

October 13, 2023

Rohit Joshi
Enduro Composites Inc.
16602 Central Green Blvd.
Houston, TX 77032

Report No.: 105594882SAT-001
Project No.: G105594882
Email: rjoshi@endurocomposites.com
Phone: (713) 358-4000

Subject: Compliance to ASTM E84-18b, *Standard Test Method for Surface Burning Characteristics of Building Materials*

Dear Mr. Joshi,

This letter is in response to your request to review three test reports of products tested to previous versions of ASTM E84 and to determine if the testing methods and results comply with ASTM E84-18b, *Standard Test Method for Surface Burning Characteristics of Building Materials*. The test reports under review are enclosed and are as follows:

- Southwest Research Institute Project No. 01.14430.01.018d, dated October 31, 2008 (ASTM E84-08a)
- Intertek Report No. 100300589SAT-001A, dated January 12, 2011 (ASTM E84-10)
- Intertek Report No. 102775700SAT-001A Rev.1, revision dated Nov. 20, 2017 (ASTM E84-16)

Intertek has reviewed the referenced reports and has verified that the test methods and test results comply with the 2018b revision of ASTM E84. The changes to the standard from the previously tested revisions to the requested 2018b revision did not affect how the product would be tested or the results.

Please contact us if there are any questions or comments.

Sincerely,

INTERTEK TESTING SERVICES NA INC

Reported by:



Juan Manuel Flores, P.E.
Chief Engineer

Reviewed by:



Ryan Ferry
Senior Project Engineer

Enclosures:

Southwest Research Institute Test Report, Project No. 01.14430.01.018d
Intertek Report Nos. 100300589SAT-001A and 102775700SAT-001A Rev.1

This evaluation is being conducted solely for the above referenced project. Due to the variables that exist from project to project and the fact that each evaluation requires review of the most current existing data and information, this evaluation is not to be used as justification for any other opinion nor used for any other project, without the express written consent of Intertek. This report should serve as Intertek's opinion regarding the use of the product in the conditions described herein. The materials used on the project, which are applied in compliance with Intertek Design Listings, must bear the Intertek Listing Mark. All certified products must be installed in accordance with the details contained in Intertek's *Directory of Listed Building Products*.





SOUTHWEST RESEARCH INSTITUTE®

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CHEMISTRY AND CHEMICAL ENGINEERING DIVISION
FIRE TECHNOLOGY DEPARTMENT
WWW.FIRE.SWRI.ORG
FAX (210) 522-3377



**INVESTIGATION OF THE SURFACE BURNING
CHARACTERISTICS OF A NOMINAL 0.06-IN.
THICK CORRUGATED EMBOSSED FIBER
REINFORCED PLASTIC (FRP) MATERIAL
MATERIAL ID: 4.2 X 1.06 SERIES 250**

FINAL REPORT
Consisting of 5 Pages
SwRI® Project No.: 01.14430.01.018d

Test Date: October 22, 2008
Report Date: October 31, 2008

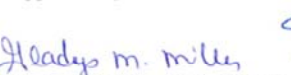
Prepared for:

ENDURO
16602 CENTRAL GREEN BLVD.
HOUSTON, TX 77032

Prepared by:


Anthony L. Saucedo
Group Leader
Material Flammability Section

Approved by:


Gladys M. Miller, M.S., M.B.A.
Assistant Director
Fire Technology Department

10/31/08
Reviewed by:


Barry L. Badders, Jr., P.E.
No. 61907, Florida

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INTRODUCTION

This report presents the test results for a specimen submitted by Enduro, located in Houston, TX, and tested at Southwest Research Institute's (SwRI's) Fire Technology Department, located in San Antonio, Texas. The test is conducted in accordance with the procedure outlined in ASTM E 84 - 08a, *Standard Test Method for Surface Burning Characteristics of Building Materials* (NFPA 255, ANSI/UL 723 and UBC 8-1).

This test method is applicable to exposed surfaces, such as ceilings or walls, provided that the material or assembly of materials, by its own structural quality or the manner in which it is tested and intended for use, is capable of supporting itself in position or being supported during the test period. The test is conducted with the material in the ceiling position.

The purpose of this test method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame Spread and Smoke Developed index are reported. However, there is not necessarily a relationship between these two measurements.

