

PERFORMANCE TEST REPORT

Rendered to:

VELUX America, Inc.

PRODUCT: SUN TUNNEL™ Acrylic Dome

Report No: D3964.01-106-31

Report Date: 06/19/14

Test Record Retention Date: 06/03/18

PERFORMANCE TEST REPORT

Rendered to:

VELUX America, Inc.
P.O. Box 5001
1418 Evans Pond Road
Greenwood, South Carolina 29648-5001

Report No: D3964.01-106-31
Test Dates: 03/05/14
Through: 06/03/14
Report Date: 06/19/14
Test Record Retention Period: 06/03/18

Product: SUN TUNNEL™ Acrylic Dome

Project Summary: Architectural Testing, Inc. was contracted by VELUX America, Inc. to perform testing on the acrylic material used in the dome of their SUN TUNNEL™ system. The samples tested successfully met the performance requirements listed in the 2012 International Building Code (IBC) for light transmitting plastics for the properties listed below. Test specimens description and results are reported herein.

Test Methods: The test specimens were evaluated in accordance with the following methods.

ASTM D 1929-96(2001), *Standard Test Method for Determining Ignition Temperature of Plastics.*

ASTM D 2843-99(2004), *Standard Test Method for Density of Smoke from the Burning or Decomposition of Plastics.*

Note: The thickness of the specimens does not meet the specimen criterion as stated in the method, and was tested in the thickness intended for use in accordance with IBC.

ASTM D 635-06, *Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.*

ASTM G 155-05a, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*

Test Procedures and Test Results: Testing procedures and the results obtained from testing are reported as follows. All conditioning of test specimens and test conditions were at standard laboratory conditions.

ASTM D 1929 - Self-Ignition and Flash Ignition

Self-ignition temperature is the minimum temperature at which the self-heating properties of the specimen lead to ignition or ignition occurs of itself, under test conditions, in the absence of any additional flame ignition source. Flash ignition temperature is the minimum temperature at which, under specified test conditions, sufficient flammable gases are emitted to ignite momentarily upon application of a small external pilot flame. These temperatures were determined by observing the test specimen at a known temperature utilizing a self-ignition furnace (ICN 62156).

Caveat: These test results relate only to the behavior of test specimens under the particular conditions of the test. They are not intended to be used, and shall not be used, to assess the potential fire hazards of a material in use.

Self-Ignition

Specimen	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Initial Temperature (°C)			Final Temperature (°C)		
				Air	Furnace	Sample	Air	Furnace	Sample
1	2.8589	0	2.8589	400	426	412	463	426	414
2	3.0887	0	3.0887	440	467	453	458	469	465
3	3.0667	0	3.0667	420	445	435	426	445	444
4	2.9877	0	2.9877	430	456	444	436	460	460

Specimen	Ignition (min:sec)	Combustion Type	Observations (min:sec)					
			Char	Melt	Bubble	Foam	Smoke	Soot
1	-	-	-	0:15	1:15	-	1:49	-
2	5:21	Flame	-	0:10	0:40	-	1:23	-
3	-	-	-	0:16	1:00	-	1:52	-
4	-	-	-	0:15	0:47	-	1:49	-

Self-Ignition Temperature: 440 °C

Test Results: (Continued)

Flash Ignition

Specimen	Initial Mass (g)	Final Mass (g)	Mass Loss (g)	Initial Temperature (°C)			Final Temperature (°C)		
				Air	Furnace	Sample	Air	Furnace	Sample
1	3.0115	0	3.0115	400	414	412	406	414	412
2	3.0221	0	3.0221	360	368	366	372	369	377
3	2.9125	0.3582	2.5543	340	348	348	341	347	348
4	2.8595	1.7089	1.1506	330	338	330	331	338	330

Specimen	Ignition (min:sec)	Combustion Type	Observations (min:sec)					
			Char	Melt	Bubble	Foam	Smoke	Soot
1	2:47	Flame	-	0:38	0:57	-	2:33	-
2	4:20	Flame	-	0:25	2:13	-	3:11	-
3	9:59	Flame	-	0:37	2:30	-	4:38	-
4	-	-	-	0:36	3:03	-	5:25	-

