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**EVALUATION OF THE WATER VAPOR PERMEANCE OF
"TWO-BY-FOUR" AND "TWO-BY-SIX" WOODEN FRAMING MEMBERS
IN ACCORDANCE WITH ASTM E96 – 05**

A Report to:

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08-006-10999

Report No.:

09-06-M0097
6 Pages, 1 Appendix

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1.0 INTRODUCTION

1.1 PROJECT INITIATION

At the request of Canadian Urethane Foam Contractors Association (CUFCA), Exova was retained to evaluate several samples of “two-by-four” and “two-by-six” wooden framing members, in accordance with ASTM E96 – 05 “Standard Test Method for Water Vapor Transmission of Materials”. The details of the testing were agreed upon in Proposal No. 08-006-10999.

As proposed and agreed upon, the testing was to be conducted for the purposes of comparing the water vapor permeance of several configurations of framing members, under different ASTM E96 – 05 test conditions.

1.2 SAMPLING & IDENTIFICATION

The materials used for this testing were purchased by an Exova Technical Representative from regular stock at a local contractors supply depot. The sampled material consisted of construction grade “two-by-four” and “two-by-six” wooden framing members chosen randomly from the lot on the sales floor on the date of purchase.

The “two-by-four” and “two-by-six” materials were then cut to an appropriate size for testing and the pieces were randomly distributed to be adhered into several configurations. Each piece was planed to make its adhered surfaces substantially flat and parallel. The pieces were assembled and adhered using a two-part epoxy material, in order to ensure that vapor transport was solely through the wooden framing members. The assemblies were arranged in four (4) configurations, and six (6) assemblies of each configuration were created. Each configuration was tested by Method A (Desiccant) and Method B (Water) of ASTM E96-05, each sample consisting of three (3) assemblies. Once assembled, the samples were assigned the following Exova Sample Nos.:

Client Sample Identification	Exova Sample No.
Construction Grade “Two-by-Four” Wooden Framing Member Horizontal Configuration (Short Edges Adhered) ASTM E96 – 05, Method A (Desiccant)	09-06-M0097-A
Construction Grade “Two-by-Four” Wooden Framing Member Horizontal Configuration (Short Edges Adhered) ASTM E96 – 05, Method B (Water)	09-06-M0097-B
Construction Grade “Two-by-Six” Wooden Framing Member Horizontal Configuration (Short Edges Adhered) ASTM E96 – 05, Method A (Desiccant)	09-06-M0097-C
Construction Grade “Two-by-Six” Wooden Framing Member Horizontal Configuration (Short Edges Adhered) ASTM E96 – 05, Method B (Water)	09-06-M0098-D
Construction Grade “Two-by-Four” Wooden Framing Member Vertical Configuration (Long Edges Adhered) ASTM E96 – 05, Method A (Desiccant)	09-06-M0097-E
Construction Grade “Two-by-Four” Wooden Framing Member Vertical Configuration (Long Edges Adhered) ASTM E96 – 05, Method B (Water)	09-06-M0097-F
Construction Grade “Two-by-Six” Wooden Framing Member Vertical Configuration (Long Edges Adhered) ASTM E96 – 05, Method A (Desiccant)	09-06-M0097-G
Construction Grade “Two-by-Six” Wooden Framing Member Vertical Configuration (Long Edges Adhered) ASTM E96 – 05, Method B (Water)	09-06-M0098-H

2.0 PROCEDURE

2.1 TEST METHOD AND SPECIFICATIONS

The sample was tested in accordance with the following standard test method. No material specification or requirement was provided by the client.

Test Description	Test Method
Standard Test Methods for Water Vapor Transmission of Materials	ASTM E96 – 05 Method A and B

2.2 TEST APPARATUS & PARAMETERS

The following is a description of the test conditions, parameters and equipment used to perform the testing to the required specification, provided above.