This standard should be used to measure and describe the response of materials, products, or assemblies to heat and flame under controlled conditions and should not be used to describe or appraise the fire-hazard or fire-risk of materials, products, or assemblies under actual fire conditions. However, results of the test may be used as elements of a fire-hazard assessment or a fire-risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard or fire risk of a particular end use.

Test specimens are conditioned as appropriate in an atmosphere maintained between 68 and 78 °F and 45 to 55% relative humidity. Immediately prior to the test, the specimen is mounted in the furnace with the side to be tested facing the test flame. Cement board is placed on the unexposed side of the specimen to protect the furnace lid assembly. Sometimes, because of the nature of the material undergoing testing, additional support (e.g. wire, wire and rods, rods, and/or bars) is used to ensure that the specimen will remain in position during the test. The use of supporting materials on the underside of the test specimen may lower the Flame Spread Index from that which might be obtained if the specimen could be tested without such support, and the test results do not necessarily relate to indices obtained by testing materials without such support.

The flame front position and light obscuration are recorded throughout the 10-minute test and used to calculate the Flame Spread and Smoke Developed indices. The temperature at 23 ft is also recorded. The Flame Spread and Smoke Developed indices reported herein are relative to the results obtained for mineral fiber-reinforced cement board and select grade red oak (moisture content between 6 and 8%). The mineral fiber-reinforced cement board is the calibration material used to obtain 0 values for Flame Spread and Smoke; red oak decks are used to obtain 100 values for Flame Spread and Smoke.

The results apply specifically to the specimens tested, in the manner tested, and not to the entire production of these or similar materials, nor to the performance when used in combination with other materials.

Two model building codes (2003 International Building Code®, Chapter 8 *Interior Finishes*, Section 803 *Wall and Ceiling Finishes*; NFPA 5000, Chapter 10 *Interior Finish*, Section 10.3 *Interior Wall or Ceiling Finish Testing and Classification*) classify materials based on the Flame Spread and Smoke Developed indices. For reference purposes, the classification criteria are listed below:

Classification	Flame Spread Index	Smoke Developed Index
A	0 – 25	0 – 450
B	26 – 75	0 – 450
C	76 – 200	0 – 450



ASTM E 84 – 08a REPORT

CLIENT: ENDURO
SWRI PROJECT NO.: 01.14430.01.018d
TEST DATE: OCTOBER 22, 2008
DAILY TEST NO.: 4

DESCRIPTION OF SPECIMEN

DATE RECEIVED:	October 10, 2008 (received ready-to-test)
MATERIAL ID:*	4.2 x 1.06 Series 250
TRADE NAME:*	Tuffspan
DESCRIPTION:*	Corrugated embossed fiber reinforced plastic (FRP) material
COMPOSITION:*	Fiber reinforced plastic
THICKNESS:	0.06-in. FRP (nominal) molded into a 1.0-in. corrugation (nominal)
COLOR:	Gray
SPECIMEN SIZE:	One panel, 23.25 in. wide × 288.0 in. long
CONDITIONING TIME:	5 days at 70 °F and 50% relative humidity
SUPPORT USED:	None
WITNESSED BY:	Mr. Doug Thomas, representing Enduro and Mr. Barry L. Badders (Professional Engineer, License No. 61907, registered in the State of Florida) of Southwest Research Institute
COMMENTS:	Test Notification Number from Miami-Dade County Florida for this test program is SWRI 08069

* From Client's material description and/or instructions



ASTM E 84 – 08a REPORT

CLIENT: ENDURO
SWRI PROJECT NO.: 01.14430.01.018d
TEST DATE: OCTOBER 22, 2008
DAILY TEST NO.: 4

TEST RESULTS

FLAME SPREAD INDEX (FSI): 20
SMOKE DEVELOPED INDEX (SDI): 250

TEST DATA

UNROUNDED FSI: 19.9
UNROUNDED SDI: 270.4
FS*TIME AREA (Ft*Min): 38.7
SMOKE AREA (%*Min): 231.8
FUEL AREA (°F*Min): 4358.9

