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Testing. calibrating. advising

ASTM E 1354 Caloric Content Determination of "3M Scotch-Weld™1357"

A Report To:	**3M** **Industrial Adhesives and Tapes Division** 3M Center, Building 230-2S-29 St. Paul, MN 55144-1000 USA
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Submitted By:	Exova Warringtonfire North America
Report No.	14-002-743(B2) 8 pages + 1 appendix
Date:	December 16, 2014

ACCREDITATION To ISO/IEC 17025 for a defined Scope of Testing by the International Accreditation Service

SPECIFICATIONS OF ORDER

Determine Effective Heat of Combustion according to ASTM E 1354 and derive Caloric Content, as per 3M Purchase Order No. USMMM6NM4 and Exova Warringtonfire North America Quotation No. 14-002-327,516 accepted November 24, 2014.

IDENTIFICATION

Neoprene contact adhesive, identified as "3M Scotch-Weld™ 1357".

(Exova sample identification number 14-002-S0743-2)

SAMPLE PREPARATION

As per client's instructions, the adhesive material was applied onto 6 mm thick fiberglass reinforced cement substrate using a medium nap paint roller. Due to the porous nature of the substrate, a second coat was applied in order to achieve the required 2.5 - 3.5 gms/ft^2 dry coat weight. The adhesive was applied and allowed to cure at room temperature for at least 20 minutes prior to testing.

SUMMARY OF TEST PROCEDURE

Each specimen is mounted into a holder and placed horizontally below a cone-shaped radiant heat source which has been previously calibrated to emit a predetermined heat flux. Testing can occur with or without a spark ignition source. The test is performed in ambient air conditions, while a load cell continuously monitors specimen weight loss.

Exhaust gas flow rate and oxygen concentration are used to determine the amount of heat release, based on the observation that the net heat of combustion is directly related to the amount of oxygen required for combustion. The relationship is that approximately 13.1 x 10^3 kJ of heat are released per 1 kg of oxygen consumed.

In addition to rate of heat release, other specified measurements include mass-loss rate, time to sustained flaming and smoke obscuration.