Flash Ignition Temperature: 340 °C

ASTM D 2843 - Smoke Density

A test specimen was exposed to a flame inside a Smoke Chamber (ICN 004388). Due to the dripping of the test specimen, a second flame was introduced into the chamber to keep the entire test specimen exposed to a flame for the duration of the test. The horizontal light absorption was measured across the light beam path of a photoelectric cell, and the condition of the smoke chamber was observed. The Light Absorption Curves are presented in Appendix A.

***Caveat:** This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions, but does not by itself incorporate all factors required for fire-hazard or fire risk assessment of the materials, products, or assemblies under actual fire conditions.*

Smoke Density

Specimen	Width (in)	Length (in)	Thickness (in)	Maximum Smoke Density (%)	Smoke Density Rating
1	1.043	1.034	0.176	37.28	23.1
2	1.042	1.016	0.176	26.62	13.8
3	1.050	1.026	0.176	29.09	17.3

Average Smoke Density Rating: 18.0

***Note:** During all smoke density tests, the letters on the exit sign were visible and readable through the smoke. The test specimens melted, flamed, and extinguished during the test.*

Test Results: (Continued)

ASTM D 635 - Rate of Burn

The test specimen was supported horizontally at one end and the free end exposed to a gas flame from a laboratory burner (ICN Y002875) for 30 seconds. After removal of the flame, the test specimen was observed for time and extent of burning.

Caveat: This standard is used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions but does not by itself incorporate all factors required for fire hazards or fire risk assessment of materials, products, or assemblies under actual fire conditions.

Rate of Burn

Specimen	Initial Burn	Sustained Burn Beyond 30 sec or 25 mm	Length Burned, L (mm)	Time, t (sec)	Linear Burn Rate, V (mm/min)	Comments
1	Y	Y	160	75	28.1	Melting, Bubbling, Flaming, drips that could be helping to burn, Charring
2	Y	Y	163	75	27.6	
3	Y	Y	159	75	28.3	

Average Linear Burning Rate, $V = 60L/t = 28.0$ mm/min

Note: 28.0 mm/min linear burning rate corresponds to a Class CC2 product. The test specimens were an average of 5" (nominal 127 mm) long by 0.5" (nominal 27.1 mm) wide by 0.128" (nominal 3.25 mm) thick.

Test Results: (Continued)

ASTM D 638 - Tensile Tests

Test Procedure and Summary of Results: Test specimens were cut by ATI to the dimensions designated for a Type I specimen. Test specimens were conditioned in lab conditions forty eight hours prior to testing. Five control specimens at room temperature & five specimens weathered in accordance with ASTM G 155-05a for 2000 hours were tested. Tensile properties were determined by utilizing an Instron Model 3369 Universal Test Machine (005740) operating at a cross head speed of 0.2 in/min and a Class C extensometer.

Tensile Properties

Control Specimens				
Specimen	Width (in)	Thickness (in)	Maximum Load (lbf)	Tensile Strength (psi)
1	0.500	0.125	461	7,380
2	0.500	0.123	450	7,320
3	0.500	0.123	458	7,380
4	0.500	0.125	449	7,190
5	0.500	0.124	451	7,270
Average				7,310

Weathered Specimens				
Specimen	Width (in)	Thickness (in)	Maximum Load (lbf)	Tensile Strength (psi)
1	0.498	0.128	459	7,200
2	0.501	0.128	397	6,200
3	0.498	0.127	402	6,360
4	0.499	0.127	381	6,020
5	0.499	0.126	486	7,730
Average				6,702

Note: These results represent an 8% decrease in tensile strength after weathering.

Architectural Testing will service this report for the entire test record retention period. Test records that are retained such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation will be retained by Architectural Testing, Inc. for the entire test record retention period.

