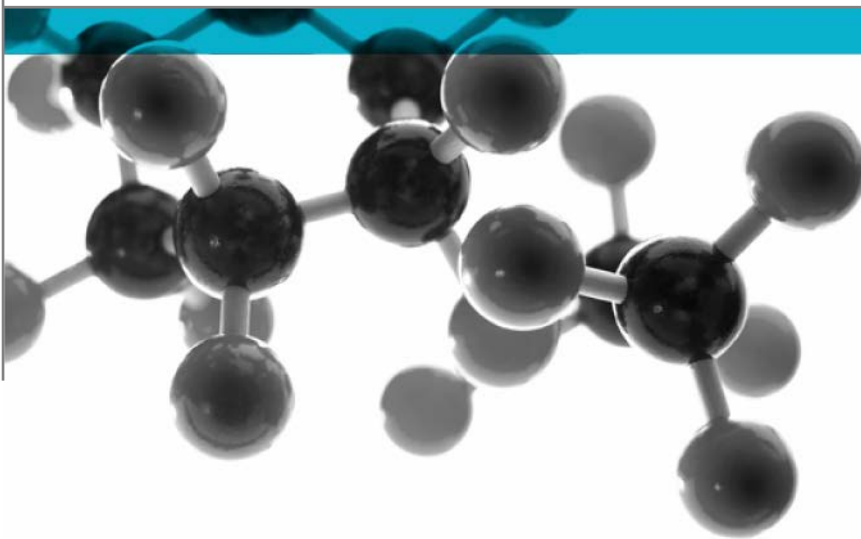


Exova Warringtonfire  
Holmesfield Road  
Warrington  
WA1 2DS  
United Kingdom

T : +44 (0) 1925 655116  
F : +44 (0) 1925 655419  
E : warrington@exova.com  
W: www.exova.com



# ISO 5660-1:2015



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

A Report To: PPG Italia

Document Reference: 396286

Date: 8th May 2018

Issue No.: 2

Page 1

Testing  
Advising  
Assuring



## 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, density or specific gravity
Coated aluminium	"PPG R50059/698/1"	2mm	5.50kg/m <sup>2</sup> *
<b>Individual components used to manufacture composite:</b>			
Coating	"Selemix Aqua 8-110/8-111"	2 x 30-40µ (Total 60-80µ)	1.9
Substrate	"6082 T6"	2mm	2.7g/cm <sup>3</sup>
<b>*determined by Exova Warringtonfire</b>			
<b>Please see page 6 of this test report for the full description of the product tested</b>			

**Test Sponsor** PPG Italia, Via Comasina 121, Milan, Italy


**Test Results:**

<b>Peak Heat Release Rate</b>	=	<b>23.59kW/m<sup>2</sup></b>
<b>Total Heat Release</b>	=	<b>2.4MJ/m<sup>2</sup></b>
<b>MARHE</b>	=	<b>6.40kW/m<sup>2</sup></b>

**Date of Test** 6<sup>th</sup> March 2018


**Reason for Revision** This document replaces issue 1 (dated 9<sup>th</sup> March 2018) of the same number which has been withdrawn. The total film thickness was stated incorrectly in the issue 1 report. This has been amended in this issue 2 report.

## Signatories



Responsible Officer  
 T. Mort \*  
 Senior Technical Officer

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



Authorised  
 S. Deeming \*  
 Business Unit Head

Report Issued: 8th May 2018

This version of the report has been produced from a .pdf format electronic file that has been provided by **Exova Warringtonfire** to the sponsor of the report and must only be reproduced in full. Extracts or abridgements of reports must not be published without permission of **Exova Warringtonfire**.