TEST RESULTS

ASTM E 1354-13

Standard Test Method for Heat and Visible Smoke Release Rates

for Materials and Products Using an Oxygen Consumption Calorimeter

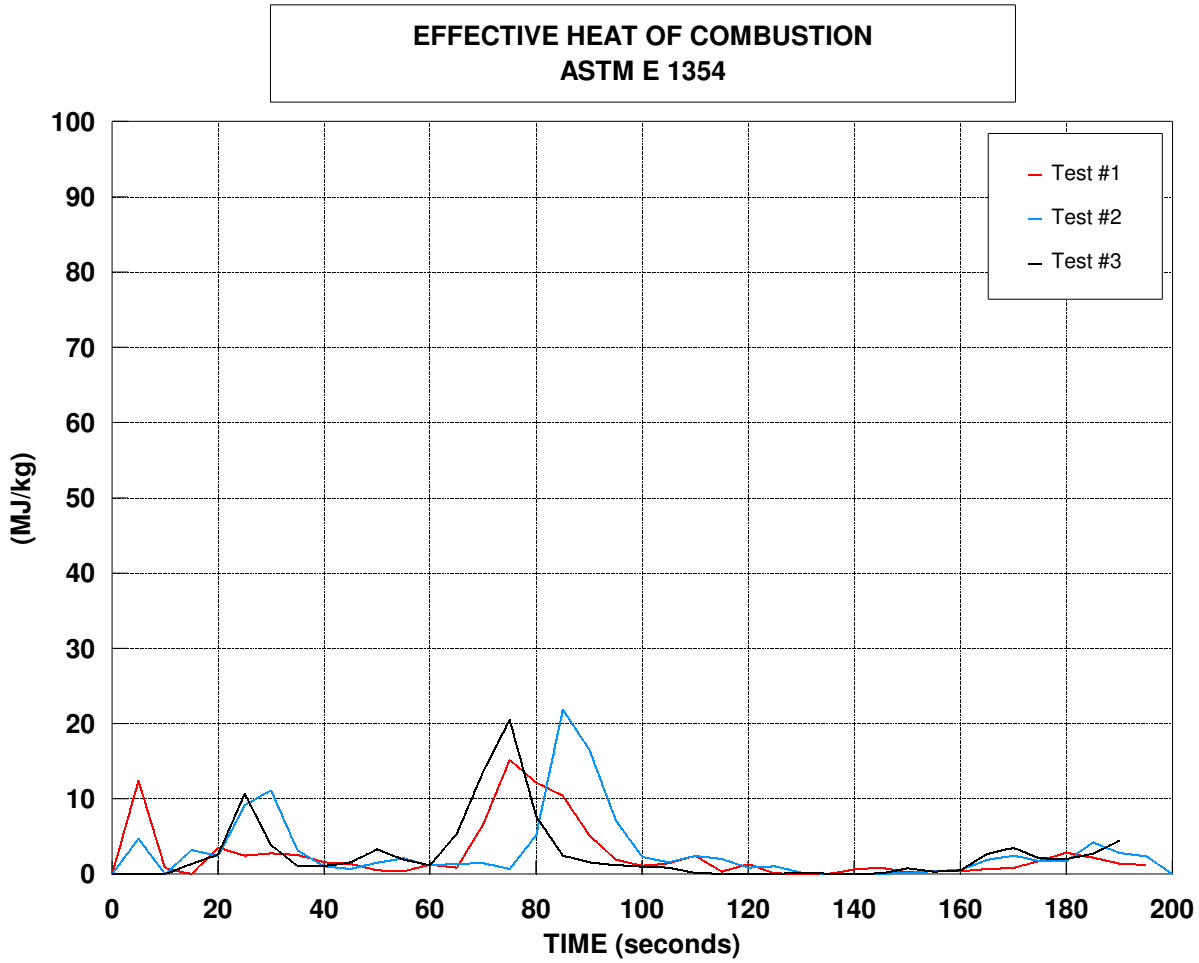
Testing was performed on December 11, 2014 with the sample in the horizontal configuration, utilizing the specimen holder and edge frame and also the specified spark ignition source.

	Test #1	Test #2	Test #3	Average	
Heat Flux (kW/m²)	50	50	50		
Exhaust Flow Rate (l/s)	24	24	24		
Specimen Thickness (mm)	0.1	0.1	0.1		
Initial Mass (g)(including substrate)	88.8	92.9	95.7		
Mass at Sustained Flaming (g)(including substrate)	87.2	91.0	94.3		
Final Mass (g)(including substrate)	85.2	89.6	92.5		
Sample Mass Loss (kg/m²)	0.19	0.14	0.18	0.17	
Peak Specific Mass Loss Rate (g/s·m²)	10.78	10.34	11.50	10.87	
Average Mass Loss Rate (g/s·m²)	7.63	7.36	7.14	7.38	
Time to Ignition (s)	62	74	55	64	
Time to Flame-out (s)	85	90	80	85	
Time of Peak Rate of Heat Release (s)	75	85	70	77	
Peak Rate of Heat Release (kW/m²)	104.3	90.1	80.4	91.6	
Average Rate of Heat Release (kW/m²)	73.5	56.1	47.3	59.0	
Total Heat Released (MJ/m²)	1.50	0.87	1.18	1.19	
Average Effective Heat of Combustion (MJ/kg)	8.57	7.86	6.62	**7.69**	*
Average Effective Heat of Combustion (BTU/lb)	3691.9	3387	2850.1	**3310**	*
Caloric Content (MJ/kg)	0.15	0.08	0.11	**0.11**	**
Caloric Content (BTU/lb)	64.318	35.793	47.012	**49**	**
Peak Extinction Area (m²/kg)	681.1	265.6	412.9	453.2	
Average Extinction Area (m²/kg)	220.4	134.9	197.3	184.2	

* Total heat produced per unit mass of material consumed

** Total heat produced per unit mass of material tested

TEST RESULTS (continued)

