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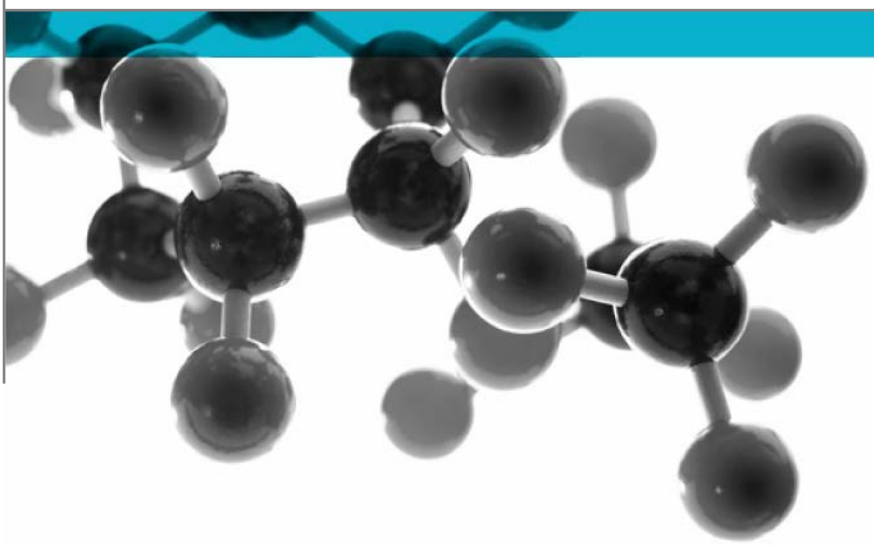
ISO 5660-1:2015



Heat release rate (Cone Calorimeter Method) &
Smoke Production Rate (Dynamic Measurement)

A Report To: 3M Deutschland GmbH

Document Reference: 385399

Date: 12th October 2017

Issue No.: 1

Testing
Advising
Assuring

UKAS TESTING
0249

Executive Summary

Objective To determine the performance of the following product when tested in accordance with ISO 5660-1:2015

Generic Description		Product reference	Thickness	Weight per unit area or density
Four layers of polyester film with acrylic PSA (pressure-sensitive adhesive) applied to a 4mm thick annealed glass substrate		Not stated	4.51mm	9.90kg/m²*
Individual components used to manufacture composite:				
Self-adhesive film	Film	"3M™ Scotchgard™ Multi-Layer Protective Film 1004"	4 x 4 mils	Unwilling to provide
	Adhesive	Unwilling to provide	4 x 1 mil	Unwilling to provide
Substrate		Unwilling to provide	4mm	Unwilling to provide
***Determined by Exova Warringtonfire**				
Please see page 6 of this test report for the full description of the product tested				

Test Sponsor 3M Deutschland GmbH, Industrial Tapes & Adhesives Division, Carl-Schurz-Str. 1, 41453 Neuss

Test Results:

Peak Heat Release Rate	**=**	**88.2kW/m²**
Total Heat Release	**=**	**5.6MJ/m²**
MARHE	**=**	**18.5kW/m²**

Date of Test 9th and 10th October 2017

Signatories

	
Responsible Officer T. Mort * Senior Technical Officer	Authorised B. Dean * Technical Leader

* For and on behalf of **Exova Warringtonfire**.

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Test Details

Purpose of test

To determine the performance of a product when it is subjected to the conditions of the test specified in ISO 5660-1:2015, “Heat release rate (Cone Calorimeter Method)” and “Smoke Production Rate (Dynamic Measurement)”.

This test was performed in accordance with the procedures specified in ISO 5660-1 and this report should be read in conjunction with these standards.

Scope of test

ISO 5660-1:2015 specifies a method for assessing the heat release rate of a specimen exposed in the horizontal orientation to controlled levels of irradiance with an external igniter. The heat release rate is determined by measurement of the oxygen consumption derived from the oxygen concentration and the flow rate in the combustion product stream. The time to ignition (sustained flaming) is also measured in this test.

The dynamic smoke production rate is calculated from measurement of the attenuation of a laser light beam by the combustion product stream. Smoke obscuration is recorded for the entire test, regardless of whether the specimen is flaming or not.

