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Testing. Advising. Assuring.

**ISO 5660-1, "Heat release rate  
(Cone Calorimeter Method)"**

**ISO 5660-2, "Smoke Production  
Rate (Dynamic Measurement)"**

**WF Report Number**

**188523**

**Date:**

**22<sup>nd</sup> January 2010**

**Test Sponsor:**

**CPFilms Solutia UK Limited**



**0249**

**Exova Warringtonfire Test Report No. 188523**

**ISO 5660-1, "Heat release rate  
(Cone Calorimeter Method)"**

**ISO 5660-2, "Smoke Production Rate  
(Dynamic Measurement)"**

**Sponsored By**

**CPFilms Solutia UK Limited  
Chadwick Road  
Ashmoor Industrial Estate  
Runcorn  
Cheshire  
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## Test Details

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<b>Purpose of test</b>	<p>To determine the performance of a product when it is subjected to the conditions of the test specified in ISO 5660-1, "Heat release rate (Cone Calorimeter Method)" and ISO 5660-2, "Smoke Production Rate (Dynamic Measurement)".</p> <p>This test was performed in accordance with the procedures specified in ISO 5660-1 and ISO 5660-2 and this report should be read in conjunction with these standards.</p>
<b>Scope of test</b>	<p>ISO 5660-1 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.</p> <p>ISO 5660-2 specifies a small scale method for assessing the dynamic smoke production rate of essentially flat specimens exposed to controlled levels of radiant heating under well ventilated conditions with or without an external igniter. The rate of smoke production 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. The measurement system prescribed by this international standard is an extension of the apparatus described in part 1 of ISO 5660. Therefore, this international standard must be used in conjunction with ISO 5660-1.</p>
<b>Fire test study group/EGOLF</b>	<p>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.</p>
<b>Test procedure</b>	<p>The apparatus consists of a cone shaped, radiant electric heater, capable of producing a uniform irradiance of up to <math>100\text{kW/m}^2</math> on the surface of a <math>100\text{mm} \times 100\text{mm}</math> specimen, situated on a load cell. The heater is controlled by a temperature controller capable of holding the element temperature steady to within <math>\pm 2^\circ\text{C}</math>. External ignition is facilitated by a spark igniter powered from a <math>10\text{kV}</math> 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.</p> <p>The heat release rate is calculated using the relationship that approximately <math>13.1 \times 10^3\text{kJ}</math> 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.</p>
<b>Instruction to test</b>	<p>The test was conducted on the 15<sup>th</sup> January 2010 at the request of CPFilms Solutia UK Limited, the sponsor of the test.</p>
<b>Provision of test specimens</b>	<p>The specimens were supplied by the sponsor of the test. <b>Exova Warringtonfire</b> was not involved in any selection or sampling procedure.</p>

<b>Conditioning of specimens</b>	<p>The specimens were received on the 6<sup>th</sup> November 2009.</p> <p>Prior to test the specimens were conditioned to constant mass at a temperature of <math>23 \pm 2^{\circ}\text{C}</math> and a relative humidity of <math>50 \pm 5\%</math>.</p>
<b>Test face</b>	<p>The decorative film face of each specimen was exposed to the igniting flame.</p>
<b>Test orientation</b>	<p>Horizontal.</p>
<b>Specimen preparation</b>	<p>A retaining frame was used, leaving an exposed specimen surface area of <math>8.836 \times 10^{-3}\text{m}^2</math>. Retaining wires were used.</p>
<b>Number of replicate tests</b>	<p>Three specimens were subjected to an irradiance of <math>50 \text{ kW/m}^2</math>.</p>
<b>Frequency of measurement</b>	<p>The data was recorded every two seconds throughout the tests.</p>
<b>Orifice plate calibration factor</b>	<p>0.04320</p>
<b>Exhaust system flow rate</b>	<p>The exhaust flow rate was set to <math>0.024 \pm 0.002 \text{ m}^3/\text{s}</math>.</p>
<b>End of test criteria</b>	<p>The data was collected until the oxygen concentration returned to the pre-test value within 100 parts per million (0.01%).</p>
<b>Test operator</b>	<p>L. Berry</p>

## Description of Test Specimens

The description of the specimens given below has been prepared from information provided by the sponsor of the test. All values quoted are nominal, unless tolerances are given.