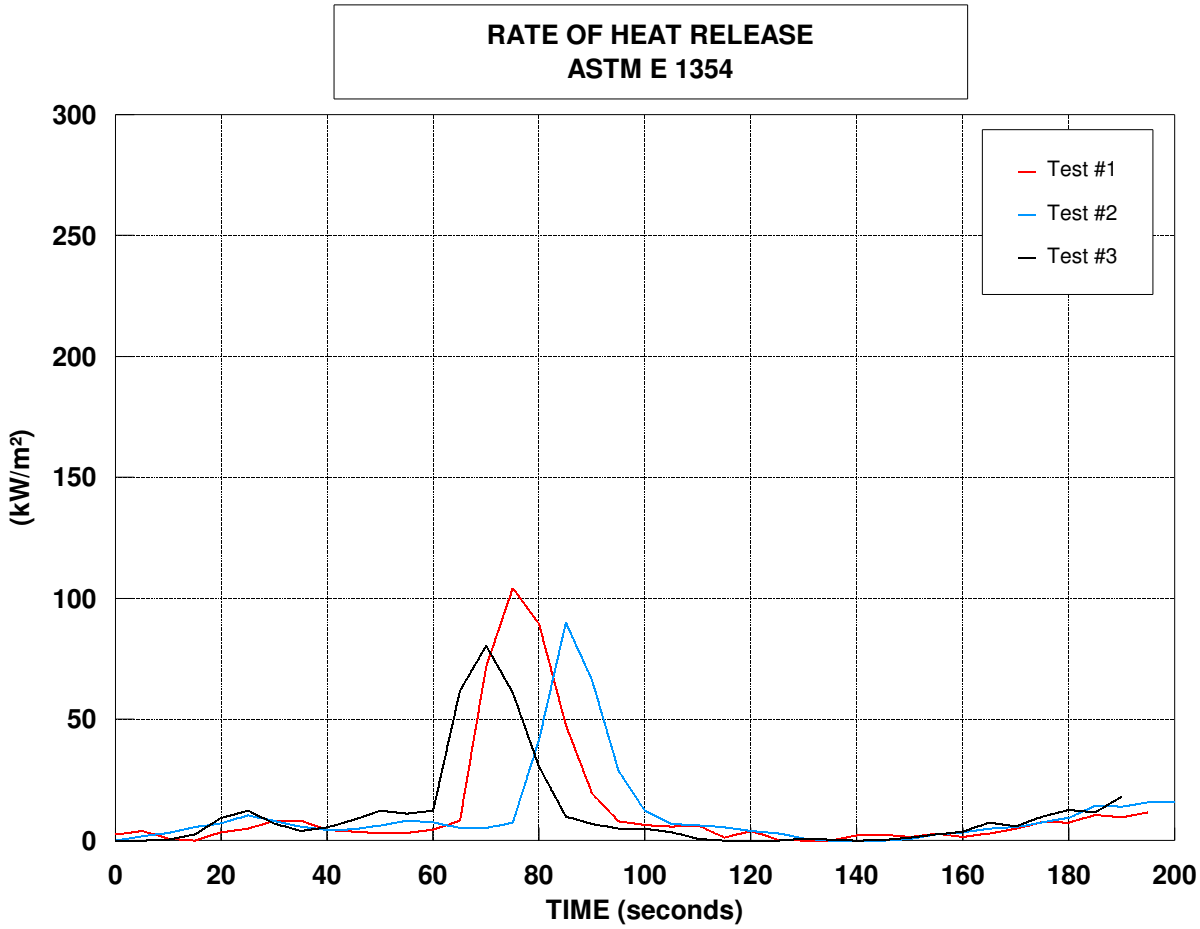


	Test #1	Test #2	Test #3	Average
Average Heat of Combustion (MJ/kg)*	8.57	7.86	6.62	7.69
Heat of Combustion @ 60 s (MJ/kg)**	5.74	4.98	4.41	5.04
Heat of Combustion @ 180 s (MJ/kg)**	0.00	0.00	0.00	0.00
Heat of Combustion @ 300 s (MJ/kg)**	0.00	0.00	0.00	0.00

* Averaged over the period starting when 10% of the ultimate mass loss occurred and ending at the time when 90% of the ultimate mass loss occurred.

** Averages, or projected averages over the 60, 180 or 300 second periods starting when 10% of the ultimate mass loss occurred.