Fire test study group/EGOLF

Certain aspects of some fire test specifications are open to different interpretations. The Fire Test Study Group and EGOLF have identified a number of such areas and has agreed Resolutions which define common agreement of interpretations between fire test laboratories which are members of the Groups. Where such Resolutions are applicable to this test they have been followed.

Test procedure

The apparatus consists of a cone shaped, radiant electric heater, capable of producing a uniform irradiance of up to 100kW/m^2 on the surface of a 100mm x 100mm specimen, situated on a load cell. The heater is controlled by a temperature controller capable of holding the element temperature steady to within ± 2°C. External ignition is facilitated by a spark igniter powered from a 10kV transformer. Exhaust gases are drawn through a hood and duct by a centrifugal fan. An orifice plate positioned across the exhaust duct and connected to a pressure transducer, measures the volume flow. A ring sampler, situated in the duct, allows a representative sample of the exhaust gases to be drawn off and the oxygen concentration measured using an in-line, paramagnetic oxygen analyser.

The heat release rate is calculated using the relationship that approximately 13.1 x 10^{3}kJ of heat are released per kilogram of oxygen consumed. Visible smoke release is determined by means of a laser extinction beam photometer situated in the duct.

Instruction to test

The test was conducted on the 9th and 10th October 2017 at the request of 3M Deutschland GmbH, the sponsor of the test.

Provision of test specimens

The specimens were supplied by the sponsor of the test. **Exova Warringtonfire** was not involved in any selection or sampling procedure.

Conditioning of specimens	The specimens were received on the 23rd June 2017. Prior to test the specimens were conditioned to constant mass at a temperature of 23 ± 2°C and a relative humidity of 50 ± 5%.
Test laboratory	The test was conducted by Exova Warringtonfire Gent, who hold Belac ISO 17025 accreditation for this test
Test face	The film face of each specimen was exposed to the igniting flame.
Test orientation	Horizontal.
Specimen preparation	A retaining frame was used, leaving an exposed specimen surface area of 8.836 x $10^{-3}m^2$. A retaining wire grid was not used.
Number of replicate tests	Three specimens were subjected to an irradiance of $50kW/m^2$.
Frequency of measurement	The data was recorded every two seconds throughout the tests.
Exhaust system flow rate	The exhaust flow rate was set to 0.024 ± 0.002 m^3/s.
End of test criteria	The data was collected for a period of 1200 seconds.
Test operator	P. Ysebie

Description of Test Specimens

The description of the system given below has been prepared from information provided by the sponsor of the test. This information has not been independently verified by **Exova Warringtonfire.**

All values quoted are nominal, unless tolerances are given.

General description			Four layers of polyester film with acrylic PSA (pressure-sensitive adhesive) applied to a 4mm thick annealed glass substrate
Overall thickness			4.51mm (stated by sponsor) 4.02mm (determined by **Exova Warringtonfire**)
Overall weight per unit area			9.90kg/m² (determined by **Exova Warringtonfire**)
Self-adhesive film	Product reference		"3M™ Scotchgard™ Multi-Layer Protective Film 1004"
	Thickness per layer		5 mils (0.127mm)
	Density / weight per unit area		**See Note 1 below**
	Number of layers		4
	Film	Generic type	Polyester
		Product reference	**See Note 1 below**
		Name of manufacturer	3M Company
		Weight per unit area	**See Note 1 below**
		Thickness	4 mils per layer
		Colour	"Transparent"
		Flame retardant details	**See Note 2 below**
	Adhesive	Generic type	Acrylic
		Product reference	**See Note 1 below**
		Name of manufacturer	3M Company
		Application thickness	1 mil per layer
		Application method	**See Note 1 below**
		Flame retardant details	**See Note 2 below**
Substrate		Generic type	Annealed glass
		Name of supplier	**See Note 1 below**
		Thickness	4mm
		Weight per unit area	**See Note 1 below**
		Flame retardant details	**See Note 2 below**
Brief description of manufacturing process			**See Note 1 below**

Note 1. The sponsor was unwilling to provide this information.

Note 2. The sponsor of the test has confirmed that no flame retardant additives were utilised in the production of the component.