Document No.: 396286

Author: C Jacques

Client: PPG Italia

Page No.: 2 of 12

Issue Date: 8th May 2018

Issue No.: 2



0249

**CONTENTS**

**PAGE NO.**

**EXECUTIVE SUMMARY .....2**

**SIGNATORIES.....2**

**TEST DETAILS.....4**

**DESCRIPTION OF TEST SPECIMENS.....6**

**TEST RESULTS .....7**

**TABLE 1 .....8**

**FIGURE 1 .....9**

**FIGURE 2.....9**

**FIGURE 3.....10**

**FIGURE 4.....10**

**FIGURE 5.....11**

**REVISION HISTORY .....12**



## Test Details

<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 5660-1:2015, "Heat release rate (Cone Calorimeter Method)" and "Smoke Production Rate (Dynamic Measurement)".</p> <p>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.</p>
<b>Scope of test</b>	<p>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.</p> <p>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.</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 100kW/m<sup>2</sup> 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 <math>\pm 2^{\circ}\text{C}</math>. 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.</p> <p>The heat release rate is calculated using the relationship that approximately 13.1 x 10<sup>3</sup>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.</p>
<b>Instruction to test</b>	<p>The test was conducted on the 6<sup>th</sup> March 2018 at the request of PPG Italia, 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>

Document No.:	396286	Page No.:	4 of 12
Author:	C Jacques	Issue Date:	8th May 2018
Client:	PPG Italia	Issue No.:	2



<b>Conditioning of specimens</b>	The specimens were received on the 16 <sup>th</sup> February 2018.  Prior to test the specimens were conditioned to constant mass at a temperature of $23 \pm 2^{\circ}\text{C}$ and a relative humidity of $50 \pm 5\%$ .
<b>Test face</b>	The coated face of each specimen was exposed to the igniting flame.
<b>Test orientation</b>	Horizontal.
<b>Specimen preparation</b>	A retaining frame was used, leaving an exposed specimen surface area of $8.836 \times 10^{-3}\text{m}^2$ . A retaining wire grid was not used.
<b>Number of replicate tests</b>	Three specimens were subjected to an irradiance of $50\text{kW}/\text{m}^2$ .
<b>Frequency of measurement</b>	The data was recorded every two seconds throughout the tests.
<b>Orifice plate calibration factor</b>	0.04057
<b>Exhaust system flow rate</b>	The exhaust flow rate was set to $0.024 \pm 0.002 \text{ m}^3/\text{s}$ .
<b>End of test criteria</b>	The data was collected for a period of 1200 seconds.
<b>Test operator</b>	H. Harper

## 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		Coated aluminium
Product reference		"PPG R50059/698/1"
Overall thickness		2mm (stated by sponsor) 2.07mm (determined by <b>Exova Warringtonfire</b> )
Overall density		5.50kg/m <sup>2</sup> (determined by <b>Exova Warringtonfire</b> )
Coating	Generic type	Waterborne 2-pack polyurethane coating
	Product reference	"Selemix Aqua 8-110 / 8-111"
	Name of manufacturer	PPG Industries
	Colour reference	"Ral 7035" "Grey" (observed by <b>Exova Warringtonfire</b> )
	Number of coats	2
	Application thickness per coat	30-40 $\mu$ (Total 60-80 $\mu$ )
	Specific gravity	1.9
	Application method	Conventional high volume low spray
	Curing process per coat	20 minutes air dry between coats at 20°C
Flame retardant details		<b>See Note 1 Below</b>
Aluminium	Generic type	Aluminium
	Product reference	"6082 T6"
	Name of manufacturer	Pro Test Panels
	Thickness	2mm
	Density	2.7g/cm <sup>3</sup>
Flame retardant details		The substrate is inherently flame retardant
Brief description of manufacturing process		<b>See Note 2 Below</b>

**Note 1:** The sponsor of the test has confirmed that no flame retardants were used in the production of this component.

**Note 2:** The sponsor of the test was unable to provide this information.

## 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.

This report may only be reproduced in full. Extracts or abridgements shall not be published without permission of **Exova Warringtonfire**.

