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SMART GLASS GROUP
TEST REPORT

SCOPE OF WORK
ASTM E1354, *STANDARD TEST METHOD FOR HEAT AND VISIBLE SMOKE RELEASE RATES FOR MATERIALS AND PRODUCTS USING AN OXYGEN CONSUMPTION CALORIMETER IN ACCIDENCE WITH NFPA 130 SECTION A.8.4.1.10*, ON PRIWATT™ FILM

REPORT NUMBER
104317617MID-003REV1

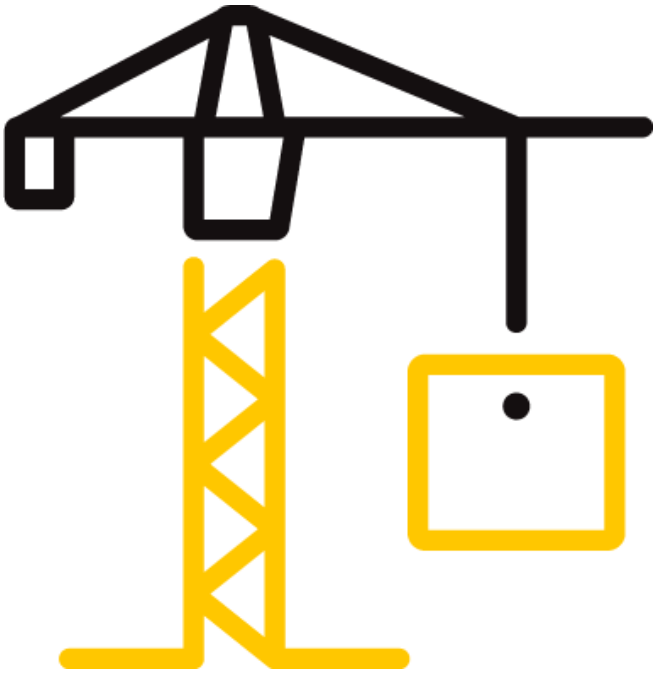
TEST DATE(S)
04/23/20

ISSUE DATE
04/23/20

REVISION DATE
09/08/20

PAGES
12

DOCUMENT CONTROL NUMBER
GFT-OP-10c (AUGUST 27, 2018)



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TEST REPORT FOR SMART GLASS GROUP
Report No.: 104317617MID-003REV1
Date: 09/08/20

REPORT ISSUED TO

SMART GLASS GROUP
7250 Keele Street Unit 93
Concord, ON L4K128
Canada

SECTION 1

SCOPE

Intertek Building & Construction (B&C) was contracted by Smart Glass Group to perform testing in accordance with ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, on their PriWatt™ Film . Results obtained are tested values and were secured by using the designated test method. Testing was conducted at Intertek test facility in Middleton, WI.

This report does not constitute certification of this product nor an opinion or endorsement by this laboratory. Intertek B&C will service this report for the entire test record retention period. The test record retention period ends four years after the test date. Test records, such as detailed drawings, datasheets, representative samples of test specimens, or other pertinent project documentation, will be retained for the entire test record retention period.

For INTERTEK B&C:

COMPLETED BY:	Bryan Bowman	**REVIEWED BY:**	Mark Crawford
TITLE:	Chemist	**TITLE:**	Engineering Team Lead
SIGNATURE:		**SIGNATURE:**	
DATE:	09/08/20	**DATE:**	09/09/20

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SECTION 2

TEST METHOD(S)

The specimens were evaluated in accordance with the following:

ASTM E1354-17, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter,* ASTM International.

NFPA 130-2017, *Standard for Fixed Guideway Transit and Passenger Rail Systems 2017, Section 8.4 Flammability and Smoke Emission*

Section A.8.4.1.10 :

"If the surface area of any individual small part is less than 100 cm^2 (16 $in.^2$) in end use configuration, materials used to fabricate such a part should be permitted to be tested in accordance with ASTM E1354 as an alternative to both the ASTM E162 flammability test procedure or the appropriate flammability test procedure otherwise specified in Table 8.4.1 and the ASTM E662 smoke generation test procedure. Testing should be at 50 kW/m2 (4.4 Btu/sec·ft^2) applied heat flux in the horizontal orientation with a retainer frame. Materials tested in accordance with ASTM E1354 should meet the performance criteria of a 180-second average heat release rate of q"180 < 100 kW/m^2 (8.8 Btu/sec·ft^2) and test average smoke extinction area of (F f) < 500 m^2/kg (2441.2 ft2/lb)."