Results obtained are tested values and were secured using the designated test methods. This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. It is the exclusive property of the client so named herein and relates only to the specimens tested. This report may not be reproduced, except in full, without the written approval of Architectural Testing, Inc.



Digitally Signed by: Rodney E. Holland

Rodney E. Holland - Technician I
Components / Materials Testing



Digitally Signed by: Gary Hartman

Gary Hartman, P.E. - Director
Components / Materials Testing

REH:reh/nlh

Attachments (pages) This report is complete only when all attachments listed are included.

Appendix A - Drawing (1)

Appendix B - Light Absorption Curves (4)

Revision Log

<u>Rev. #</u>	<u>Date</u>	<u>Page(s)</u>	<u>Revision(s)</u>
0	06/19/14	N/A	Original report issue.

Smoke Density Testing per ASTM D 2843

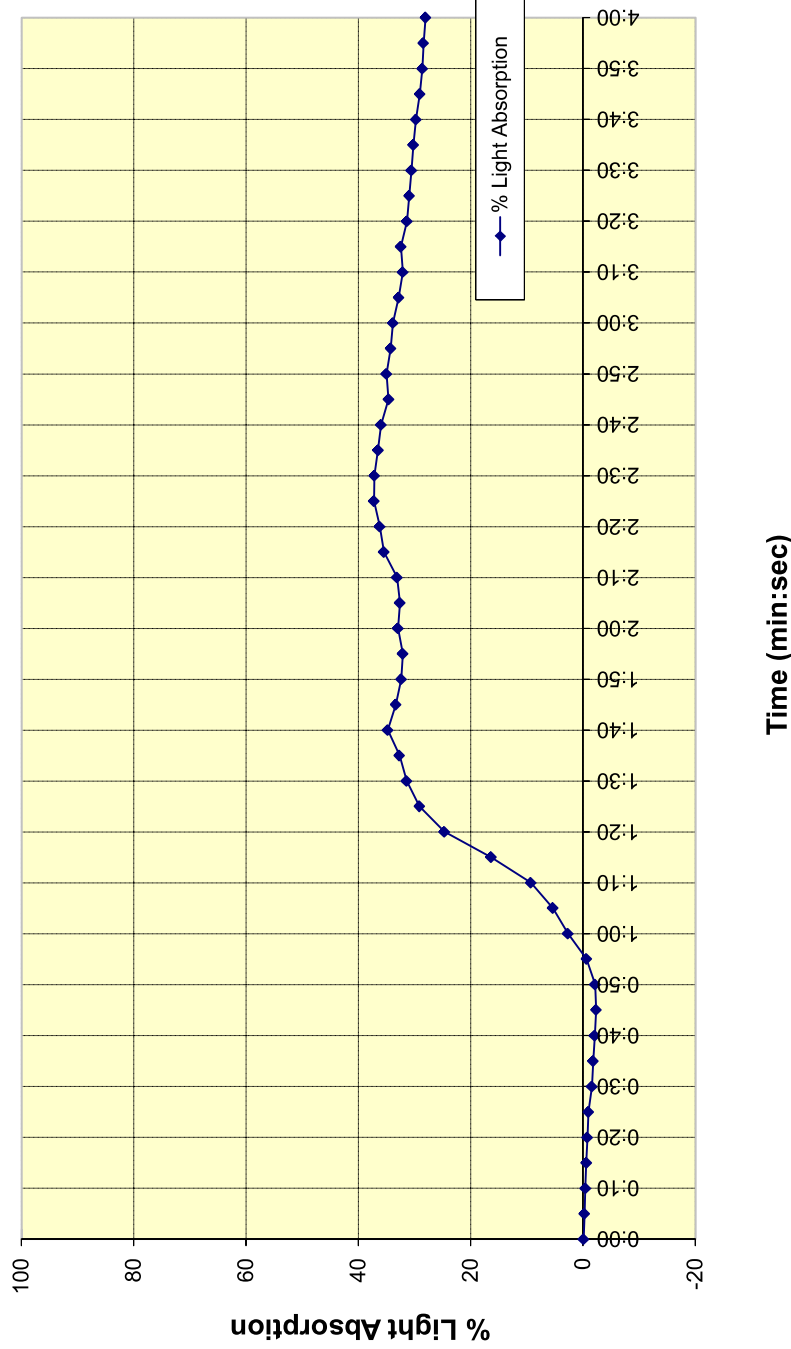
Exit Sign Chamber

ATI No.: D3964.01-106-31
 Test Date: 3/1/2014
 Technician: DMC

Time (min:sec)	% Light Absorption	% Light Absorption
0:00	100.07	-0.07
0:05	100.23	-0.23
0:10	100.37	-0.37
0:15	100.54	-0.54
0:20	100.72	-0.72