Test Results

Results of test

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

The test results relate only to the specimens of the product in the form in which they were tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and will therefore invalidate the test results. It is the responsibility of the supplier of the product to ensure that the product which is supplied is identical to the specimens which were tested.

The data generated during the tests are contained in Table 1.

Graphs of heat release rate, total heat release, smoke production rate, total smoke production and average heat release rate are shown in Figures 1 to 5 respectively.

Observations

None

Validity

The specification and interpretation of fire test methods are the subject of ongoing development and refinement. Changes in associated legislation may also occur. For these reasons it is recommended that the relevance of test reports over five years old should be considered by the user. The laboratory that issued the report will be able to offer, on behalf of the legal owner, a review of the procedures adopted for a particular test to ensure that they are consistent with current practices, and if required may endorse the test report.

Table 1

PARAMETER			Test 1	Test 2	Test 3	Mean
Time to sustained flaming		seconds	128	53	109	97
Test duration		seconds	1200	1200	1200	1200
Peak heat release rate	$\dot{q}''_{max}$	kWm^{-2}	90.2	71.5	102.8	88.2
Time to peak heat release rate		seconds	152	132	134	139
Total heat release	q''_{tot}	MJm^{-2}	6.6	4.7	5.4	5.6
Average $\dot{q}''$ for 180 sec after ignition	$\dot{q}''_{180}$	kWm^{-2}	21.9	17.8	20.2	20.0
Average $\dot{q}''$ for 300 sec after ignition	$\dot{q}''_{300}$	kWm^{-2}	14.4	11.0	12.7	12.7
Initial specimen mass	$m_{initial}$	g	100.0	100.0	100.0	100.0
Final specimen mass	m_{final}	g	99.5	96.5	97.1	97.7
Average mass loss rate between ignition and end of test	$\dot{m}''$	$g\ m^{-2}\ s^{-1}$	0.01	0.22	0.20	0.14
Average mass loss rate between 10-90% of mass loss		$g\ m^{-2}\ s^{-1}$	0.00	3.36	1.36	1.57
Mass at sustained flaming		g	99.6	96.5	97.1	97.7
Total smoke production	$S_1'' + S_2''$	dimensionless (m^2/m^2)	65.7	127.0	73.0	88.6
Peak smoke production rate	$\dot{S}''_{max}$	$s^{-1} \equiv [(m^2\ s^{-1})/m^2]$	2.99	3.72	5.45	4.05
Time to peak smoke production rate		seconds	138	114	114	122
CO_2 Yield		kg/kg	0.35	0.33	0.10	0.26
CO Yield		kg/kg	0.04	0.05	0.00	0.03

Supplementary calculations

Maximum average heat release (MARHE)	kW/m^2	17.0	19.0	19.6	18.5
Time to MARHE	seconds	196	156	168	173