OBSERVATIONS DURING TEST

IGNITION TIME (Min:Sec): 00:40
MAXIMUM FLAME FRONT ADVANCE (Ft.): 4.5
TIME TO MAXIMUM ADVANCE (Min:Sec): 2:21
MAXIMUM TEMP. AT EXPOSED TC (°F): 503
TIME TO MAXIMUM TEMP. (Min:Sec): 10:00
TOTAL FUEL BURNED (Cu. Ft.): 53.0
DRIPPING (Min:Sec): None
FLAMING ON FLOOR (Min:Sec): None
AFTERFLAME TOP (Min:Sec): None
AFTERFLAME FLOOR (Min:Sec): None
SAGGING (Min:Sec): 05:20
DELAMINATION (Min:Sec): None
SHRINKAGE (Min:Sec): None
FALLOUT (Min:Sec): None

CALIBRATION DATA

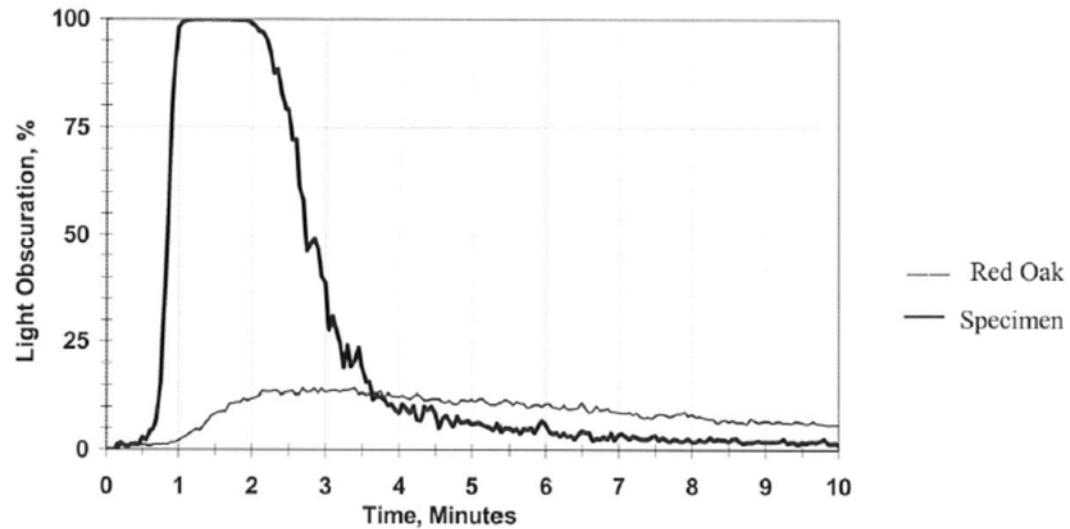
RED OAK SMOKE AREA (%*Min): 82.6
RED OAK FUEL AREA (°F*Min): 7883
GRC BOARD FUEL AREA (°F*Min): 5075



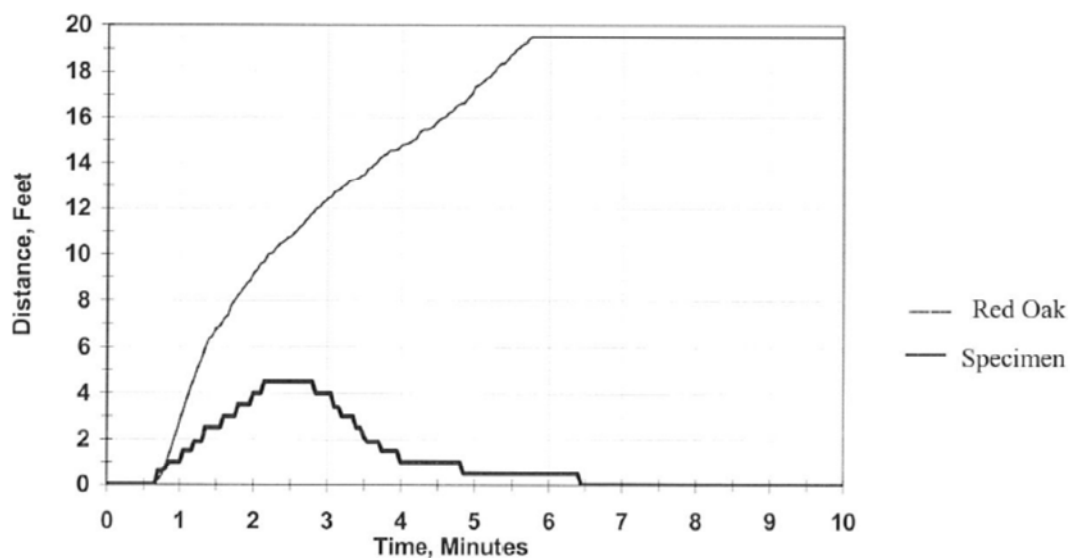
ASTM E 84 – 08a REPORT

CLIENT: ENDURO
SWRI PROJECT NO.: 01.14430.01.018d
TEST DATE: OCTOBER 22, 2008
DAILY TEST NO.: 4

LIGHT OBSCURATION



FLAMESPREAD





REPORT NUMBER: 100300589SAT-001A
ORIGINAL ISSUE DATE: January 12, 2011
REVISED DATE:

EVALUATION CENTER
Intertek Testing Services NA Inc.
16015 Shady Falls Road
Elmendorf, TX 78112

RENDERED TO

Enduro Systems, Inc.
16602 Central Green Blvd.
Houston, TX 77032

TEST REPORT

Report of Testing "TUFFSPAN 7.2 x 1.5 SERIES 250" for compliance with the applicable requirements of the following criteria: ASTM E84-10 TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS (UL 723, UBC 8-1, NFPA 255)



Project No. 100300589SAT-001A
Enduro Systems, Inc.

January 12, 2011
Page 2 of 9

ABSTRACT

Specimen I. D. "TUFFSPAN 7.2 x 1.5 SERIES 250"

Test Standard: ASTM E84-10 TEST FOR SURFACE BURNING
CHARACTERISTICS OF BUILDING MATERIALS (UL
723, UBC 8-1, NFPA 255)

Test Date: January 6, 2011

Client: Enduro Systems, Inc.

Test Results:

FLAME SPREAD INDEX	25
SMOKE DEVELOPED INDEX	400

Darrell R. Gonzales

Darrell Gonzales
Tunnel Operator

Date: January 12, 2011

Reviewed and Approved:

Servando Romo

Servando Romo
Project Manager

Date: January 12, 2011

Reviewed and approved:

Rick Curkeet

Rick Curkeet, P.E.
Chief Engineer, Building Products
Florida P.E. #60450

Date: January 12, 2011





Project No. 100300589SAT-001A
Enduro Systems, Inc.

January 12, 2011
Page 3 of 9

I. INTRODUCTION

This report describes the results of the ASTM E84 TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS a method for determining the comparative surface burning behavior of building materials. This test is applicable to exposed surfaces, such as ceilings or walls, provided that the material or assembly of materials, by its own structural quality or the manner in which it is tested and intended for use, is capable of supporting itself in position or being supported during the test period.

The purpose of the method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame spread and smoke density developed are reported, however, there is not necessarily a relationship between these two measurements.

"The use of supporting materials on the underside of the test specimen may lower the flame spread index from that which might be obtained if the specimen could be tested without such support... This method may not be appropriate for obtaining comparative surface burning behavior of some cellular plastic materials... Testing of materials that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed, results in low flame spread indices that do not relate directly to indices obtained by testing materials that remain in place."

This test method is also published under the following designations:

NFPA 255
UL 723
UBC 8-1

This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.



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Enduro Systems, Inc.

January 12, 2011
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II. PURPOSE

The ASTM E84 (25 foot tunnel) test method is intended to compare the surface flame spread and smoke developed measurements to those obtained from tests of mineral fiber cement board and select grade red oak flooring. The test specimen surface (18 inches wide and 24 feet long) is exposed to a flaming fire exposure during the 10 minute test duration, while flame spread over its surface and density of the resulting smoke are measured and recorded. Test results are presented as the computed comparisons to the standard calibration materials.

The furnace is considered under calibration when a 10 minute test of red oak decking will pass flame out the end of the tunnel in five minutes, 30 seconds, plus or minus 15 seconds. Mineral fiber cement board forms the zero point for both flame spread and smoke developed indexes, while the red oak flooring smoke developed index is set as 100.

III. TEST PROCEDURE

The tests were conducted in accordance with the procedures outlined in the ASTM E84. The specimens are placed directly on the tunnel ledges. As required by the standard, one or more layers of 0.25 inch thick reinforced concrete board are placed on top of the test sample between the sample and the tunnel lid. After the test, the samples are removed from the tunnel, examined and disposed of.

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Enduro Systems, Inc.