0:25	100.94	-0.94
0:30	101.54	-1.54
0:35	101.76	-1.76
0:40	102.06	-2.06
0:45	102.29	-2.29
0:50	102.11	-2.11
0:55	100.59	-0.59
1:00	97.27	2.73
1:05	94.58	5.42
1:10	90.69	9.31
1:15	83.57	16.43
1:20	75.28	24.72
1:25	70.84	29.16
1:30	68.53	31.47
1:35	67.28	32.72
1:40	65.18	34.82
1:45	66.63	33.37
1:50	67.59	32.41
1:55	67.88	32.12
2:00	67.02	32.98
2:05	67.37	32.63
2:10	66.84	33.16
2:15	64.51	35.49
2:20	63.75	36.25
2:25	62.72	37.28
2:30	62.82	37.18
2:35	63.45	36.55
2:40	63.98	36.02
2:45	65.33	34.67
2:50	64.95	35.05
2:55	65.73	34.27
3:00	66.13	33.87
3:05	67.12	32.88
3:10	67.85	32.15
3:15	67.51	32.49
3:20	68.61	31.39
3:25	69.00	31.00
3:30	69.41	30.59
3:35	69.76	30.24
3:40	70.20	29.80
3:45	70.89	29.11
3:50	71.37	28.63
3:55	71.56	28.44
4:00	71.91	28.09

Sample #	Manufacturer	Product Name	Material Type	Width (in)	Length (in)	Thickness (in)
1	Velux America Inc.	Dome	Acrylic	1.043	1.034	0.176

% Light Absorption Curve for Sample 1



Calibration	Resistance (kΩ)
100% Light	2.730

Plot Area 240 Maximum Smoke Density 37.28 %
 Area Under Curve 55.4 Smoke Density Rating* 23.1

* Note: Miami-Dade County requires the Smoke Density Rating to be less than 75.