SECTION 3

MATERIAL SOURCE

Test samples were provided by the client. Samples were received at the Evaluation Center on March 23, 2020 in good condition. Sample ID is MID2003230650-001.

SECTION 4

EQUIPMENT

EQUIPMENT			
DESCRIPTION - ASSET #:	Cone Calorimeter - 1199	**VBU:**	4/23/2020
DESCRIPTION - ASSET #:	Scale - 1482	**CALIBRATION DUE:**	4/7/2021
DESCRIPTION - ASSET #:	Balance - 1396	**CALIBRATION DUE:**	4/7/2021
DESCRIPTION - ASSET #:	Caliper - 1062	**CALIBRATION DUE:**	7/9/2020
DESCRIPTION - ASSET #:	Room Temp/Humidity -1451	**CALIBRATION DUE:**	12/12/2020
DESCRIPTION - ASSET #:	Conditioning Chamber - 1450	**CALIBRATION DUE:**	12/12/2020

SECTION 5

TEST PROCEDURE

The cone calorimeter test was run as written in ASTM E1354 section 11 – Procedure.

SECTION 6

TEST CALCULATIONS

The cone calorimeter calculations were performed as written in ASTM E1354 section 13 – Calculations.

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SECTION 7
TEST SPECIMEN DESCRIPTION

PriWatt™ Film is a PDLC Film (Polymer Dispersed Liquid Crystals) that is semitransparent material 0.59 mm thick. The specimens were cut to size by the client. The front and back protective coatings were removed. The sample was applied to 11.9 mm glass provide by the client with the tacky surface facing away from the heat source. Specimens were conditioned to moisture equilibrium (constant mass) at an ambient temperature of 23 ± 3°C and a relative humidity of 50 ± 5%.

SECTION 8
TEST RESULTS

Specimen information

E	13.1 MJ/kg	Specimen number	1	Conditioned?	Yes
Thickness	12.4 mm	Nominal duct flow rate	24 l/s	Temperature	23°C
Initial mass	306.1 g	Edge frame used?	Yes	RH	50%
Surface area	88.4 cm²	Grid used?	No		
Heat flux	50 kW/m²	Fixed to substrate?	Yes		
Separation	25 mm	Substrate	Glass		
Orientation	Horizontal	Manufacturer			
		Sponsor			

Test		**Pre-test conditions**		**Test times**	
Standard used	ASTM E1354	Ambient temperature	20°C	Time to ignition	47 s
Date of test	23/04/2020	Ambient pressure	98.148 kPa	Time to flameout	359 s
Time of test	11:02	Relative humidity	25%	End of test criterion	User entered
Date of report	23/04/2020			End of test time (for calculations)	479 s
Apparatus specifications		**Initial conditions**		**Heat Release Results**	
C-factor	0.04062	Baseline ambient oxygen	20.831%	THR (0-300)	10.47 MJ/m²
Duct diameter	0.114 m	Baseline oxygen	20.956%	THR (0-600)	-
O2 delay time	15 s	Baseline carbon dioxide	0.0497%	THR (0-1200)	-
CO2 delay time	15 s	Mass at sustained flaming	306.2 g	Fuel load	0.33 MJ/kg
CO delay time	15 s				
OD corr. factor	1.0000				

Test results (between 47 and 479 s)