Table 1

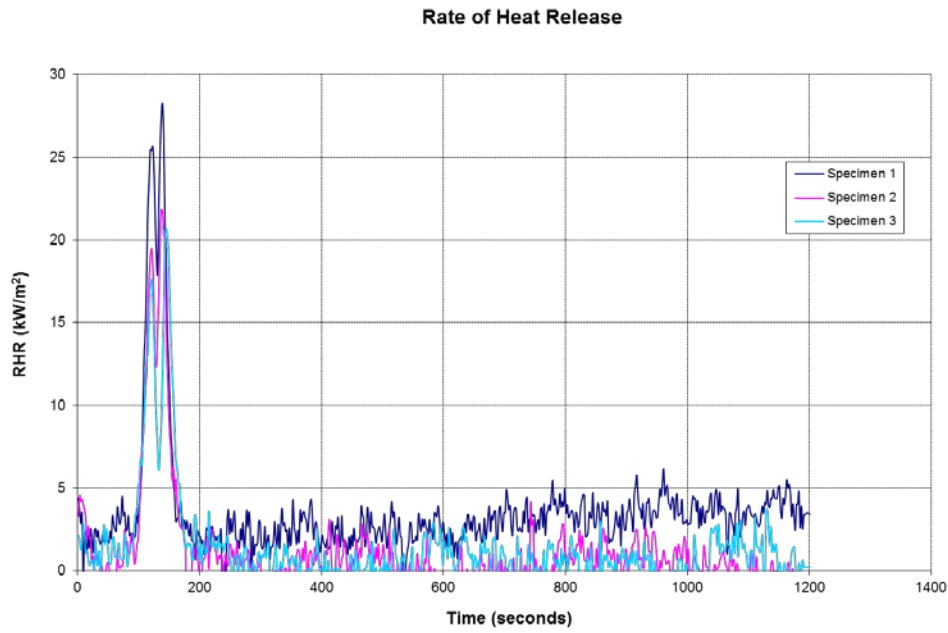
PARAMETER		Test 1	Test 2	Test 3	Mean
Time to sustained flaming	seconds	106	107	111	108
Test duration	seconds	1200	1200	1200	1200
Peak heat release rate	$\dot{\phi}''_{max}$ kWm <sup>-2</sup>	28.24	21.85	20.67	23.59
Time to peak heat release rate	seconds	139	136	144	139
Total heat release	$q''_{tot}$ MJm <sup>-2</sup>	4.3	1.2	1.6	2.4
Average $\dot{\phi}''$ for 180 sec after ignition	$\dot{\phi}''_{180}$ kWm <sup>-2</sup>	6.95	4.62	4.70	5.42
Average $\dot{\phi}''$ for 300 sec after ignition	$\dot{\phi}''_{300}$ kWm <sup>-2</sup>	5.09	2.82	2.98	3.63
Initial specimen mass	$m_{initial}$ g	54.87	54.76	54.95	54.86
Final specimen mass	$m_{final}$ g	53.40	53.72	53.87	53.66
Mass loss	g/m <sup>2</sup>	111.87	95.89	67.33	91.70
Mass at sustained flaming	g	54.48	54.65	54.77	54.63
Smoke production non flaming phase (m <sup>2</sup> /m <sup>2</sup> )	$S_1''$ dimensionless	54.76	69.39	71.97	65.37
Smoke production flaming phase (m <sup>2</sup> /m <sup>2</sup> )	$S_2''$ dimensionless	469.80	714.41	572.03	585.41
Total smoke production	$S_1'' + S_2''$ dimensionless (m <sup>2</sup> /m <sup>2</sup> )	524.56	783.80	644.00	650.79
Peak smoke production rate	$\dot{S}''_{max}$ s <sup>-1</sup> ≡ [(m <sup>2</sup> s <sup>-1</sup> )/m <sup>2</sup> ]	1.215	1.324	1.353	1.297
Time to peak smoke production rate	seconds	92	122	116	110