Method: Samples 09-06-M0097-A, C, E, G – Desiccant (granulated CaCl₂)
Samples 09-06-M0097-B, D, F, H – Water (Deionized H₂O)

Sealant: 60% Microcrystalline Wax
40% Refined Crystalline Paraffin Wax
Two-Part Loctite™ Epoxy Adhesive
(for bond between framing members)

Tray Type: Stainless Steel
Test Area: 0.0645 m²

Environment: 23 ± 2°C; 50 ± 2% Relative Humidity
(Controller MII # A11354)

Vapor Flow: Samples 09-06-M0097-A, B, C, D
Vapor flow through long side of sample

Samples 09-06-M0097-E, F, G, H
Vapor flow through short side of sample

Sample: Construction Grade Wooden Framing Members

Test Date: Samples 09-06-M0097-A, B, C, D
Start 2009-07-10
End 2009-07-23
Samples 09-06-M0097-E, F, G, H
Start 2009-05-26
End 2009-06-11

Test Thickness: Samples 09-06-M0097-A, B, C, D
38 mm (1.5 in.) average test thickness

Samples 09-06-M0097-E, F
90 mm (3.5 in.) average test thickness

Samples 09-06-M0097-G, H
140 mm (5.5 in.) average test thickness

3.0 RESULTS

A summary of results is presented below. In all cases, SI units are the primary units of measure. A detailed presentation of results for each sample is provided in Appendix A.

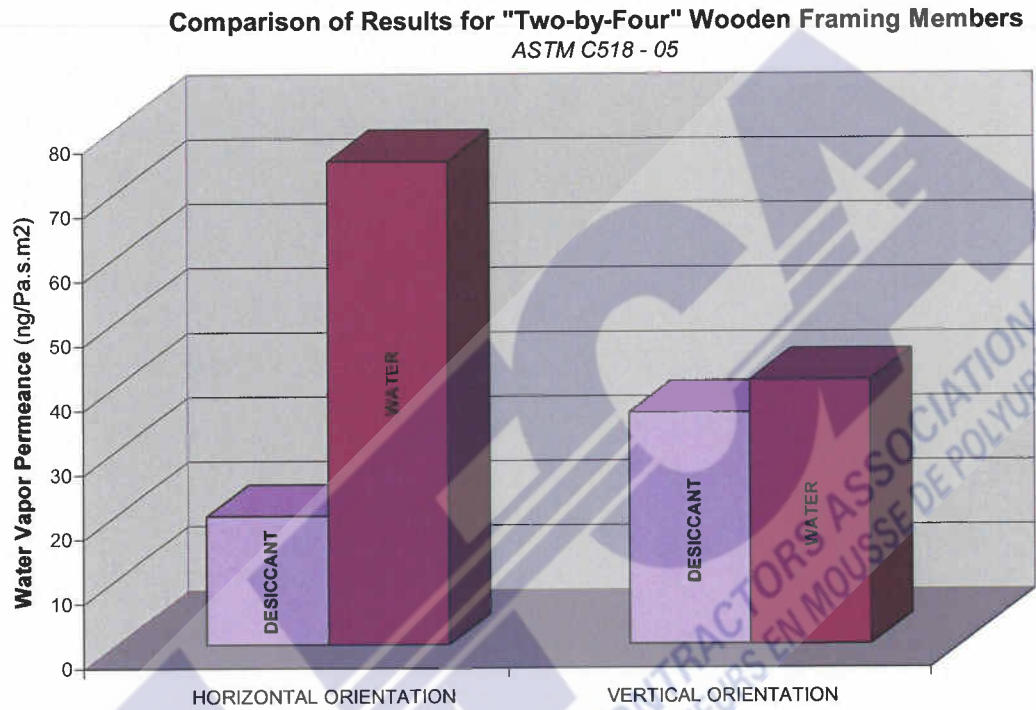


Figure 1 – Comparison of Water Vapor Permeance of "Two-by-Four" Wooden Framing Members in Horizontal and Vertical Orientations

Table 1 – Summary of Results for "Two-by-Four" Material

ASTM E 96 – 05

Exova Sample No: 09-06-M0097

Sample No.	Wood Size	Orientation	Method	Water Vapor Permeance	
				ng/Pa.s.m ²	Perms ¹
09-06-M0097-A	2 x 4	Horizontal	Desiccant	20	0.35
09-06-M0097-B	2 x 4	Horizontal	Water	75	1.31
09-06-M0097-E	2 x 4	Vertical	Desiccant	36	0.63
09-06-M0097-F	2 x 4	Vertical	Water	41	0.72