			Mean	Peak	at time (s)
Total heat release	11.4 MJ/m²	Heat release rate (kW/m²)	26.27	197.47	61
Total oxygen consumed	7.6 g	Effective heat of comb. (MJ/kg)	18.43	77.59	366
Mass lost	5.4 g	Mass loss rate (g/s)	0.013	0.206	130
Average specific MLR	2.04 g/(s·m²)	Specific extinction area (m²/kg)	411.13	4655.57	467
Total smoke release	253.1 m²/m²	Carbon monoxide yield (kg/kg)	0.0640	40.2841	245
Total smoke production	2.2 m²	Carbon dioxide yield (kg/kg)	1.62	1284.62	245
MAHRE	66.0 kW/m²				

Test averages

from ignition to ignition plus...	1 min	2 min	3 min	4 min	5 min	6 min	0 s - 576 s	0 s - 576 s
Heat release rate (kW/m²)	113.16	71.68	50.68	42.16	36.33	30.99	20.50	20.50
Effective heat of comb. (MJ/kg)	18.99	18.03	18.92	18.80	18.73	18.74	18.67	18.67
Mass loss rate (g/s)	0.053	0.034	0.024	0.020	0.017	0.015	0.010	0.010
Specific extinction area (m²/kg)	443.12	372.18	412.43	394.20	381.82	396.93	441.78	441.78
Carbon monoxide yield (kg/kg)	0.0401	0.0374	0.0421	0.0451	0.0500	0.0560	0.0787	0.0787
Carbon dioxide yield (kg/kg)	1.73	1.61	1.70	1.68	1.67	1.66	1.63	1.63

Smoke results

Total smoke release: non-flaming phase (0 s - 47 s)	1.9 m²/m²
Total smoke release: flaming phase (47 s - 479 s)	253.1 m²/m²
Total smoke release: whole test (0 s - 479 s)	255.0 m²/m²

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Specimen information

E	13.1 MJ/kg	Specimen number	2	Conditioned?	Yes
Thickness	12.4 mm	Nominal duct flow rate	24 l/s	Temperature	23°C
Initial mass	305.63 g	Edge frame used?	Yes	RH	50%
Surface area	88.4 cm²	Grid used?	No		
Heat flux	50 kW/m²	Fixed to substrate?	Yes		
Separation	25 mm	Substrate	Glass		
Orientation	Horizontal	Manufacturer			
		Sponsor			

Test

Standard used	ASTM E1354
Date of test	23/04/2020
Time of test	11:20
Date of report	23/04/2020

Apparatus specifications

C-factor	0.04062
Duct diameter	0.114 m
O2 delay time	15 s
CO2 delay time	15 s
CO delay time	15 s
OD corr. factor	1.0000

Pre-test conditions

Ambient temperature	20°C
Ambient pressure	98.15 kPa
Relative humidity	25%

Initial conditions

Baseline ambient oxygen	20.828%
Baseline oxygen	20.954%
Baseline carbon dioxide	0.0455%
Mass at sustained flaming	305.8 g

Test times

Time to ignition	46 s
Time to flameout	331 s
End of test criterion	User entered
End of test time (for calculations)	451 s

Heat Release Results

THR (0-300)	10.30 MJ/m²
THR (0-600)	-
THR (0-1200)	-
Fuel load	0.32 MJ/kg

Test results (between 46 and 451 s)

Total heat release	10.9 MJ/m²
Total oxygen consumed	7.4 g
Mass lost	5.6 g
Average specific MLR	3.13 g/(s·m²)
Total smoke release	305.1 m²/m²
Total smoke production	2.7 m²
MAHRE	60.1 kW/m²

	Mean	Peak	at time (s)
Heat release rate (kW/m²)	26.91	180.54	62
Effective heat of comb. (MJ/kg)	17.19	75.12	214
Mass loss rate (g/s)	0.014	0.237	74
Specific extinction area (m²/kg)	481.31	4612.57	119
Carbon monoxide yield (kg/kg)	0.0685	60.0814	255
Carbon dioxide yield (kg/kg)	1.56	1236.54	255