Supplementary calculations

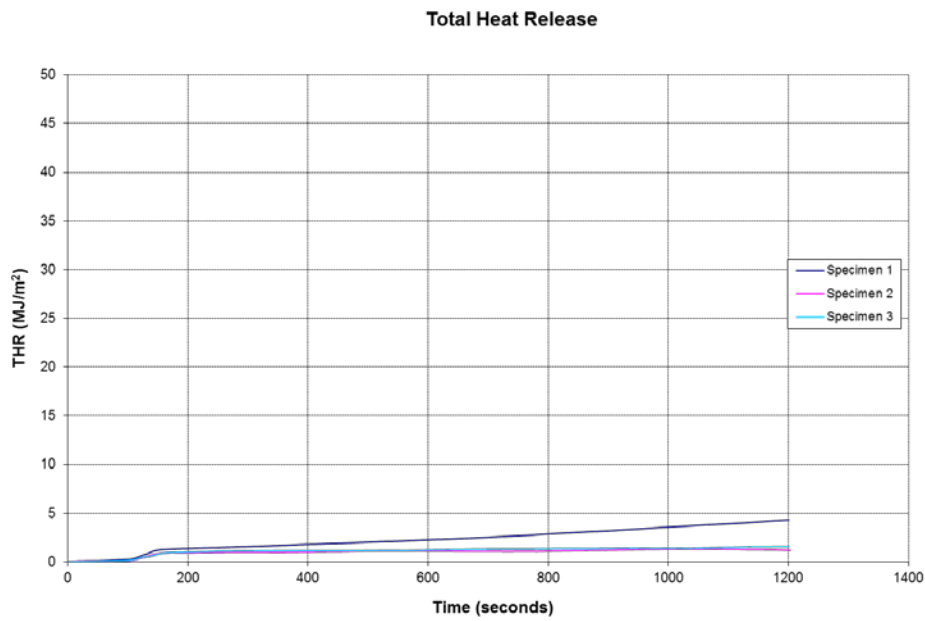
Maximum average heat release (MARHE)	kW/m <sup>2</sup>	7.97	5.62	5.60	6.40
Time to MARHE	seconds	152	156	164	157