General description		Coated polyester film with pressure sensitive adhesive backing
Product reference		"10360501 (SCL SR PS4)"
Name of manufacturer		CPFilms Solutia
Colour		"Clear"
Thickness of composite		0.12mm (without release liner – stated by sponsor) 0.14mm (with release liner – stated by sponsor) 0.15mm (without release liner – determined by <b>Exova Warringtonfire</b> )
Weight per unit area of composite		Between 145 and 160g/m <sup>2</sup> (without release liner – stated by sponsor) Between 180 and 195g/m <sup>2</sup> (with release liner – stated by sponsor) 192.2g/m <sup>2</sup> (without release liner – determined by <b>Exova Warringtonfire</b> )
Coating	Product reference	"10359493"
	Generic type	SR (scratch resistant) acrylate coating
	Name of manufacturer	<b>See Note 1 below</b>
	Application rate	Between 1 and 2g/m <sup>2</sup>
	Application method	Slot Die Coating
	Curing process	UV Light, Oven Running speed is 23m/min through 15m oven space
	Flame retardant details	<b>See Note 2 below</b>
Film	Product reference	"10359425"
	Generic type	Polyester film
	Name of manufacturer	<b>See Note 1 below</b>
	Thickness	0.10mm
	Weight per unit area	140g/m <sup>2</sup>
	Flame retardant details	<b>See Note 2 below</b>
Adhesive backing	Product reference	"10358489"
	Generic type	Acrylic pressure sensitive adhesive
	Name of manufacturer	<b>See Note 1 below</b>
	Thickness	0.02mm
	Application rate	16-20g/m <sup>2</sup>
	Application method	Slot die coating
Flame retardant details		<b>See Note 2 below</b>
Brief description of manufacturing process		Slot die coating and laminating

**Note 1. The sponsor of the test 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 product / component.**

## Test Results

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<b>Results of test</b>	<p>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.</p> <p>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.</p> <p>The data generated during the tests are contained in Table 1.</p> <p>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.</p>
<b>Observations</b>	<p>Sustained flaming occurred in the case of each of the specimens tested.</p>
<b>Validity</b>	<p>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.</p> <p>This report may only be reproduced in full. Extracts or abridgements shall not be published without permission of <b>Exova Warringtonfire</b>.</p>

## Signatories

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Responsible Officer  
S. Deeming \*  
Senior Technical Officer



Approved  
D. J. Owen \*  
Senior Technical Officer



Authorised  
C. Dean \*  
Operations Manager

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

*Report Issued: 22<sup>nd</sup> January 2010*

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Table 1

PARAMETER		Test 1	Test 2	Test 3	Mean
Time to sustained flaming	seconds	15	10	6	10
Test duration	seconds	690	686	750	709
Peak heat release rate	$\dot{q}''_{max}$ kWm <sup>-2</sup>	259.92	179.31	166.63	201.95
Time to peak heat release rate	seconds	34	30	26	30
Total heat release	$q''_{tot}$ MJm <sup>-2</sup>	4.7	4.4	6.7	5.3
Average $\dot{q}''$ for 180 sec after ignition	$\dot{q}''_{180}$ kWm <sup>-2</sup>	20.57	19.01	19.60	19.73
Average $\dot{q}''$ for 300 sec after ignition	$\dot{q}''_{300}$ kWm <sup>-2</sup>	13.36	11.73	13.15	12.75
Initial specimen mass	$m_{initial}$ g	1.96	1.95	1.96	1.96
Final specimen mass	$m_{final}$ g	0.00	0.00	0.00	0.00
Mass loss	g/m <sup>2</sup>	293.87	287.46	231.71	271.01
Average mass loss rate between ignition and end of test	$\dot{m}''$ g m <sup>-2</sup> s <sup>-1</sup>	0.411	0.438	0.289	0.379
Average mass loss rate between 10-90% of mass loss	g m <sup>-2</sup> s <sup>-1</sup>	8.914	8.714	2.095	6.574
Mass at sustained flaming	g	1.25	1.28	1.85	1.46
Smoke production non flaming phase	$S''_1$ dimensionless (m <sup>2</sup> /m <sup>2</sup> )	8.61	0.83	1.01	3.48
Smoke production flaming phase	$S''_2$ dimensionless (m <sup>2</sup> /m <sup>2</sup> )	154.19	169.64	179.11	167.65
Total smoke production	$S''_1 + S''_2$ dimensionless (m <sup>2</sup> /m <sup>2</sup> )	162.80	170.47	180.12	171.13
Peak smoke production rate	$\dot{S}''_{max}$ s <sup>-1</sup> ≡ [(m <sup>2</sup> s <sup>-1</sup> )/m <sup>2</sup> ]	9.157	6.535	6.349	7.347
Time to peak smoke production rate	seconds	26	20	18	21.3
CO <sub>2</sub> Yield	kg/kg	2.520	1.260	2.210	1.997
CO Yield	kg/kg	0.624	0.202	0.103	0.310