Note: 1 Perm (inch-pound) = 57.2 ng/Pa.s.m² per ASTM E96 – 05, Table 1

Comparison of Results for "Two-by-Six" Wooden Framing Members
ASTM C518 - 05

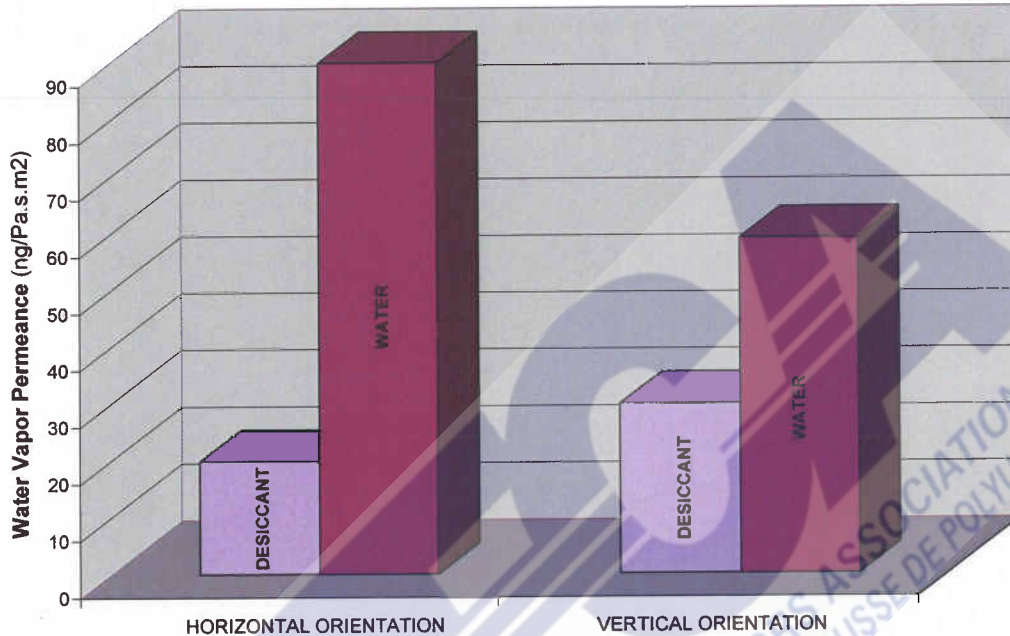


Figure 2 – Comparison of Water Vapor Permeance of "Two-by-Six" Wooden Framing Members in Horizontal and Vertical Orientations

Table 2 – Summary of Results for "Two-by-Six" Material
ASTM E 96 – 05
Exova Sample No: 09-06-M0097

Sample No.	Wood Size	Orientation	Method	Water Vapor Permeance	
				ng/Pa.s.m ²	Perms ²
09-06-M0097-C	2 x 6	Horizontal	Desiccant	20	0.35
09-06-M0097-D	2 x 6	Horizontal	Water	90	1.57
09-06-M0097-G	2 x 6	Vertical	Desiccant	30	0.52
09-06-M0097-H	2 x 6	Vertical	Water	59	1.03

Note: 1 Perm (inch-pound) = 57.2 ng/Pa.s.m² per ASTM E96 – 05, Table 1

4.0 OBSERVATIONS

Materials were tested in their as received condition; however an initial period was excluded from the measurement data of each sample to allow the materials to reach equilibrium under their exposure conditions. This excluded region was determined according to ASTM E96-05 based on the plot of mass vs. time used to find a "steady state period" for the calculation of water vapor permeance. It should be noted however, that the mass changes were small over an extended test period, and could have been influenced by the absorption of water by the wood.

In all cases, the measured average value for water vapor permeance tested by ASTM E96 – 05 Method B "Water Method" yielded higher results compared with the those tested using Method A "Desiccant Method" for the same configuration and thickness. This is an expected variance as documented in ASTM E96 – 05.