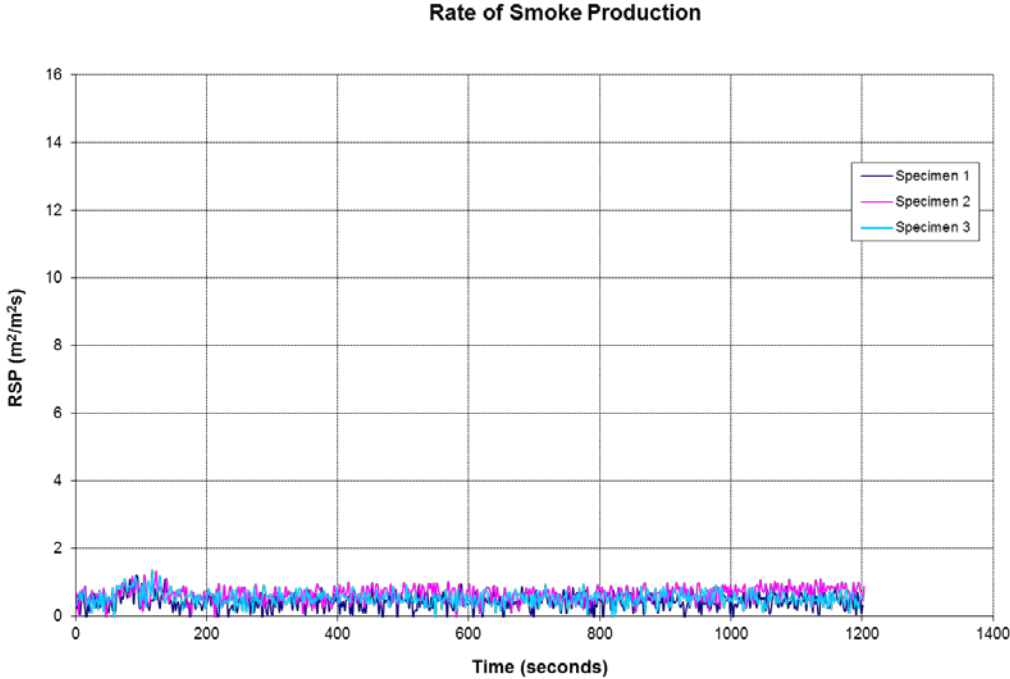
**Figure 1**



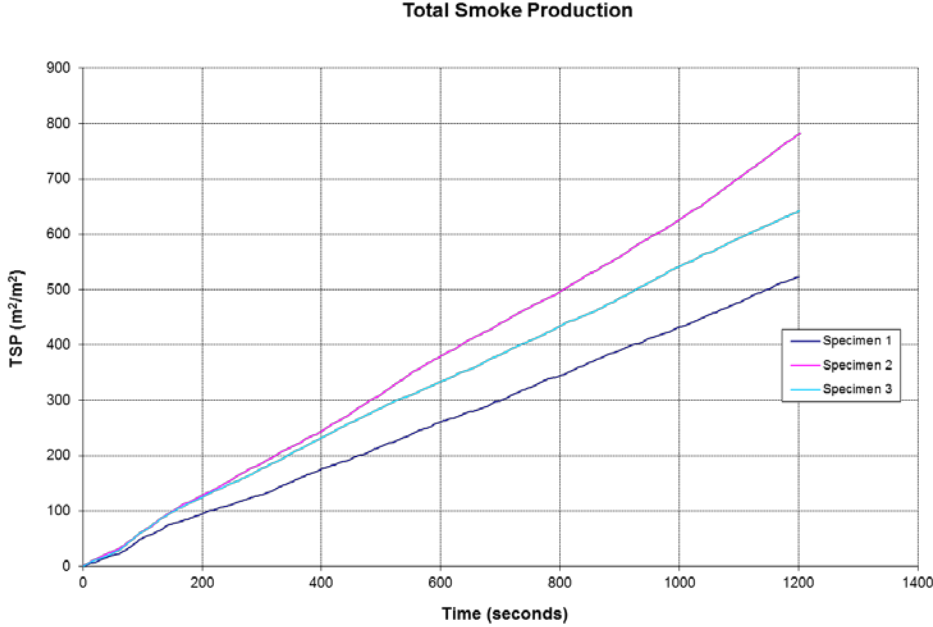
**Figure 2**



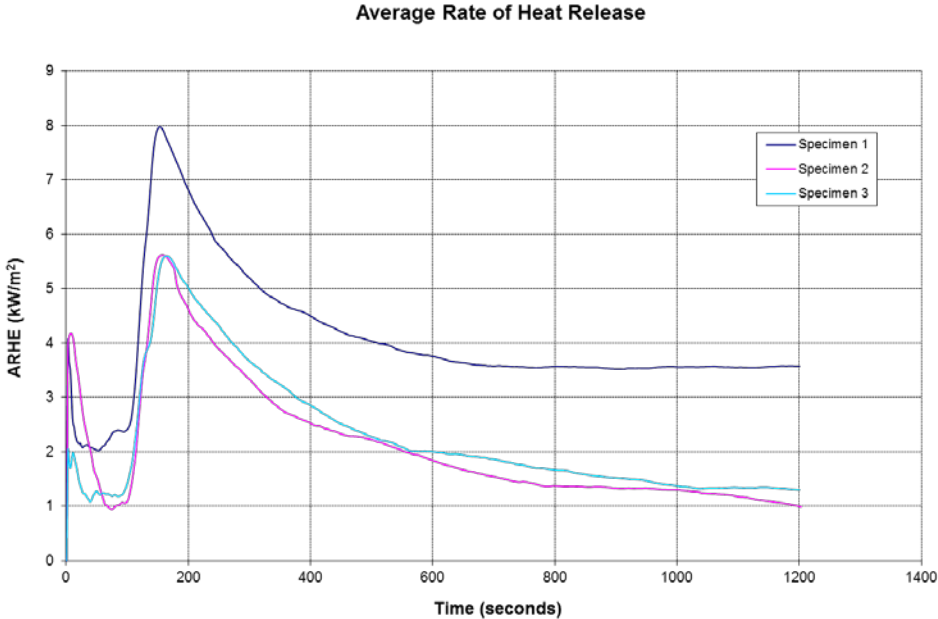
**Figure 3**



**Figure 4**



**Figure 5**



## Revision History

Issue No : 2	Re-issue Date: 8th May 2018
Revised By: T. Mort	Approved By: S. Deeming
Reason for Revision: This document replaces issue 1 (dated 9 <sup>th</sup> March 2018) of the same number which has been withdrawn. The total film thickness was stated incorrectly in the issue 1 report. This has been amended in this issue 2 report.	

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