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V. DESCRIPTION OF TEST SPECIMENS

Date Received:	12/29/2010
Date placed in the conditioning room:	12/29/2010
Conditioning (73°F & 50% R.H.):	8 days
Specimen Width (in):	23.50
Specimen Length (ft):	24
Specimen Thickness (in):	0.07
Material Weight:	N/A
Total Specimen Weight (lbs):	33
Adhesive or coating application rate:	N/A

Mounting Method:

The specimen was self-supporting. The textured side was exposed to the flames.

Specimen Description:

The specimen consisted of (2) 12-ft. long x 23.50-in. wide x 0.07-in. thick fiberglass roofing material.

The product was received by our personnel in good condition.



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Enduro Systems, Inc.

January 12, 2011
Page 6 of 9

VI. TEST RESULTS & OBSERVATIONS

The test results, computed on the basis of observed flame front advance and electronic smoke density measurements are presented in the following table.

Test Specimen	Flame Spread Index	Smoke Developed Index
"TUFFSPAN 7.2 x 1.5 SERIES 250"	25	400

The data sheets are included in Appendix A. These sheets are actual print-outs of the computerized data system which monitors the tunnel furnace, and contain all calibration and specimen data needed to calculate the test results.

VII. OBSERVATIONS

During the test, the specimen was observed to behave in the following manner.

Time (min:sec)	Observations
0:18	Cracking was observed.
0:24	A steady ignition was observed.
0:31	Blistering was observed.
1:17	The specimen begins to sag.

After the test, the specimen was observed to be damaged as follows:

Distance (FEET)	Damage Descriptions
0 - 6	The specimen was observed to be heavily charred.
6 - 12	The specimen was observed to be lightly charred.
12 - 16	The specimen was observed to show light heat damage.
16 - 24	Discoloration was observed.



Enduro Composites Inc.
October 13, 2023

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Enduro Systems, Inc.

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APPENDIX A

ASTM E84 DATA SHEETS



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Enduro Systems, Inc.

January 12, 2011
Page 8 of 9

TEST RESULTS

FLAMESPREAD INDEX: 25

SMOKE DEVELOPED INDEX: 400

SPECIMEN DATA . . .

Time to Ignition (sec): 24
Time to Max FS (sec): 111
Maximum FS (feet): 5.2
Time to 980 F (sec): Never Reached
Time to End of Tunnel (sec): Never Reached
Max Temperature (F): 489
Time to Max Temperature (sec): 600
Total Fuel Burned (cubic feet): 53.34

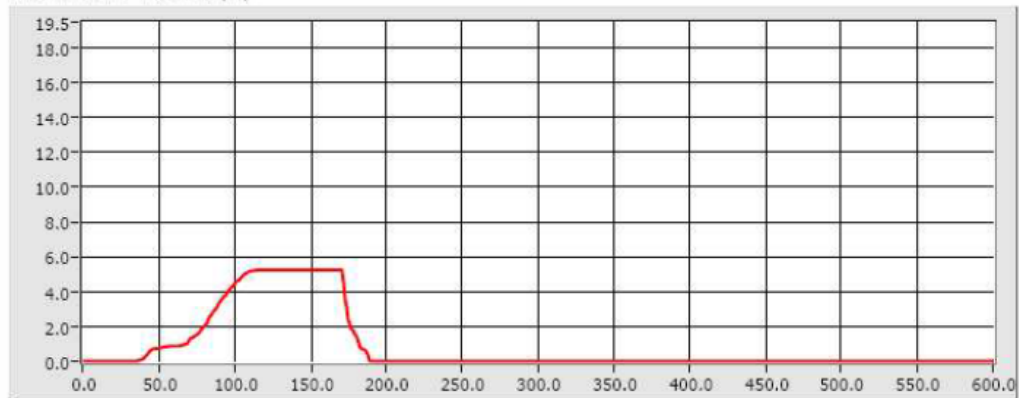
FS*Time Area (ft*min): 45.5
Smoke Area (%A*min): 419.4
Unrounded FSI: 23.4