TEST RESULTS (continued)

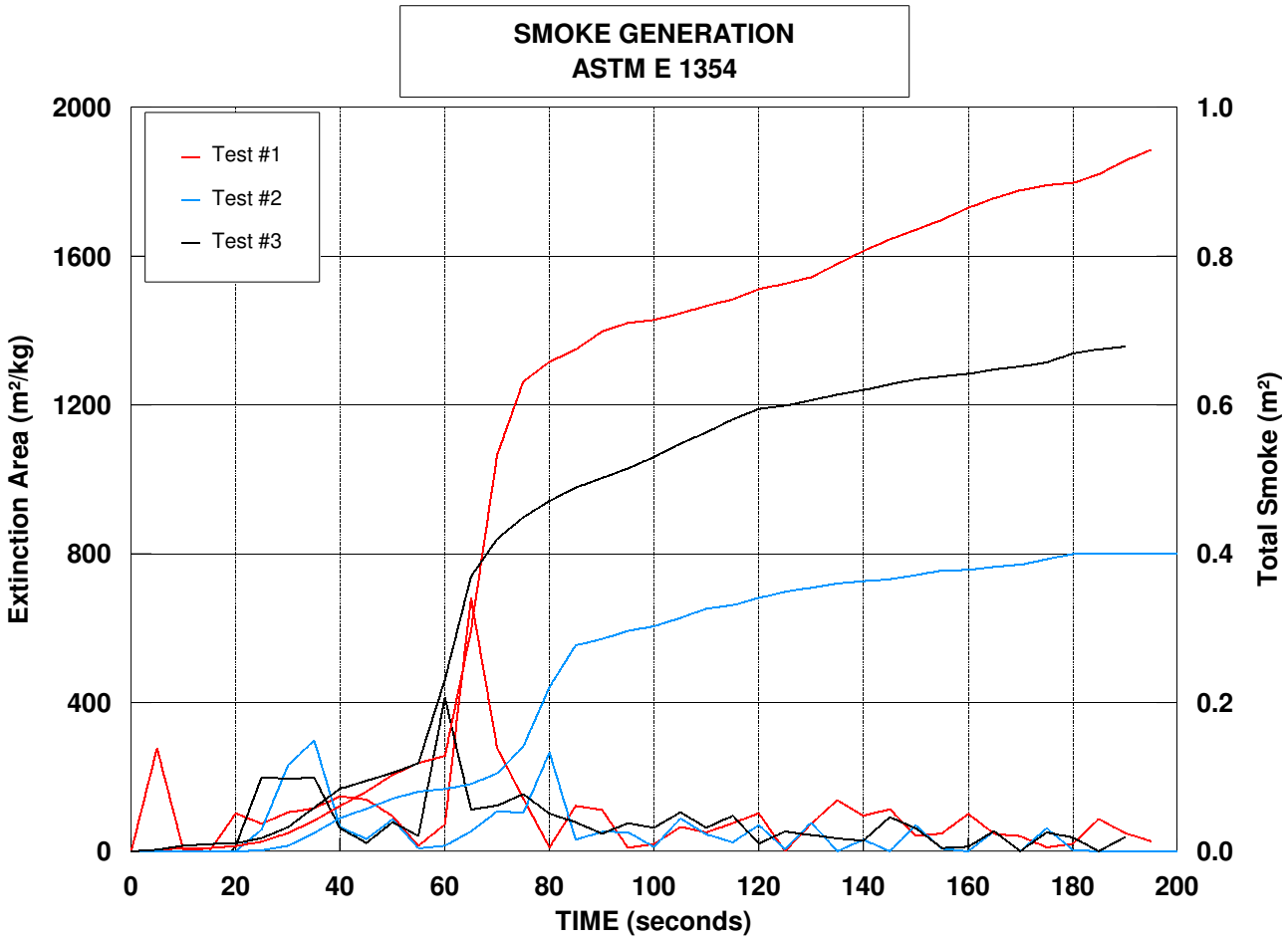


	Test #1	Test #2	Test #3	Average
Peak Rate of Heat Release (kW/m²)	104.3	90.1	80.4	91.6
Average Heat Release Rate (kW/m²)*	73.5	56.1	47.3	59.0
Heat Release Rate @ 60 s (kW/m²)**	30.7	22.3	23.5	25.5
Heat Release Rate @ 180 s (kW/m²)**	0.0	0.0	0.0	0.0
Heat Release Rate @ 300 s (kW/m²)**	0.0	0.0	0.0	0.0

* Averaged over the test period (from ignition to flameout).