Smoke Density Testing per ASTM D 2843

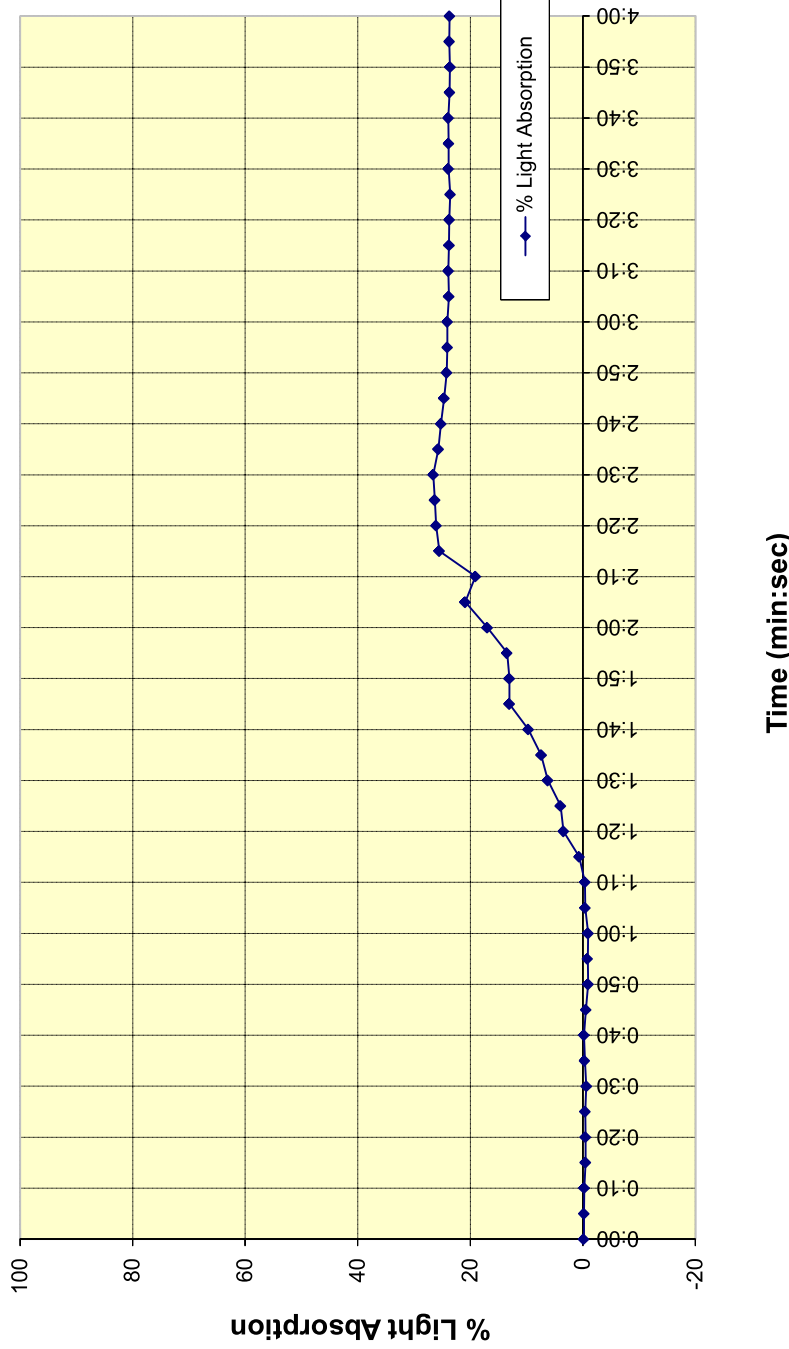
Exit Sign Chamber

ATI No.: D3964.01-106-31
 Test Date: 3/1/2014
 Technician: DMC

Time (min:sec)	% Light Absorption	% Light Absorption
0:00	100.14	-0.14
0:05	100.16	-0.16
0:10	100.24	-0.24
0:15	100.43	-0.43
0:20	100.43	-0.43
0:25	100.40	-0.40
0:30	100.59	-0.59
0:35	100.32	-0.32
0:40	100.17	-0.17
0:45	100.53	-0.53
0:50	100.88	-0.88
0:55	100.82	-0.82
1:00	100.89	-0.89
1:05	100.40	-0.40
1:10	100.36	-0.36
1:15	99.31	0.69
1:20	96.55	3.45
1:25	96.01	3.99
1:30	93.75	6.25
1:35	92.57	7.43
1:40	90.29	9.71
1:45	86.92	13.08
1:50	86.92	13.08
1:55	86.51	13.49
2:00	82.97	17.03
2:05	79.06	20.94
2:10	80.91	19.09
2:15	74.44	25.56
2:20	73.91	26.09
2:25	73.65	26.35
2:30	73.38	26.62
2:35	74.28	25.72
2:40	74.77	25.23
2:45	75.32	24.68
2:50	75.77	24.23
2:55	75.90	24.10
3:00	75.90	24.10
3:05	76.15	23.85
3:10	76.08	23.92
3:15	76.20	23.80
3:20	76.24	23.76
3:25	76.40	23.60
3:30	76.10	23.90
3:35	76.14	23.86
3:40	76.08	23.92
3:45	76.28	23.72
3:50	76.36	23.64
3:55	76.25	23.75
4:00	76.27	23.73

Sample #	Manufacturer	Product Name	Material Type	Width (in)	Length (in)	Thickness (in)
2	Velux America Inc.	Dome	Acrylic	1.042	1.016	0.179

% Light Absorption Curve for Sample 2



Calibration	Resistance (kΩ)
100% Light	2.390

Plot Area	240	Maximum Smoke Density	26.62 %
Area Under Curve	33.2	Smoke Density Rating*	13.8

* Note: Miami-Dade County requires the Smoke Density Rating to be less than 75.