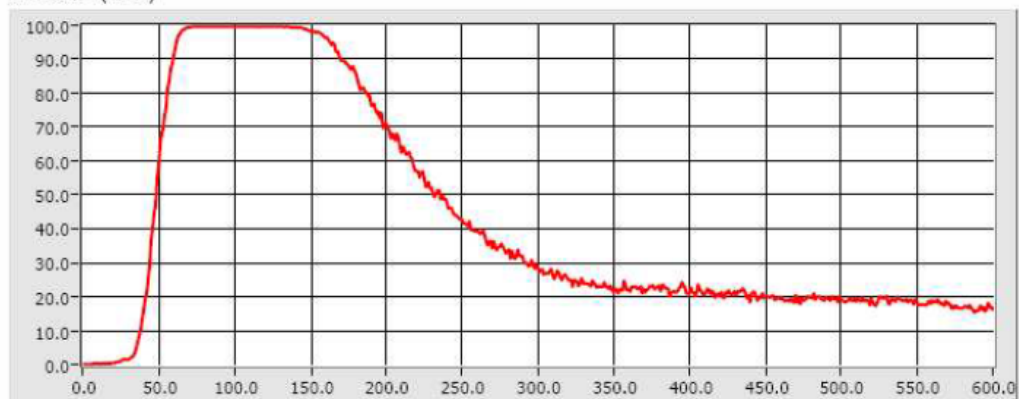
Project No. 100300589SAT-001A
Enduro Systems, Inc.

January 12, 2011
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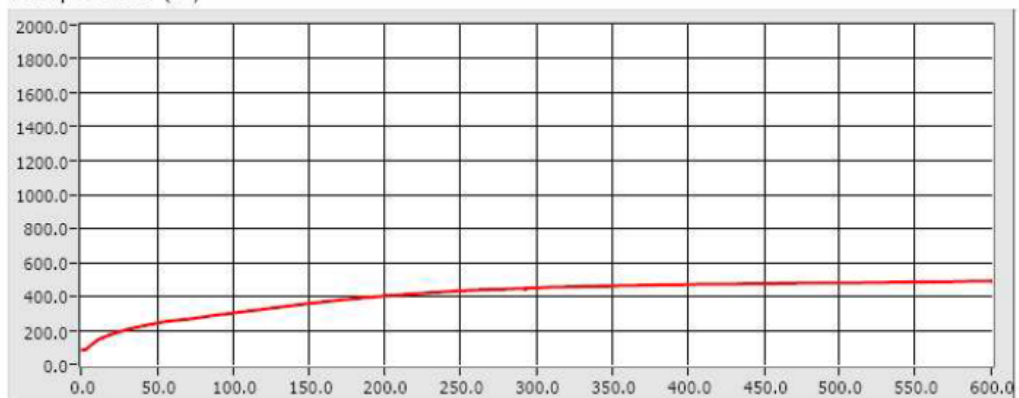
FLAME SPREAD (ft)



Smoke (%A)



Temperature (°F)



Time (sec)

600



REPORT NUMBER: 102775700SAT-001A Rev. 1
ORIGINAL ISSUE DATE: November 7, 2016
REVISED DATE: November 20, 2017

EVALUATION CENTER
Intertek Testing Services NA Inc.
16015 Shady Falls Road
Elmendorf, TX 78112

RENDERED TO

Enduro Composites Inc.
16602 Central Green Blvd
Houston, TX 77032

TEST REPORT

Report of Testing "LC2-150" for compliance with the applicable requirements of the following criteria: ASTM E84-16 TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS (UL 723, UBC 8-1, NFPA 255)



Project No. 102775700SAT-001A Rev. 1
Enduro Composites Inc.

November 20, 2017
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ABSTRACT

Specimen I. D. "LC2-150"

Test Standard: ASTM E84-16 TEST FOR SURFACE BURNING
CHARACTERISTICS OF BUILDING MATERIALS (UL
723, UBC 8-1, NFPA 255)

Test Date: November 1, 2016

Client: Enduro Composites Inc.

Test Results:

FLAME SPREAD INDEX	60
SMOKE DEVELOPED INDEX	300

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Darrell Gonzales
Technician II

Reviewed and approved:

Servando Romo
Project Engineer

Intertek



Project No. 102775700SAT-001A Rev. 1
Enduro Composites Inc.

November 20, 2017
Page 3 of 9

I. INTRODUCTION

This report describes the results of the ASTM E84-16 TEST FOR SURFACE BURNING CHARACTERISTICS OF BUILDING MATERIALS a method for determining the comparative surface burning behavior of building materials. This test is applicable to exposed surfaces, such as ceilings or walls, provided that the material or assembly of materials, by its own structural quality or the manner in which it is tested and intended for use, is capable of supporting itself in position or being supported during the test period.