Figure 1

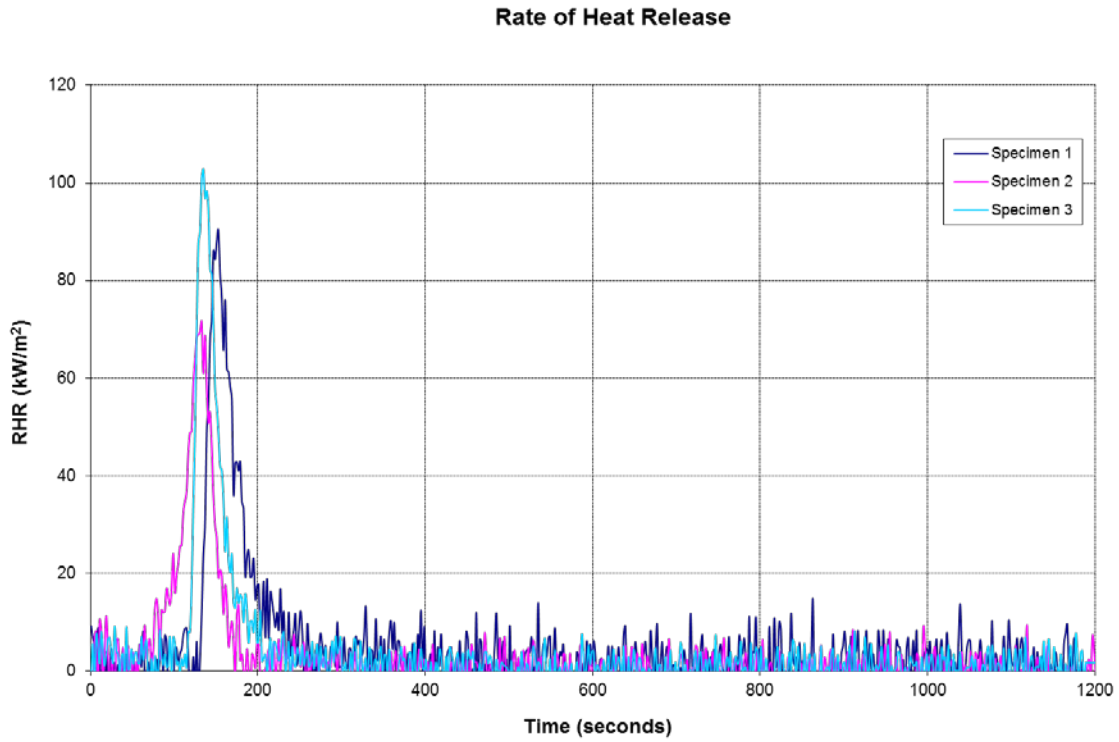


Figure 2

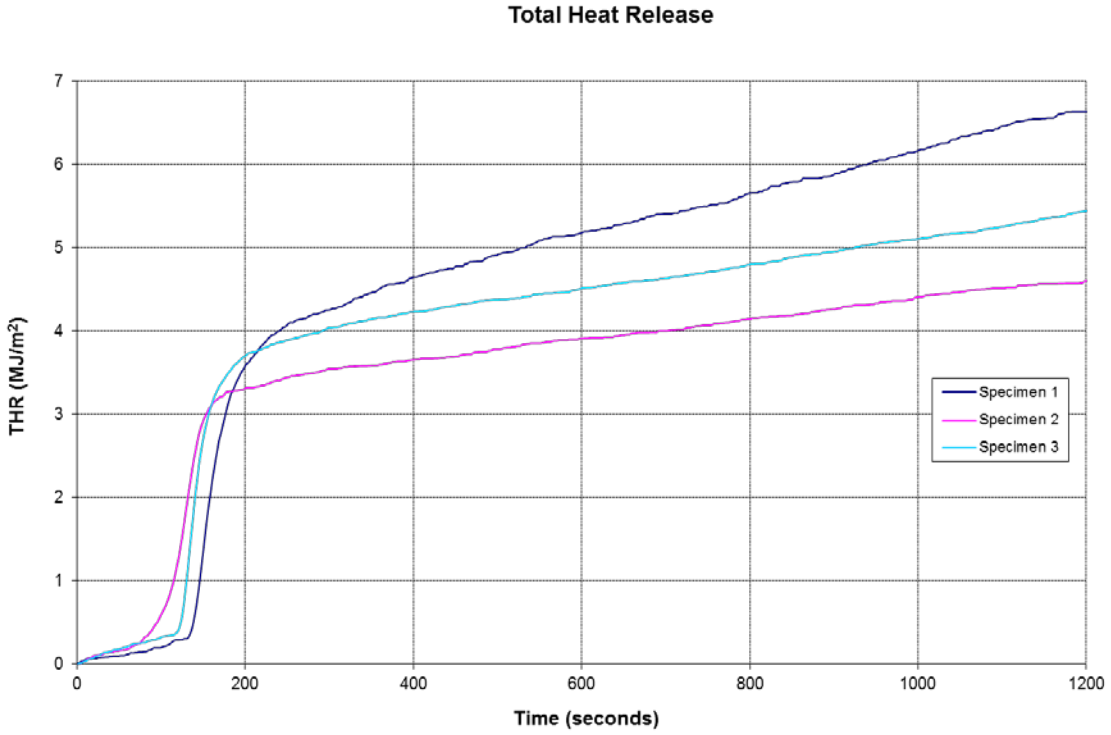


Figure 3

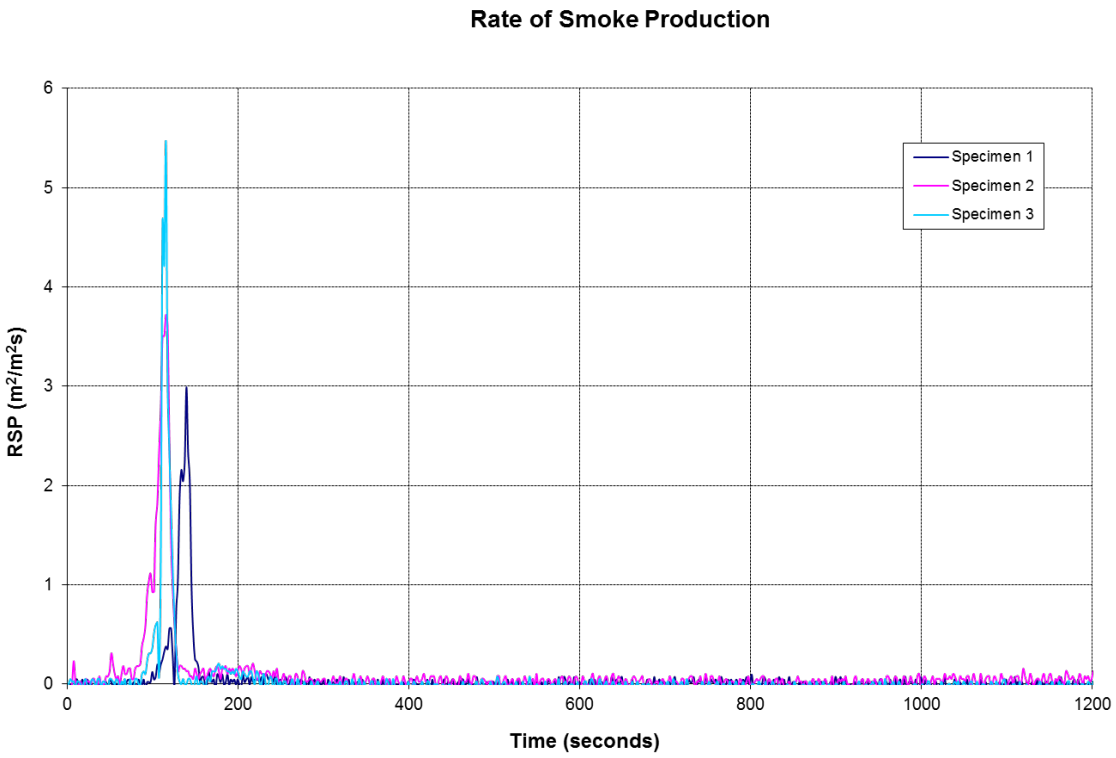


Figure 4