Test averages

from ignition to ignition plus...	1 min	2 min	3 min	4 min	5 min	6 min	0 s - 469 s	0 s - 469 s
Heat release rate (kW/m²)	105.88	73.35	52.49	42.22	35.14	29.79	23.32	23.32
Effective heat of comb. (MJ/kg)	17.16	17.00	17.13	16.97	16.78	16.94	17.58	17.58
Mass loss rate (g/s)	0.054	0.038	0.027	0.022	0.018	0.015	0.012	0.012
Specific extinction area (m²/kg)	567.69	503.24	481.09	455.52	448.22	463.50	501.72	501.72
Carbon monoxide yield (kg/kg)	0.0386	0.0368	0.0405	0.0452	0.0515	0.0607	0.0735	0.0735
Carbon dioxide yield (kg/kg)	1.57	1.56	1.57	1.57	1.54	1.55	1.61	1.61

Smoke results

Total smoke release: non-flaming phase (0 s - 46 s)	2.0 m²/m²
Total smoke release: flaming phase (46 s - 451 s)	305.1 m²/m²
Total smoke release: whole test (0 s - 451 s)	307.1 m²/m²

The test results relate to the behaviour of the test specimens of a product under the particular conditions of the test; they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use.

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Specimen information

E	13.1 MJ/kg	Specimen number	3	Conditioned?	Yes
Thickness	12.4 mm	Nominal duct flow rate	24 l/s	Temperature	23°C
Initial mass	305.68 g	Edge frame used?	Yes	RH	50%
Surface area	88.4 cm²	Grid used?	No		
Heat flux	50 kW/m²	Fixed to substrate?	Yes		
Separation	25 mm	Substrate	Glass		
Orientation	Horizontal	Manufacturer			
		Sponsor			

Test

Standard used	ASTM E1354
Date of test	23/04/2020
Time of test	11:33
Date of report	23/04/2020

Apparatus specifications

C-factor	0.04062
Duct diameter	0.114 m
O2 delay time	15 s
CO2 delay time	15 s
CO delay time	15 s
OD corr. factor	1.0000

Pre-test conditions

Ambient temperature	20°C
Ambient pressure	98.113 kPa
Relative humidity	25%

Initial conditions

Baseline ambient oxygen	20.824%
Baseline oxygen	20.949%
Baseline carbon dioxide	0.0481%
Mass at sustained flaming	305.5 g

Test times

Time to ignition	44 s
Time to flameout	215 s
End of test criterion	User entered
End of test time (for calculations)	335 s

Heat Release Results

THR (0-300)	10.15 MJ/m²
THR (0-600)	-
THR (0-1200)	-
Fuel load	0.29 MJ/kg

Test results (between 44 and 335 s)

Total heat release	10.0 MJ/m²
Total oxygen consumed	6.7 g
Mass lost	4.9 g
Average specific MLR	3.90 g/(s·m²)
Total smoke release	309.8 m²/m²
Total smoke production	2.7 m²
MAHRE	71.0 kW/m²

	Mean	Peak	at time (s)
Heat release rate (kW/m²)	34.20	197.81	58
Effective heat of comb. (MJ/kg)	17.90	78.08	86
Mass loss rate (g/s)	0.017	0.316	71
Specific extinction area (m²/kg)	557.09	4770.93	70
Carbon monoxide yield (kg/kg)	0.0532	13.5621	246
Carbon dioxide yield (kg/kg)	1.55	167.36	95

Test averages

from ignition to ignition plus...	1 min	2 min	3 min	4 min	5 min	6 min	0 s - 352 s	0 s - 352 s
Heat release rate (kW/m²)	117.92	77.63	53.69	40.99	-	-	29.20	29.20
Effective heat of comb. (MJ/kg)	18.43	19.03	18.96	18.46	-	-	17.53	17.53
Mass loss rate (g/s)	0.056	0.036	0.025	0.020	-	-	0.015	0.015
Specific extinction area (m²/kg)	538.25	448.81	469.82	519.12	-	-	549.12	549.12
Carbon monoxide yield (kg/kg)	0.0392	0.0388	0.0427	0.0478	-	-	0.0534	0.0534
Carbon dioxide yield (kg/kg)	1.66	1.68	1.66	1.60	-	-	1.51	1.51

Smoke results

Total smoke release: non-flaming phase (0 s - 44 s)	1.6 m²/m²
Total smoke release: flaming phase (44 s - 335 s)	309.8 m²/m²
Total smoke release: whole test (0 s - 335 s)	311.3 m²/m²

