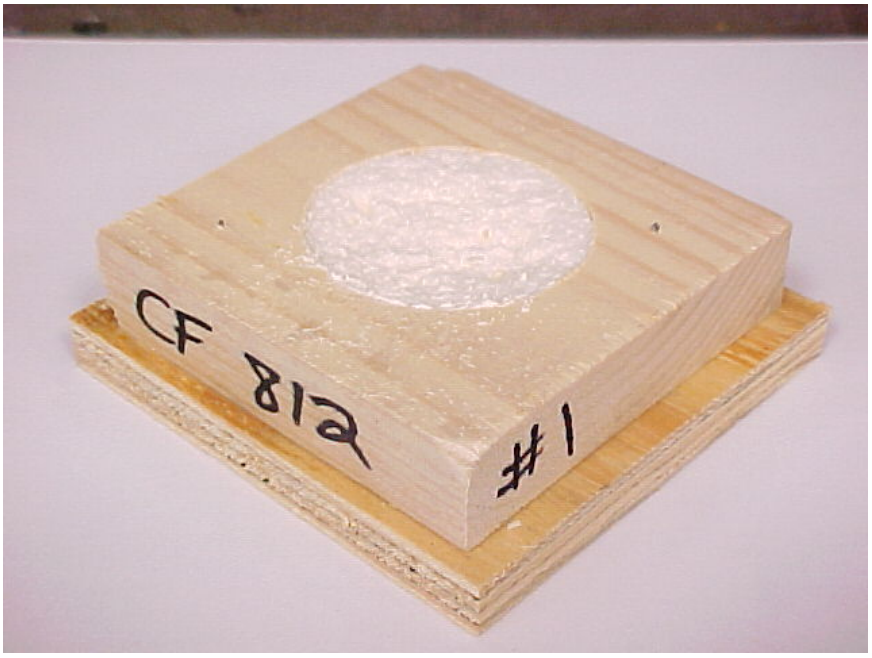

Photo No. 3
Pressure Build Construct - Struck Off Flush

Photo No. 4
Pressure Build Construct - Transducer Measurement

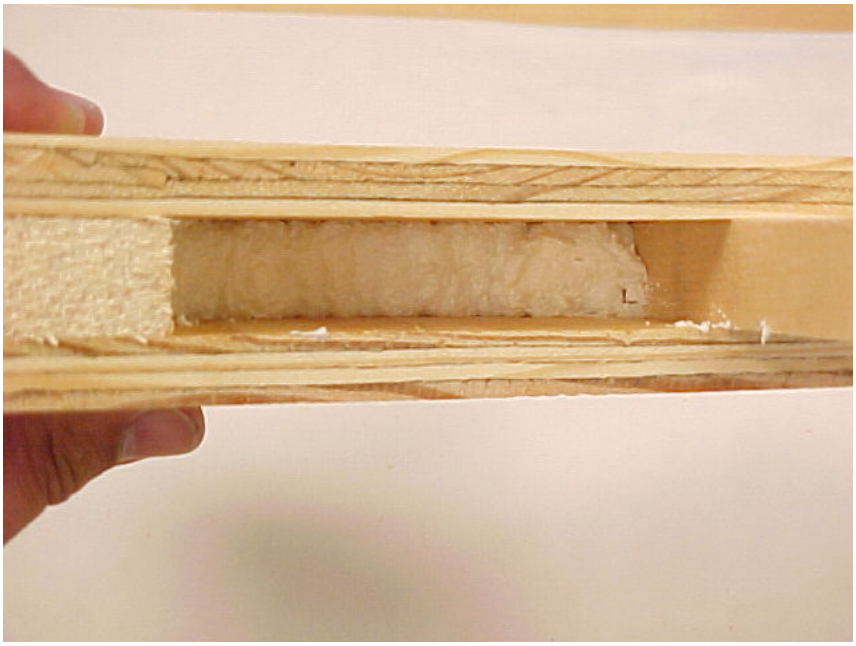

Photo No. 5
Dimensional Stability Construct - Empty

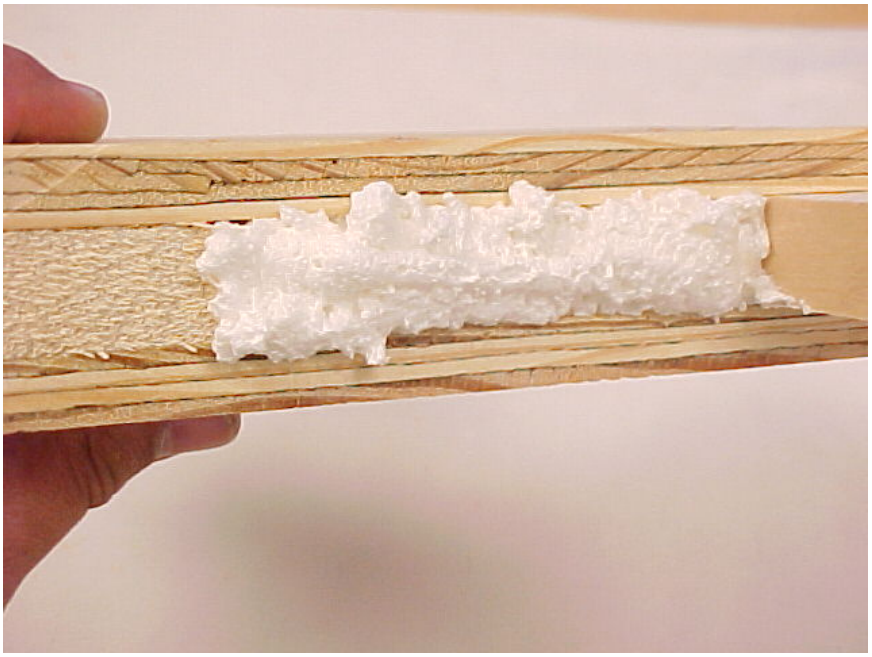

Photo No. 6
Dimensional Stability Construct - Filled

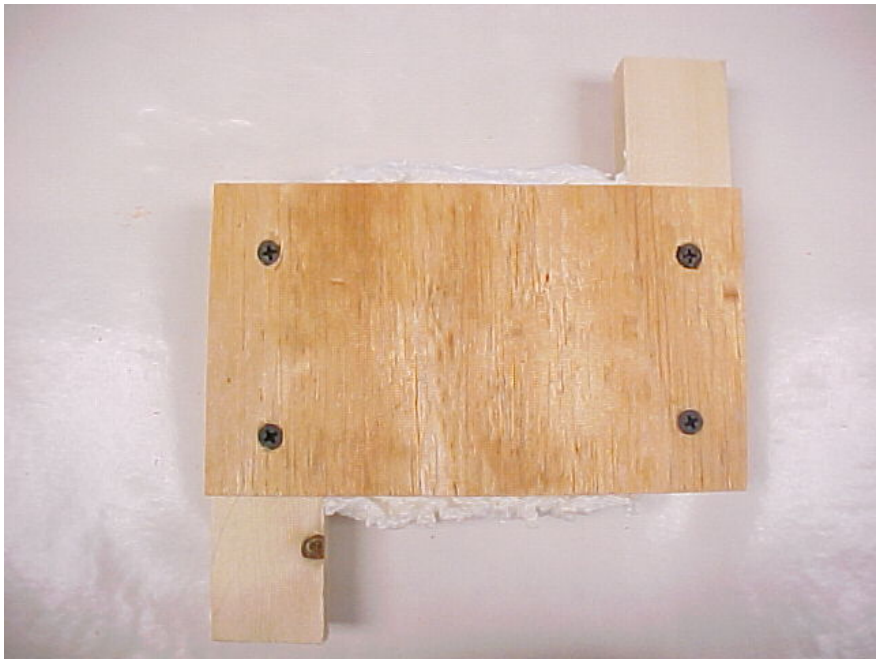

Photo No. 7
Dimensional Stability Construct - Overall View

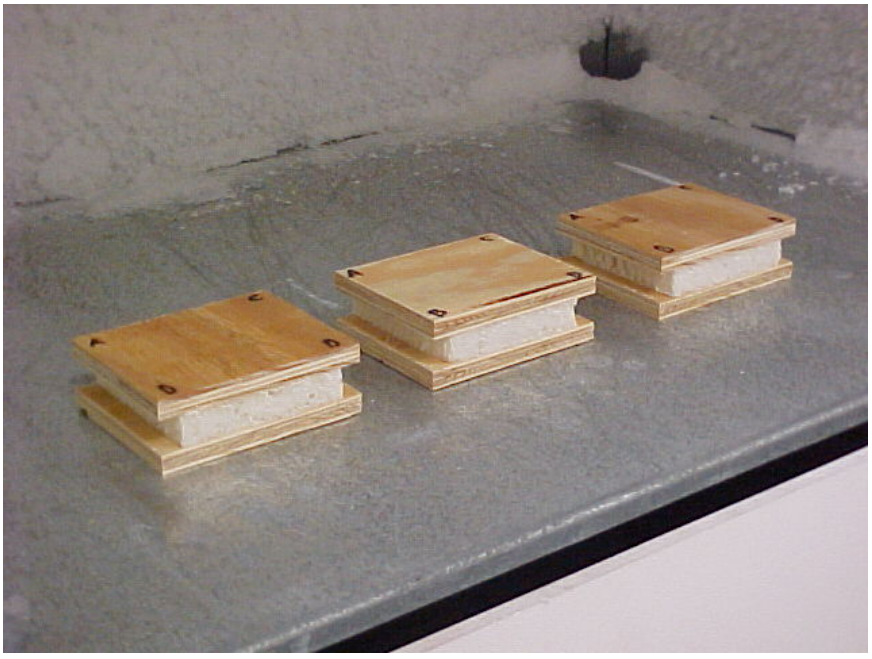

Photo No. 8
Dimensional Stability - Cold Conditioning

Photo No. 9
Dimensional Stability - Humidity Controlled Conditioning

Photo No. 10
Beam Deflection Rigid Cavity Frame - Overall View

Photo No. 11
Beam Deflection Construct - 1/2" Cavity Detail