Supplementary calculations

Maximum average heat release (MARHE)	kW/m <sup>2</sup>	70.04	65.14	66.40	67.19
Time to MARHE	seconds	44	42	40	42

Figure 1

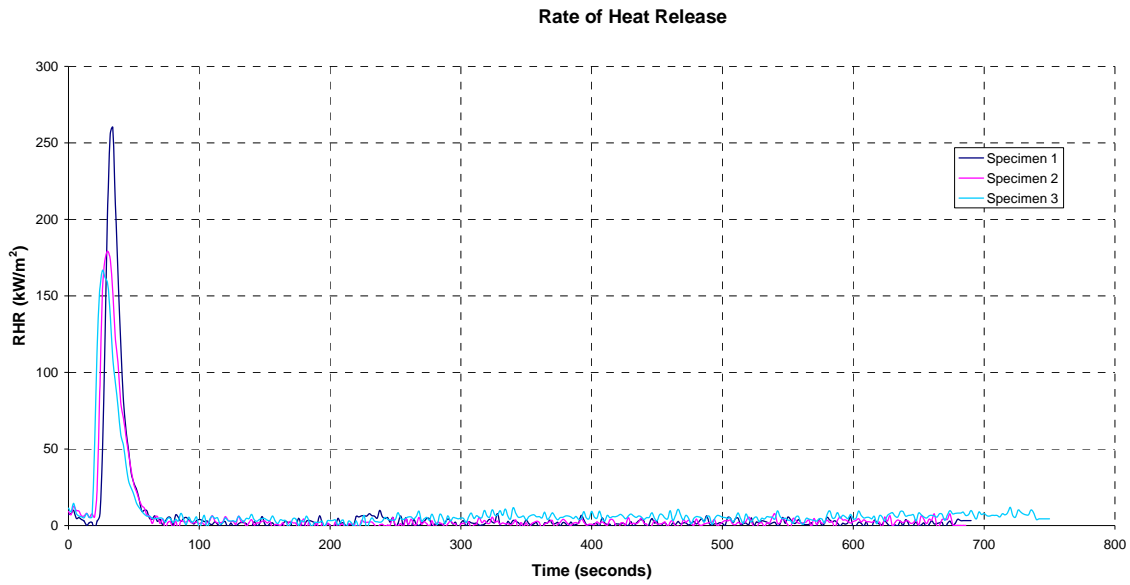


Figure 2

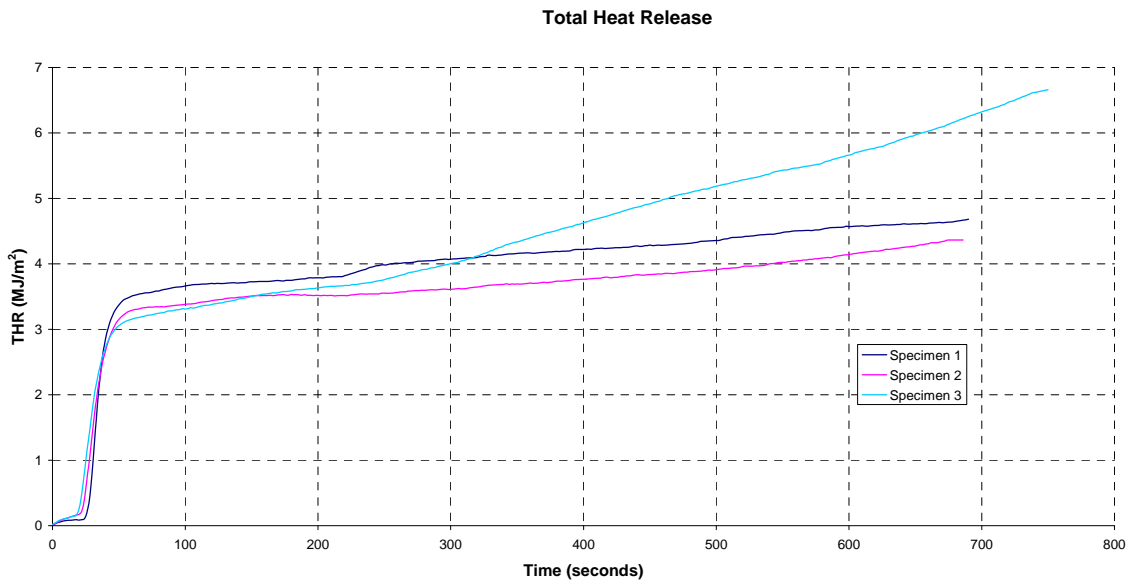


Figure 3

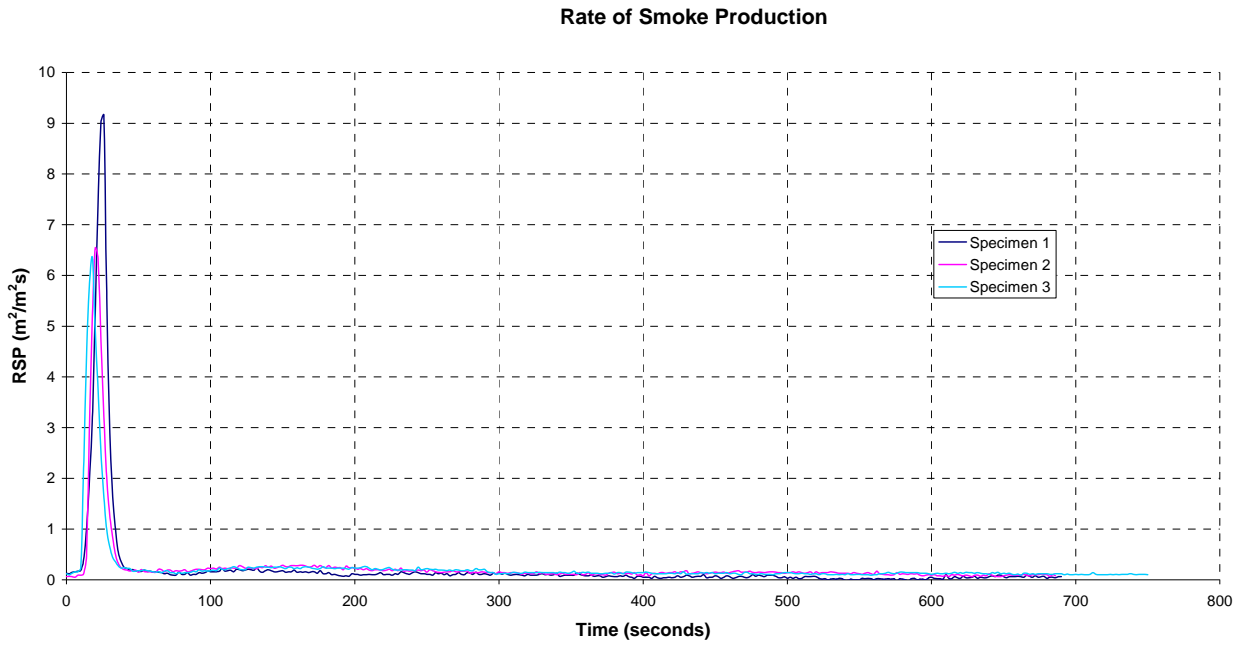


Figure 4