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Summary:

Heat flux	50 kW/m²	Surface area	88.4 cm²
Orientation	Horizontal	Retainer frame used?	Yes

Test averages

Test	t(ig) (s)	t(fo) (s)	t(end) (s)	HRR(peak) (kW/m²)	tpeak (s)	THR (MJ/m²)	HRR(60) (kW/m²)	HRR(180) (kW/m²)	HRR(300) (kW/m²)
Mean	**45.7**	**301.7**	**421.7**	**191.94**	**60.3**	**10.74**	**112.32**	**52.29**	**34.90**
1	47	359	479	197.47	61	11.35	113.16	50.68	36.33
2	46	331	451	180.54	62	10.90	105.88	52.49	35.14
3	44	215	335	197.81	58	9.95	117.92	53.69	33.24

Test	Flux (kW/m²)	t (mm)	Area (cm²)	m(i) (g)	m(s) (g)	m(f) (g)	Δm (g)	Ave MLR (g/s·m²)	EHC(av) (MJ/kg)
Mean		**12.4**		**305.8**	**305.8**	**300.5**	**5.3**	**3.0**	**17.84**
1	50	12.4	88.4	306.1	306.2	300.7	5.4	2.0	18.43
2	50	12.4	88.4	305.63	305.8	300.2	5.6	3.1	17.19
3	50	12.4	88.4	305.68	305.5	300.6	4.9	3.9	17.90

Test	THR(0-300) (MJ/m²)	THR(0-600) (MJ/m²)	THR(0-1200) (MJ/m²)	SPR(av) (m²/s)	SEA(av) (m²/kg)	Fuel load (MJ/kg)	MARHE (kW/m²)
Mean	**10.31**	-	-	**0.0071**	**483.18**	**0.31**	**65.71**
1	10.47	-	-	0.0052	411.13	0.33	66.01
2	10.30	-	-	0.0067	481.31	0.32	60.14
3	10.15	-	-	0.0094	557.09	0.29	70.98

Specimen #	Line colour	Filename
1		C:\CC5\Data\Smart Glass Technologies\Smart Glass Technologie
2		C:\CC5\Data\Smart Glass Technologies\Smart Glass Technologie
3		C:\CC5\Data\Smart Glass Technologies\Smart Glass Technologie

General Observations:

At about 28 seconds started to blister on the surface. At about 35 seconds white smoke observed. Ignition with orange flames and black smoke.

The 180-second average heat release rate was 52.29 kW/m^2 and test average smoke extinction area of was 483.18 m^2/kg.