** Averages, or projected averages over the first 60, 180 or 300 seconds after ignition.

TEST RESULTS (continued)

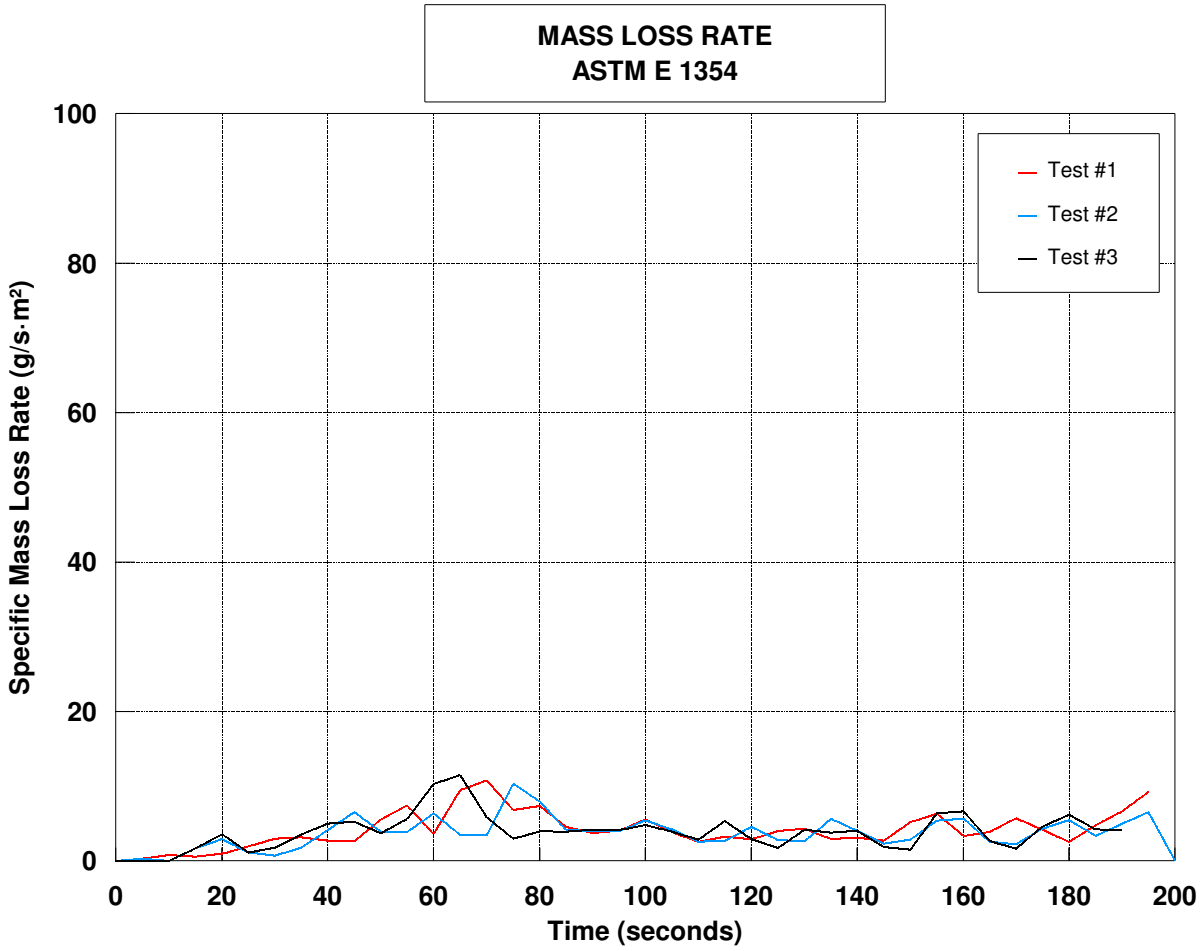


	Test #1	Test #2	Test #3	Average
Peak Extinction Area (m²/kg)	681.1	265.6	412.9	453.2
Average Extinction Area (m²/kg)*	220.4	134.9	197.3	184.2
Extinction Area @ 60 s (m²/kg)**	145.1	80.3	144.6	123.4
Extinction Area @ 180 s (m²/kg)**	0.0	0.0	0.0	0.0
Extinction Area @ 300 s (m²/kg)**	0.0	0.0	0.0	0.0
Total Smoke (m²)	0.94	0.40	0.68	0.67

* Averaged over the test period (from ignition to flameout).