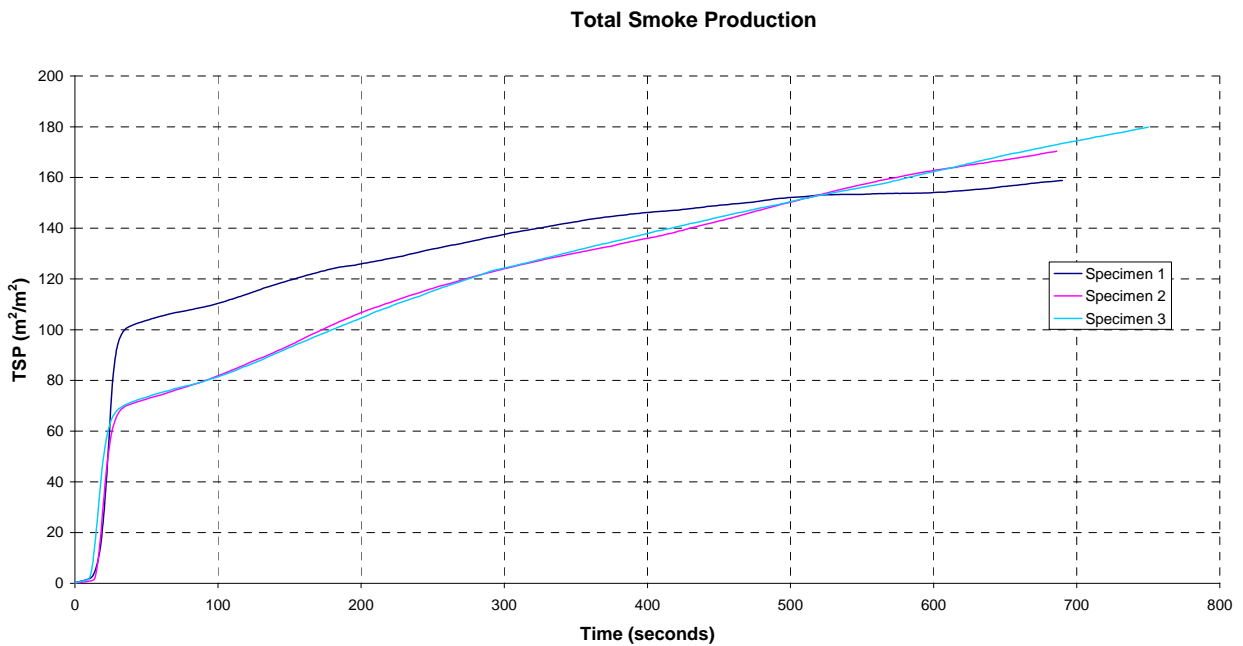
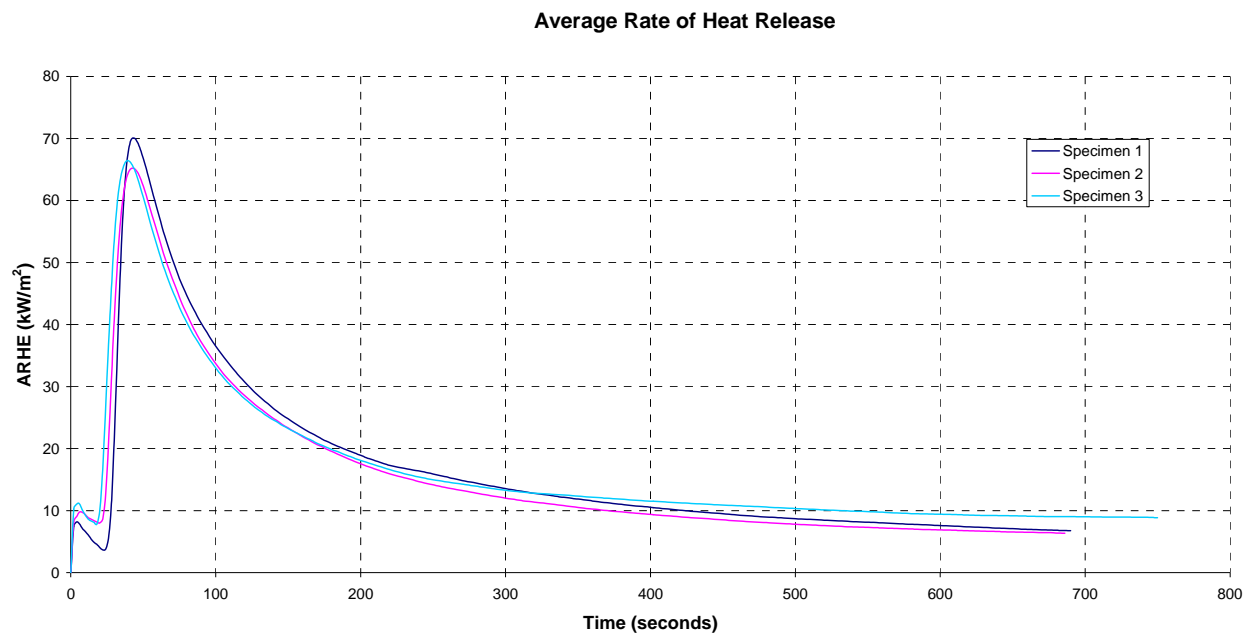


Figure 5



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