Samples tested in their horizontal orientation showed a lower water vapor permeance than samples tested in their vertical orientation, despite the increased thickness. This could be attributed to a natural bias in the wood which provides improved moisture vapor transport in one direction.


Samples 09-06-M0097-B and 09-06-M0097-D have the same thicknesses, tested by the same method, however sample 09-06-M0097-D yielded a 20% higher result. There are several possible sources for this inconsistency, such as material variability/density or the increase in sealed joint length between members in 09-06-M0097-B.

The overall uncertainty of this set of data (due to natural variability in the material and the test method in general) is high, and significant when compared to the low water vapor permeance results. Further testing is therefore recommended to increase confidence in the data and to eliminate some of the variable identified in this set of testing.


5.0 CONCLUSION

The testing performed for Canadian Urethane Foam Contractors Association Inc., as described in this report gave an average water vapor permeance between 20 and 90 ng/Pa.s.m² depending on the orientation and thickness of the test sample.

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APPENDIX A

Detailed Test Data

(3 Pages)

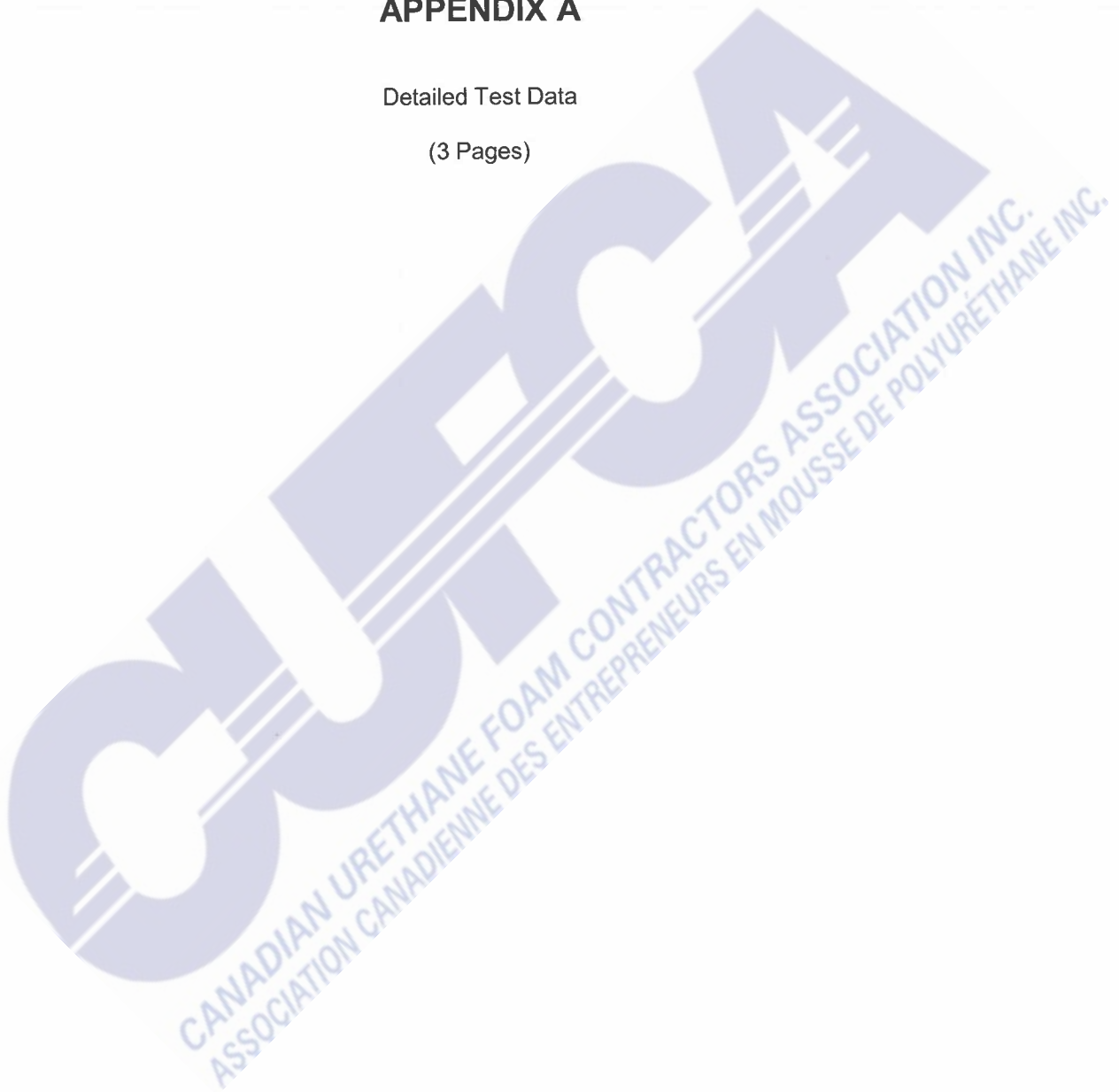


Table A1 – Water Vapor Permeance ASTM E 96 – 05 <i>Exova Sample No.: 09-06-M0097-A (2x4, Horizontal, Desiccant)</i>				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Gain, grams	Water Vapor Permeance, ng/Pa.s.m²
1	4028.16	4029.98	1.82	18
2	4050.43	4052.11	1.68	17
3	4142.60	4145.03	2.43	25
Average	--	--	1.98	20

Table A2 – Water Vapor Permeance ASTM E 96 – 05 <i>Exova Sample No.: 09-06-M0097-B (2x4, Horizontal, Water)</i>				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Loss, grams	Water Vapor Permeance, ng/Pa.s.m²
1	4237.86	4230.74	7.12	72