** Averages, or projected averages over the first 60, 180 or 300 seconds after ignition.

TEST RESULTS (continued)



	Test #1	Test #2	Test #3	Average
Peak Mass Loss Rate (g/s·m²)	10.78	10.34	11.50	10.87
Avg. Specific Mass Loss Rate (g/m²·s)*	7.63	7.36	7.14	7.38
Mass Loss Rate @ 60 s (g/s)**	0.05	0.04	0.05	0.05
Mass Loss Rate @ 180 s (g/s)**	0.00	0.00	0.00	0.00
Mass Loss Rate @ 300 s (g/s)**	0.00	0.00	0.00	0.00

* Averaged over the period starting when 10% of the ultimate mass loss occurred and ending at the time when 90% of the ultimate mass loss occurred.

** Averages, or projected averages over the 60, 180 or 300 second periods starting when 10% of the ultimate mass loss occurred.

CONCLUSIONS

The neoprene contact adhesive identified in this report, when tested applied onto 6 mm thick fiberglass reinforced cement substrate, affords an average Effective Heat of Combustion of 7.69 MJ/kg (3310 BTU/lb) of consumed material when tested according to ASTM E 1354 at an imposed heat flux of 50 kW/m². Based on the initial mass of each specimen, this calculates to an overall average Caloric Content of 0.11 MJ/kg (49 BTU/lb).

Note: This is an electronic copy of the report. Signatures are on file with the original report.

Mel Garces,
Senior Technologist.

Ian Smith,
Technical Manager.

Note: This report and service are covered under Exova Canada Inc. Standard Terms and Conditions of Contract which may be found on the Exova website (www.exova.com), or by calling 1-866-263-9268.

APPENDIX

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ASTM E 1354 Definitions

ASTM E 1354 DEFINITIONS

In evaluating the data produced by the oxygen consumption (cone) calorimeter, the following definitions and comments are offered:

Effective Heat of Combustion	This is the measured heat release divided by the mass loss for a specified time period and represents, therefore, the calorific value of the consumed portion only of the tested material. Caloric content under the test conditions can be derived by dividing the total heat released by the original mass of the material under test. It generally differs from the theoretical heat of combustion, since the latter involves complete combustion - a phenomenon which rarely takes place in an actual fire.
Time to Ignition	Also known as ignition delay time, this parameter provides a measure of a material's propensity to ignition as measured by the time to sustained ignition at a given heat flux. It can also be considered to be related to the volatility of the degradation products and the time required to achieve a critical fuel concentration in the vapour phase. This gasification rate is temperature dependent: the higher the imposed heat flux the shorter the time to ignition.
Heat Release Rate (HRR)	HRR is the heat evolved per unit time and is highly dependent on applied heat flux: the higher the flux the greater the HRR. HRR curves can fluctuate significantly with time and it is generally considered that the average HRR can be a better predictor of full-scale fire performance than the peak value.
Total Heat Release	This is the integrated area under the HRR curve over the test period, expressed in MJ/m^2. If one knows the surface area of a material used in a room or transit vehicle, this value is more properly used to estimate "potential heat load" than is the more commonly used "caloric content" based upon the weight of material used.
Mass Loss Rate	This is roughly correlatable with heat release rate because it is the rate at which the test material is degraded to produce combustible fuels. The peak mass loss rate and average mass loss rate are derivative terms generated by the load cell.
Extinction Area	This refers to the "yield" of smoke which is, through mathematical manipulation, expressed as an area per unit mass.

In addition to average values for the test, data averaged to the 60, 180 and 300 second marks after ignition are also typically provided. Where materials burn for different lengths of time, for example, it is more technically sound to compare the average heat release rates over the first 1, 3 or 5 minutes of burning than to compare the test average results which encompass differing time periods.