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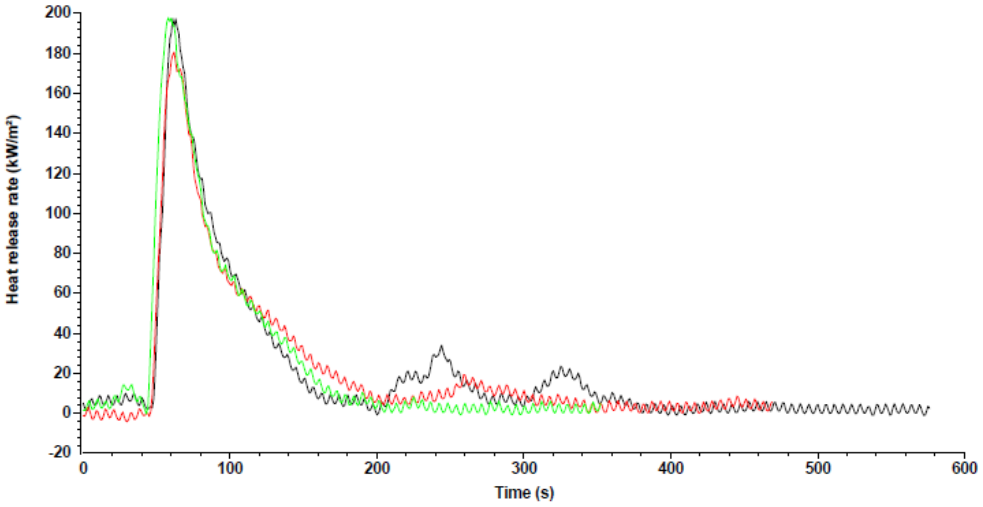
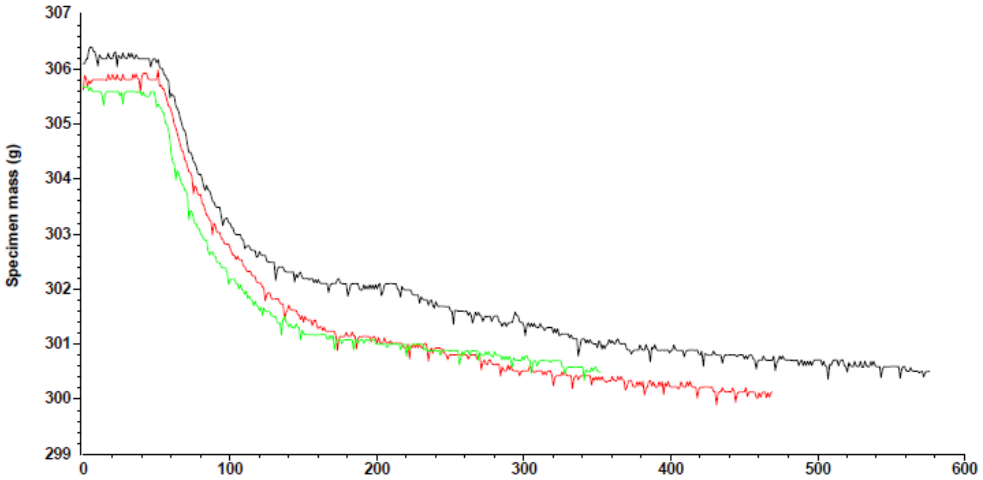
Graphs:





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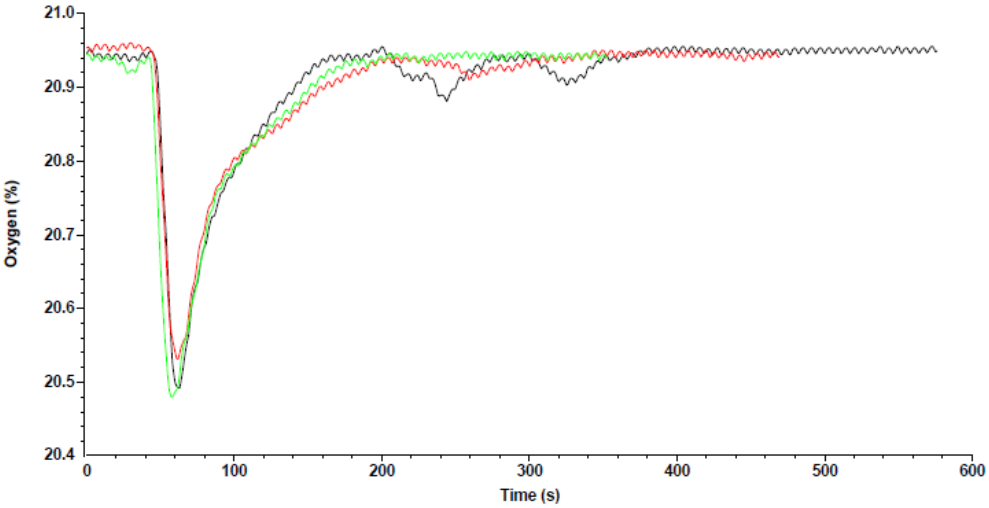