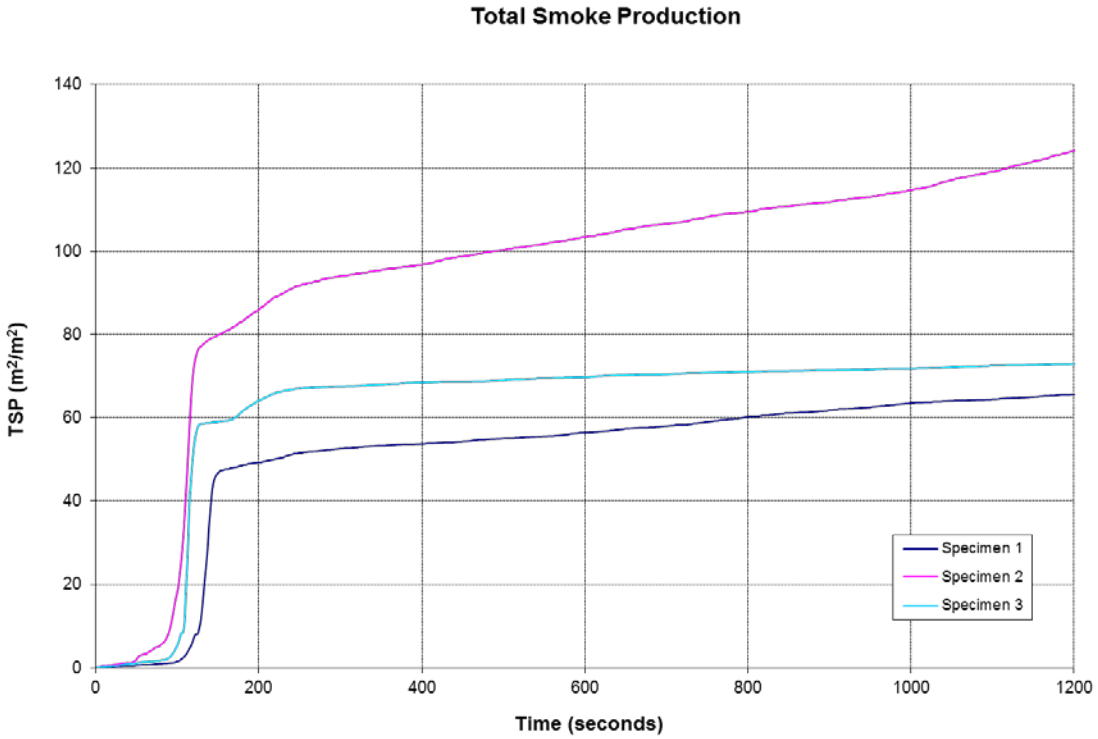
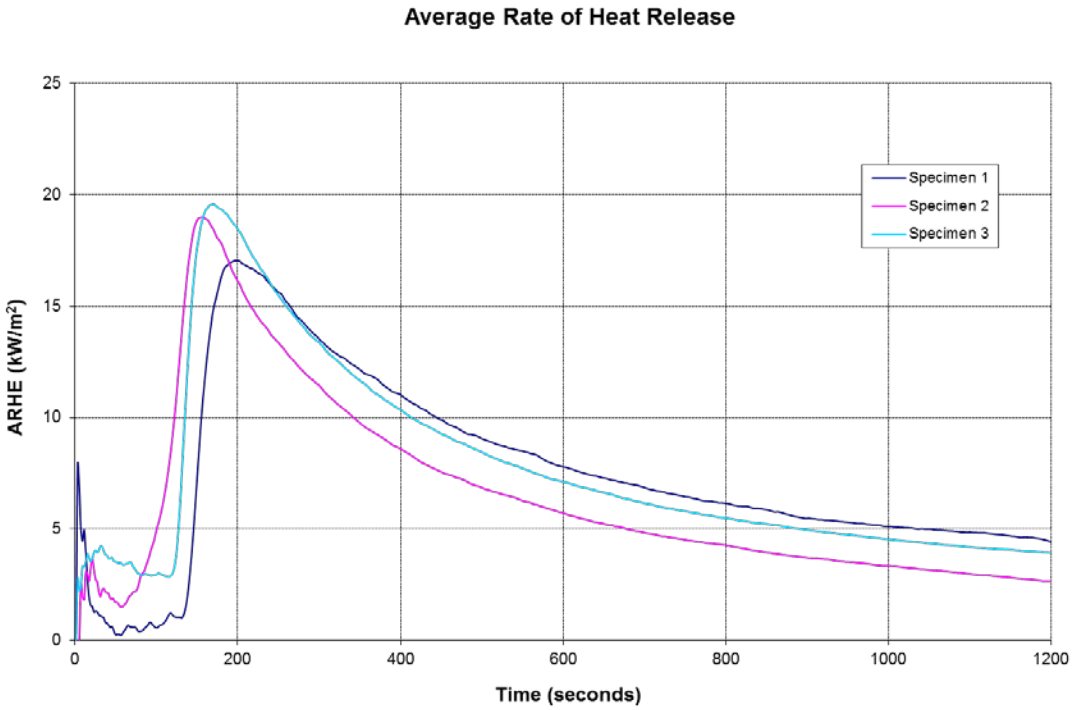


Figure 5


Average Rate of Heat Release
ARHE (kW/m²)
Time (seconds)
Specimen 1
Specimen 2
Specimen 3
0
5
10
15
20
25
0
200
400
600
800
1000
1200

Revision History

Issue No :	Re-issue Date:
Revised By:	Approved By:
Reason for Revision:	

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