Smoke Density Testing per ASTM D 2843

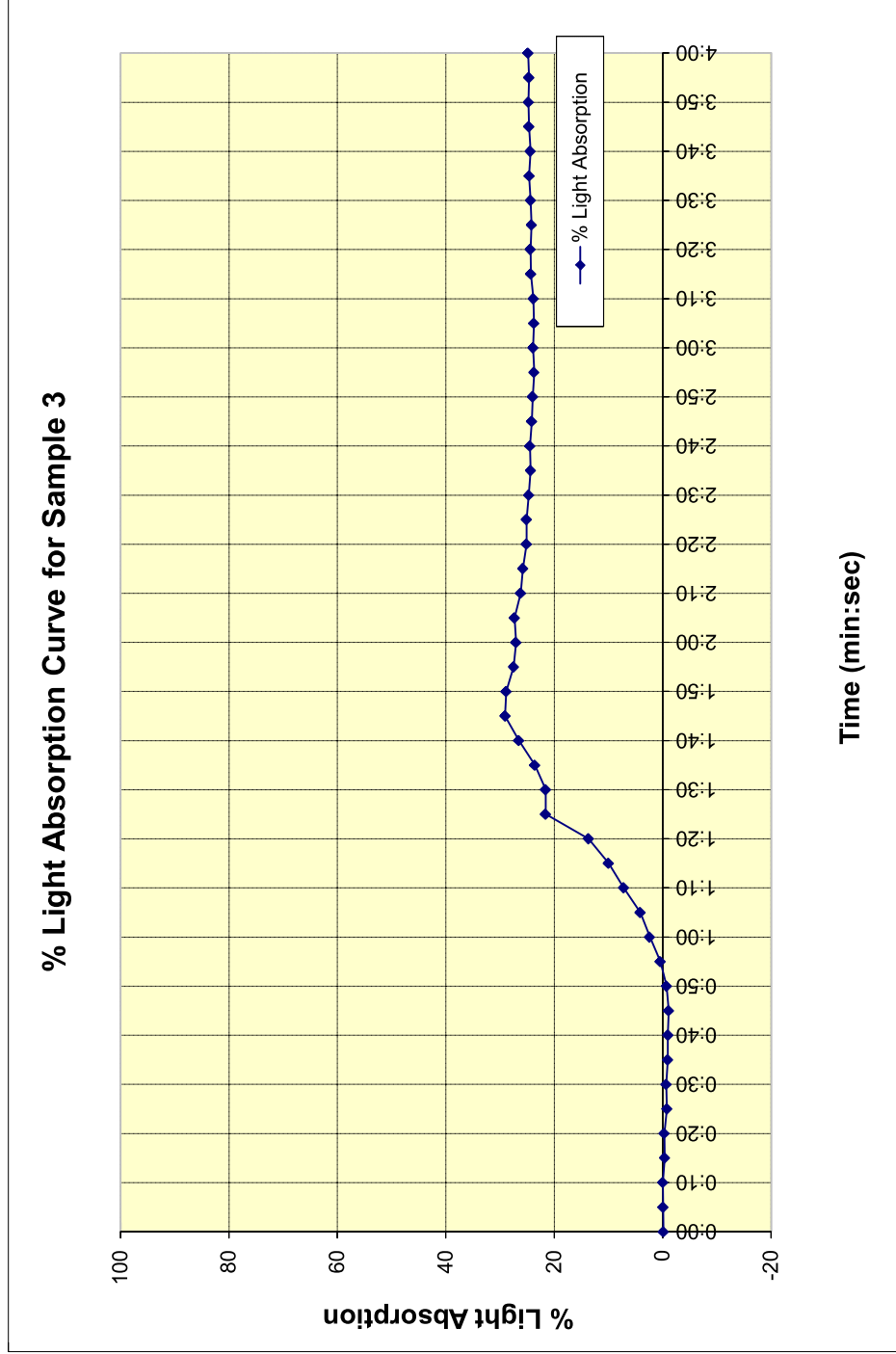
Exit Sign Chamber

ATI No.: D3964.01-106-31
 Test Date: 3/1/2014
 Technician: DMC

Time (min:sec)	% Light Absorption	% Light Absorption
0:00	100.09	-0.09
0:05	100.05	-0.05
0:10	99.99	0.01
0:15	100.32	-0.32
0:20	100.26	-0.26
0:25	100.75	-0.75
0:30	100.62	-0.62
0:35	100.90	-0.90
0:40	100.92	-0.92
0:45	101.07	-1.07
0:50	100.69	-0.69
0:55	99.55	0.45
1:00	97.59	2.41
1:05	95.84	4.16
1:10	92.78	7.22
1:15	89.97	10.03
1:20	86.32	13.68
1:25	78.37	21.63
1:30	78.37	21.63
1:35	76.39	23.61
1:40	73.45	26.55
1:45	70.91	29.09
1:50	71.09	28.91
1:55	72.49	27.51
2:00	72.94	27.06
2:05	72.63	27.37
2:10	73.77	26.23
2:15	74.19	25.81
2:20	74.86	25.14
2:25	74.86	25.14
2:30	75.28	24.72
2:35	75.61	24.39
2:40	75.50	24.50
2:45	75.80	24.20
2:50	76.00	24.00
2:55	76.27	23.73
3:00	76.08	23.92
3:05	76.21	23.79
3:10	76.12	23.88
3:15	75.64	24.36
3:20	75.59	24.41
3:25	75.77	24.23
3:30	75.60	24.40
3:35	75.35	24.65
3:40	75.59	24.41
3:45	75.33	24.67
3:50	75.23	24.77
3:55	75.31	24.69
4:00	75.13	24.87

Sample #	Manufacturer	Product Name	Material Type	Width (in)	Length (in)	Thickness (in)
3	Velux America Inc.	Dome	Acrylic	1.050	1.026	0.176

% Light Absorption Curve for Sample 3



Calibration	Resistance (kΩ)
100% Light	2.407

Plot Area	240	Maximum Smoke Density	29.09 %
Area Under Curve	41.6	Smoke Density Rating*	17.3

* Note: Miami-Dade County requires the Smoke Density Rating to be less than 75.