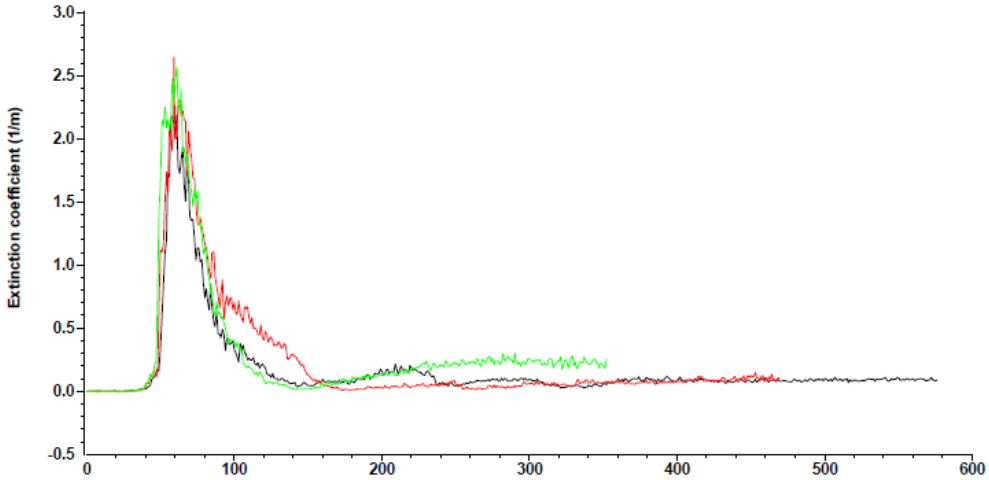

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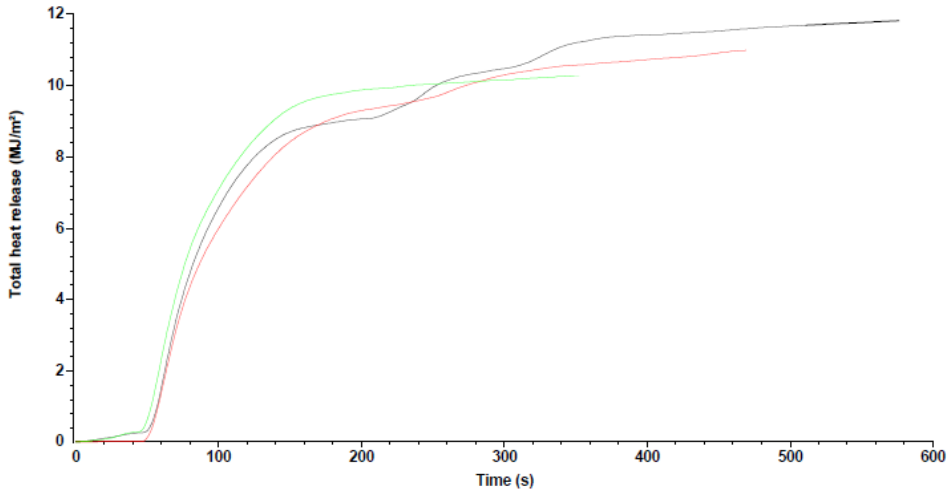