The purpose of the method is to determine the relative burning behavior of the material by observing the flame spread along the specimen. Flame spread and smoke density developed are reported, however, there is not necessarily a relationship between these two measurements.

"The use of supporting materials on the underside of the test specimen may lower the flame spread index from that which might be obtained if the specimen could be tested without such support... This method may not be appropriate for obtaining comparative surface burning behavior of some cellular plastic materials... Testing of materials that melt, drip, or delaminate to such a degree that the continuity of the flame front is destroyed, results in low flame spread indices that do not relate directly to indices obtained by testing materials that remain in place."

This test method is also published under the following designations:

NFPA 255
UL 723
UBC 8-1

This standard should be used to measure and describe the properties of materials, products, or assemblies in response to heat and flame under controlled laboratory conditions and should not be used to describe or appraise the fire hazard or fire risk of materials, products, or assemblies under actual fire conditions. However, results of this test may be used as elements of a fire risk assessment which takes into account all of the factors which are pertinent to an assessment of the fire hazard of a particular end use.



Project No. 102775700SAT-001A Rev. 1
Enduro Composites Inc.

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II. PURPOSE

The ASTM E84 (25 foot tunnel) test method is intended to compare the surface flame spread and smoke developed measurements to those obtained from tests of fiber cement board and select grade red oak flooring. The test specimen surface (18 inches wide and 24 feet long) is exposed to a flaming fire exposure during the 10 minute test duration, while flame spread over its surface and density of the resulting smoke are measured and recorded. Test results are presented as the computed comparisons to the standard calibration materials.

The furnace is considered under calibration when a 10 minute test of red oak decking will pass flame out the end of the tunnel in five minutes, 30 seconds, plus or minus 15 seconds. The fiber cement board which complies with Annex A3 of the ASTM E 84 standard forms the zero point for both flame spread and smoke developed indexes, while the red oak flooring smoke developed index is set as 100.

III. TEST PROCEDURE

The tests were conducted in accordance with the procedures outlined in the ASTM E84. The specimens are placed directly on the tunnel ledges. As required by the standard, one or more layers of 0.25 inch thick reinforced concrete board are placed on top of the test sample between the sample and the tunnel lid. After the test, the samples are removed from the tunnel, examined and disposed of.

IV. REVISION SUMMARY

	SUMMARY
<i>Darrell Gonzales</i> Darrell Gonzales	1) Changed sample ID 2) Updated report to Rev 1.
<i>Servando Romo</i> Servando Romo	
<i>[Signature]</i> November 20, 2017	





Project No. 102775700SAT-001A Rev. 1
Enduro Composites Inc.

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V. DESCRIPTION OF TEST SPECIMENS

Date Received:	10/17/16
Date placed in the conditioning room:	10/17/16
Conditioning (73°F & 50% R.H.):	14 days
Specimen Width (in):	24
Specimen Length (ft):	24
Specimen Thickness (in):	0.06
Material Weight (lbs):	23

Specimen Description:

The specimen was described by the client as "Panel".

The 24-ft. long test specimen consisted of two 10-ft. and one 4-ft. long corrugated plastic panels.

The product was received by our personnel in good condition and given an identification number of SAT1610171313-001.

Mounting Method:

The specimen was supported with 0.25-in. diameter metal rods spaced every two feet apart. The finished side was exposed to the flames.



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Enduro Composites Inc.

November 20, 2017
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VI. TEST RESULTS & OBSERVATIONS

The test results, computed on the basis of observed flame front advance and electronic smoke density measurements are presented in the following table.

Test Specimen	Flame Spread Index	Smoke Developed Index
"LC2-150"	60	300

The data sheets are included in Appendix A. These sheets are actual print-outs of the computerized data system which monitors the tunnel furnace, and contain all calibration and specimen data needed to calculate the test results.

VII. OBSERVATIONS

During the test, the specimen was observed to behave in the following manner.

Time (min:sec)	Observations
0:00	The test burners were turned on.
0:28	Transient ignition was observed.
0:34	Steady ignition was observed.
0:59	Flaking was observed.
8:02	Strands of the material began to fall.
10:00	The test burners were shut off.

After the test, the specimen was observed to be damaged as follows:

Distance (FEET)	Damage Descriptions
0 - 10	The sample was heavily charred.
10 - 24	The sample was heavily discolored and covered with soot.



Project No. 102775700SAT-001A Rev. 1
Enduro Composites Inc.