Smoke Density Testing per ASTM D 2843

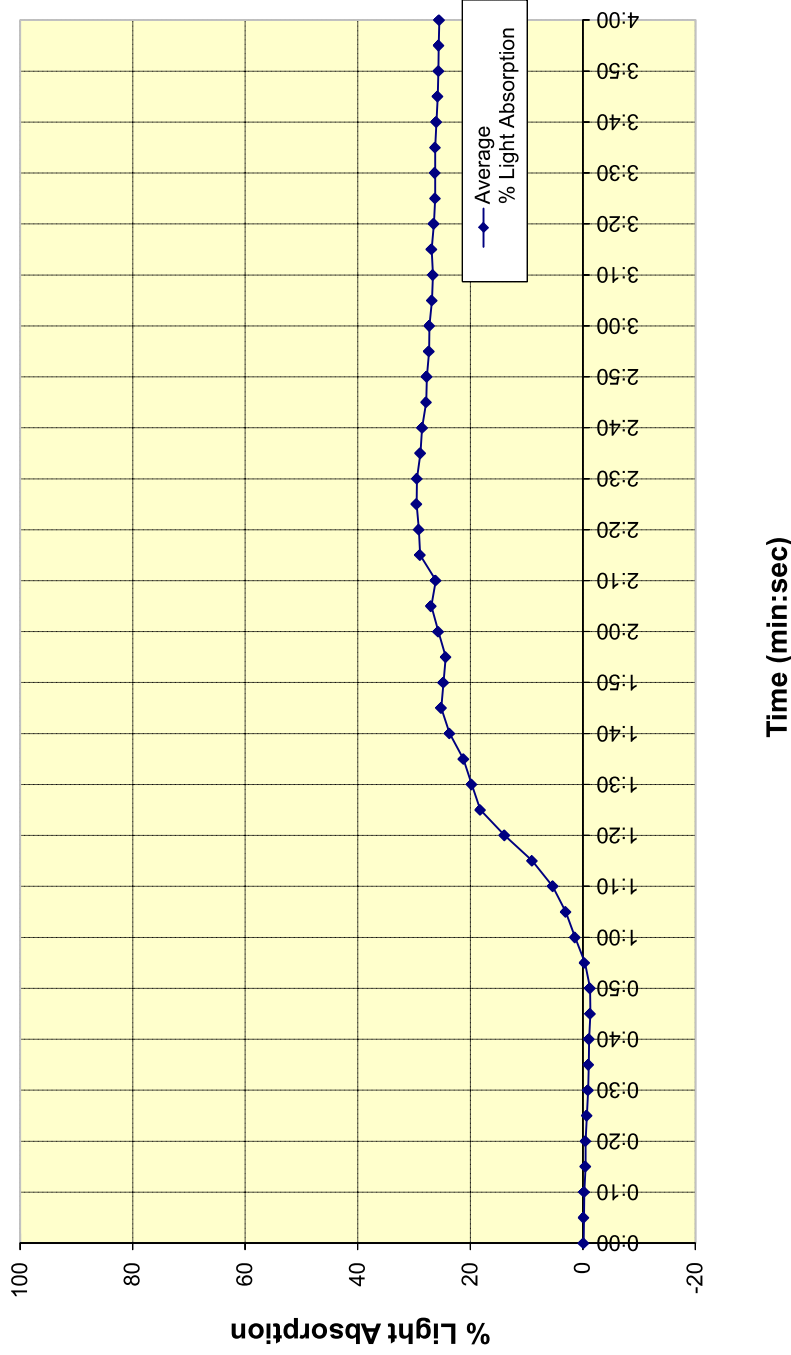
Exit Sign Chamber

ATI No.: D3964.01-106-31
 Test Date: 3/1/2014
 Technician: DMC

Time (min:sec)	Average % Light Absorption
0:00	-0.10
0:05	-0.14
0:10	-0.20
0:15	-0.43
0:20	-0.47
0:25	-0.70
0:30	-0.91
0:35	-0.99
0:40	-1.05
0:45	-1.30
0:50	-1.23
0:55	-0.32
1:00	1.42
1:05	3.06
1:10	5.39
1:15	9.05
1:20	13.95
1:25	18.26
1:30	19.78
1:35	21.25
1:40	23.69
1:45	25.18
1:50	24.80
1:55	24.38
2:00	25.69
2:05	26.98
2:10	26.16
2:15	28.95
2:20	29.16
2:25	29.59
2:30	29.51
2:35	28.89
2:40	28.58
2:45	27.85
2:50	27.76
2:55	27.36
3:00	27.30
3:05	26.84
3:10	26.65
3:15	26.88
3:20	26.52
3:25	26.28
3:30	26.29
3:35	26.25
3:40	26.04
3:45	25.83
3:50	25.68
3:55	25.63
4:00	25.56

Sample #	Manufacturer	Product Name	Material Type	Width (in)	Length (in)	Thickness (in)
AVERAGE	Velux America Inc.	Dome	Acrylic	1.045	1.025	0.177

Average % Light Absorption Curve



Calibration	Resistance (kΩ)
100% Light	2.730

Plot Area	240	Maximum Smoke Density	29.59 %
Area Under Curve	43.3	Smoke Density Rating*	18.0

* Note: Miami-Dade County requires the Smoke Density Rating to be less than 75.