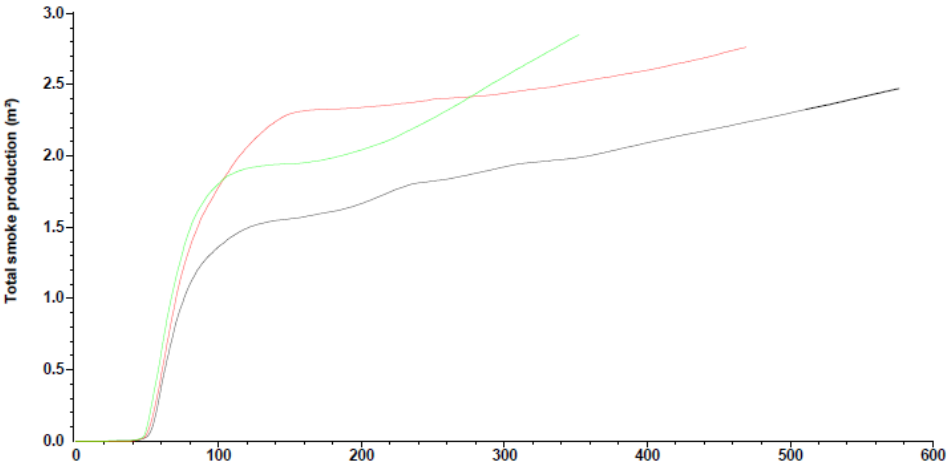

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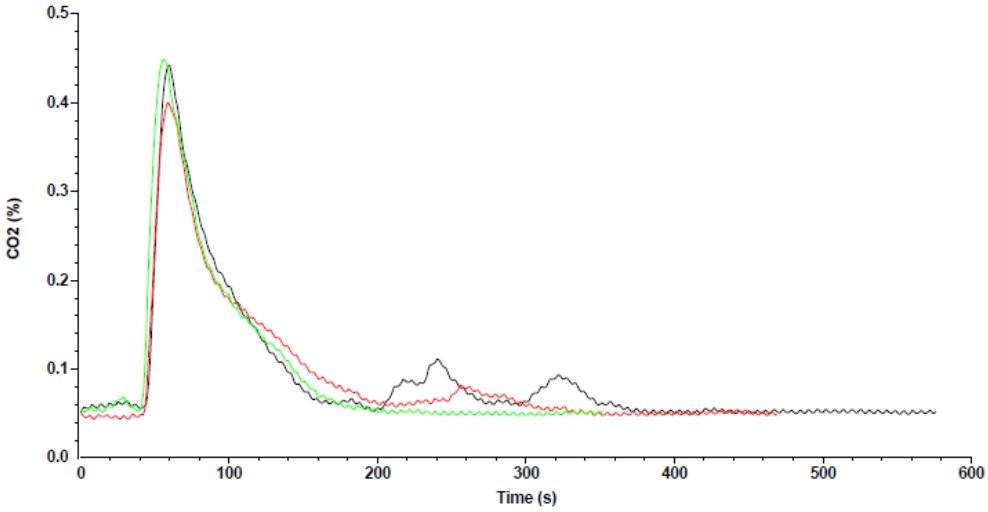

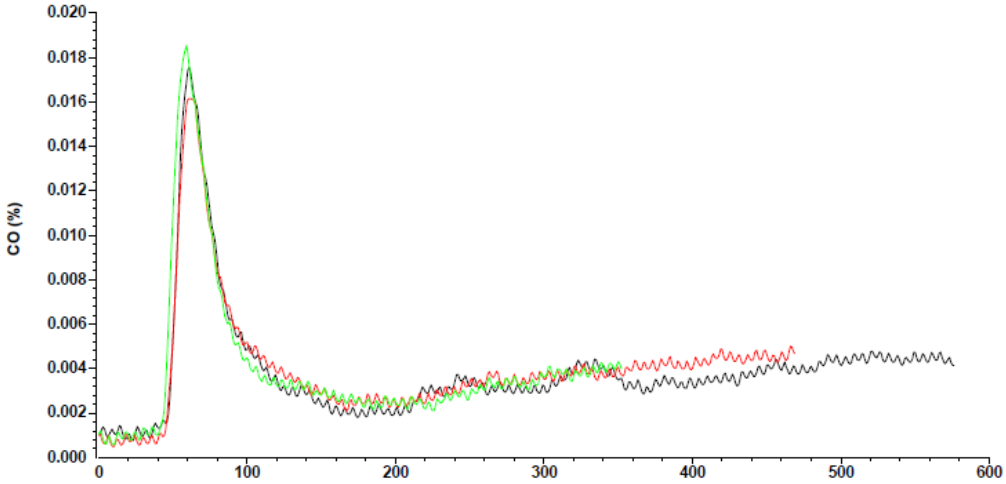

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SECTION 9
CONCLUSION

Materials tested in accordance with ASTM E1354 met the performance criteria of a 180-second average heat release rate of less than 100 kW/m^2 (8.8 Btu/sec·ft^2) and test average smoke extinction area of less than 500 m^2/kg (2441.2 ft2/lb).

There were no deviations to the ASTM E1354 standard procedure.

SECTION 10
REVISION LOG

REVISION #	DATE	PAGES	REVISION
0	04/23/20	12	Original Report Issue
1	09/08/20	12	Updated product name