2	4167.79	4162.04	5.75	58
3	4191.39	4182.03	9.36	95
Average	--	--	7.41	75

Table A3 – Water Vapor Permeance ASTM E 96 – 05 <i>Exova Sample No.: 09-06-M0097-C (2x6, Horizontal, Desiccant)</i>				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Gain, grams	Water Vapor Permeance, ng/Pa.s.m²
1	3607.78	3609.11	1.33	13
2	3513.49	3515.77	2.28	23
3	3513.49	3515.77	2.28	23
Average	--	--	1.96	20

Table A4 – Water Vapor Permeance ASTM E 96 – 05 Exova Sample No.: 09-06-M0097-D (2x6, Horizontal, Water)				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Loss, grams	Water Vapor Permeance, ng/Pa.s.m ²
1	3300.09	3290.85	9.24	94
2	4142.65	4135.13	7.52	76
3	3888.00	3878.14	9.86	100
Average	--	--	8.87	90

Table A5 – Water Vapor Permeance ASTM E 96 – 05 Exova Sample No.: 09-06-M0097-E (2x4, Vertical, Desiccant)				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Gain, grams	Water Vapor Permeance, ng/Pa.s.m ²
1	5761.00	5764.20	3.20	26
2	5738.50	5743.70	5.20	43
3	5513.10	5517.80	4.70	38
Average	--	--	4.37	36

Table A6 – Water Vapor Permeance ASTM E 96 – 05 Exova Sample No.: 09-06-M0097-F (2x4, Vertical, Water)				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Loss, grams	Water Vapor Permeance, ng/Pa.s.m ²
1	5071.30	5067.60	3.70	35
2	5312.90	5310.90	2.00	19
3	5932.90	5925.40	7.50	70
Average	--	--	4.40	41

Table A7 – Water Vapor Permeance ASTM E 96 – 05 Exova Sample No.: 09-06-M0097-G (2x6, Vertical, Desiccant)				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Gain, grams	Water Vapor Permeance, ng/Pa.s.m ²
1	8091.90	8094.40	2.50	23
2	7436.20	7438.90	2.70	25
3	8230.30	8234.80	4.50	42
Average	--	--	3.23	30

Table A8 – Water Vapor Permeance ASTM E 96 – 05 Exova Sample No.: 09-06-M0097-H (2x6, Vertical, Water)				
Specimen No.	Initial Mass, grams	Final Mass, grams	Mass Loss, grams	Water Vapor Permeance, ng/Pa.s.m ²
1	7360.70	7354.30	6.40	60
2	7666.20	7659.30	6.90	64
3	7964.00	7958.20	5.80	54
Average	--	--	6.37	59