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APPENDIX A

ASTM E84 DATA SHEETS



Project No. 102775700SAT-001A Rev. 1
Enduro Composites Inc.

November 20, 2017
Page 8 of 9

TEST RESULTS

FLAMESPREAD INDEX: 60

SMOKE DEVELOPED INDEX: 300

SPECIMEN DATA . . .

Time to Ignition (sec): 34
Time to Max FS (sec): 134
Maximum FS (feet): 13.0
Time to 980 F (sec): Never Reached
Time to End of Tunnel (sec): Never Reached
Max Temperature (F): 658
Time to Max Temperature (sec): 171
Total Fuel Burned (cubic feet): 48.98

FS*Time Area (ft*min): 110.6
Smoke Area (%A*min): 202.9
Unrounded FSI: 58.1

CALIBRATION DATA . . .

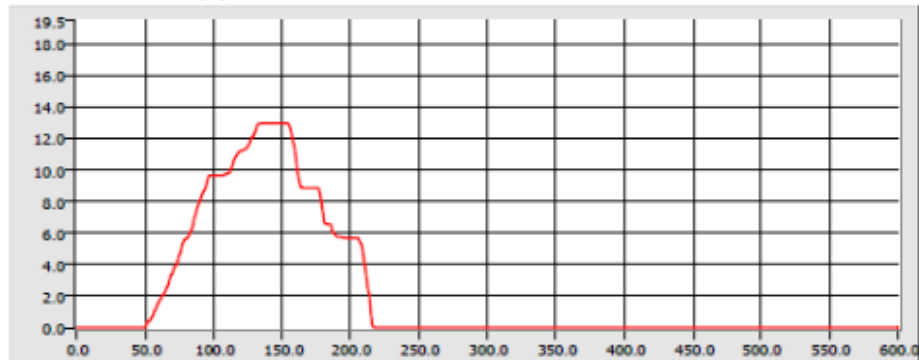
Time to Ignition of Last Red Oak (Sec): 42.0
Red Oak Smoke Area (%A*min): 65.0



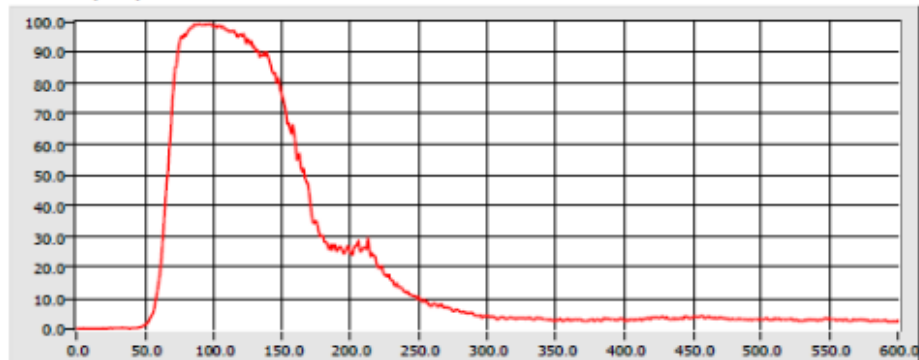
Project No. 102775700SAT-001A Rev. 1
Enduro Composites Inc.

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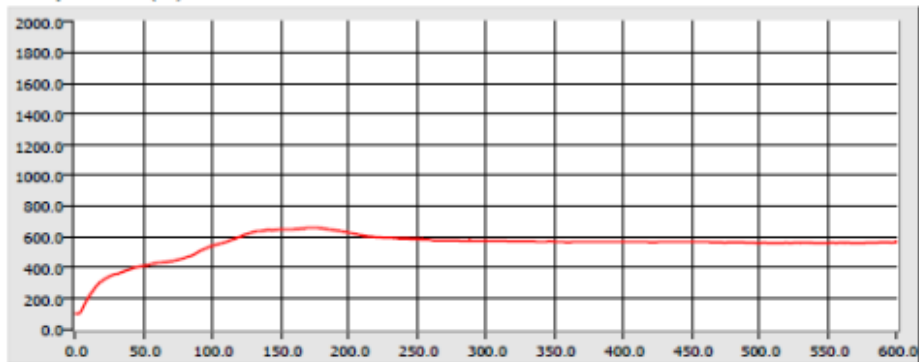
FLAME SPREAD (ft)



Smoke (%A)



Temperature (F)



Time (sec)

600