Photo No. 12
Beam Deflection Construct - Pinned Connection Detail

Photo No. 13
Beam Deflection Construct - Deflection Gauge

Photo No. 14
Beam Deflection Construct - Deflection Gauge Detail

APPENDIX B

Moment of Inertia Table

	Douglas Fir			Hemlock / Fir		
	Select / Grade 1	Grade 2	Grade 3	Select / Grade 1	Grade 2	Grade 3
Modulus of Elasticity (psi)	1,800,000	1,700,000	1,500,000	1,500,000	1,400,000	1,200,000
Foam Pressure / 10 (psi)	0.0796	0.0796	0.0796	0.0796	0.0796	0.0796
Beam Length (in)	60	60	60	60	60	60
Beam Depth (in)	3	3	3	3	3	3
Desired Deflection (in)	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625
Moment of Inertia (in^4)	0.3585	0.3794	0.4300	0.4300	0.4607	0.5374

	Southern Pine			PVC - Cell Class 1		Aluminum	Mild Steel
	Select / Grade 1	Grade 2	Grade 3	Minimum	Maximum	6063-T5	A7
Modulus of Elasticity (psi)	1,700,000	1,600,000	1,400,000	290,000	600,000	10,100,000	29,000,000
Foam Pressure / 10 (psi)	0.0796	0.0796	0.0796	0.0796	0.0796	0.0796	0.0796
Beam Length (in)	60	60	60	60	60	60	60
Beam Depth (in)	3	3	3	3	3	3	3
Desired Deflection (in)	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625	0.0625
Moment of Inertia (in^4)	0.3794	0.4031	0.4607	2.2239	1.0749	0.0639	0.0222

A foam having average Pressure Build results of 0.7960psi can be theoretically expected to deflect a window stile 0.0625" provided the stile is designed using the above material specifications with the Moment of Inertia and beam dimensions listed. Actual deflection values may differ.