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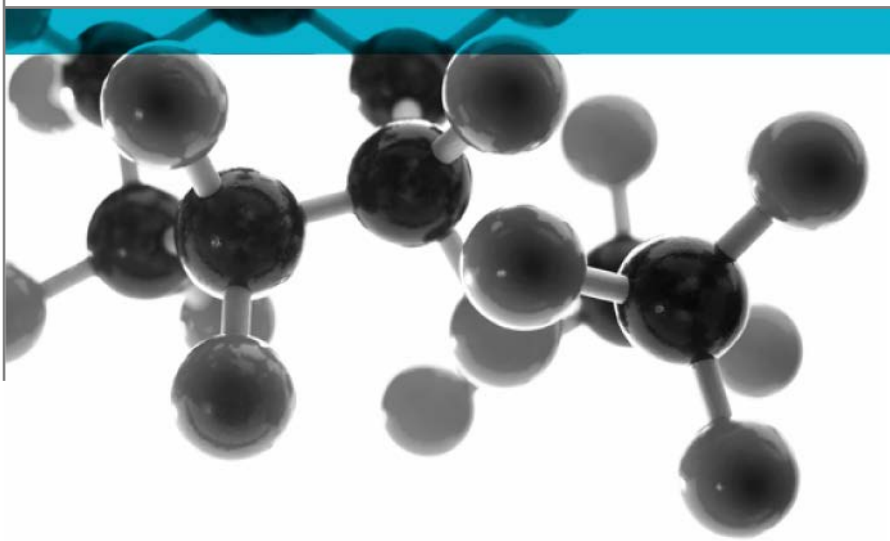
ISO 5660-1:2015+A1:2019



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

A Report To: IGP Pulvertechnik AG

Document Reference: 503849

Date: 20th May 2021

Issue No.: 1

0249

Executive Summary

Objective To determine the performance of the following product when tested in accordance with ISO 5660-1:2015+A1:2019

Generic Description	Product reference	Thickness	Weight per unit area or specific gravity
Polyester powder coating on aluminium	"IGP HWF Classic"	1.12mm*	2.92kg/m^{2*}
Individual components used to manufacture composite:			
Polyester coating	"59 Series"	0.06-0.08mm	1.60
Aluminium	"Aluminium"	0.7mm	Unable to provide
*** determined by** Warringtonfire			
Please see pages 5, 6 & 7 of this test report for the full description of the product tested			

Test Sponsor IGP Pulvertechnik AG, Ringstrasse 30, 9500 Wil, Switzerland

Test Results:

Peak Heat Release Rate	**=**	**208.54kW/m^2**
Total Heat Release	**=**	**3.60MJ/m^2**
MARHE	**=**	**33.8kW/m^2**

Please note that the averages stated are from six specimen runs. Please refer to page 7 of this test report for further information.

Date of Test 10th May 2021

Signatories

Responsible Officer H. Harper * Testing Officer	Authorised C. Jacques * Senior Technical Officer

* For and on behalf of Warringtonfire.

Report Issued: 20th May 2021

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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+A1:2019, “Heat release rate (Cone Calorimeter Method)” and “Smoke Production Rate (Dynamic Measurement)”.

This test was performed in accordance with the procedures specified in ISO 5660-1:2015+A1:2019 and this report should be read in conjunction with these standards.

Scope of test

ISO 5660-1:2015+A1:2019 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.

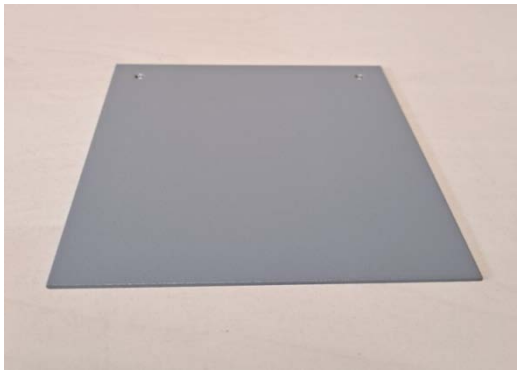
Test procedure

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 10th May 2021 at the request of IGP Pulvertechnik AG, the sponsor of the test.

Provision of test specimens	The specimens were supplied by the sponsor of the test. Warringtonfire was not involved in any selection or sampling procedure. The results stated in this report apply to the sample as received. The specimens were prepared in accordance with EN 45545-2: 2013+A1:2015 Annex D.
Conditioning of specimens	The specimens were received on the 4th May 2021. 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 face	The <face> face of each specimen was exposed to the igniting flame.
Condition of specimen edges	Coating applied to test face only, not applied to edges.
Photograph of specimen	
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	Six specimens were subjected to an irradiance of 50kW/m^2.
Frequency of measurement	The data was recorded every two seconds throughout the tests.
Orifice plate calibration factor	0.04183
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	C Lawrence

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 Warringtonfire**.** All values quoted are nominal, unless tolerances are given.

General description		Polyester powder coating on aluminium
Product reference of coating system		"IGP HWF Classic"
Name of manufacturer		IGP Pulvertechnik AG
Overall thickness		1.12mm (determined by Warringtonfire)
Overall weight per unit area		2.92kg/m^2 (determined by Warringtonfire)
Final coating product (Test face)	Generic type	Polyester coating
	Product reference	"59 Series"
	Name of manufacturer	IGP Pulvertechnik AG
	Colour reference	"A70370"
	Colour	Grey
	Number of coats	One
	Thickness per coat	60-80 microns
	Specific gravity	1.60
	Application method	Spray
	Flame retardant details	**See Note 1 Below**
	Curing process	**See Note 1 Below**
Substrate	Generic type	Aluminium
	Product reference	"Aluminium"
	Name of manufacturer	**See Note 1 Below**
	Thickness	0.7mm
	Weight per unit area / density	**See Note 1 Below**
	Flame retardant details	The substrate is inherently flame retardant
Brief description of manufacturing process of coatings		**See Note 1 Below**

Note 1: The sponsor 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.

Section 11.3.7 of ISO 5660-1:2015+A1:2019 states that initially three specimens are tested and the 180 s mean heat release readings shall be compared. If any of these mean readings differ by more than 10% from the arithmetic mean of the three readings, then a further set of three specimens shall be tested. In such cases, the arithmetic mean of the set of six specimens shall be reported.

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. Where this report is used to confirm compliance for use on European rolling stock as per the Technical Specification for Interoperability (LOC&PAS TSI (Commission Regulation (EU) No. 1302/2014)), all tests must have been conducted within the last 5 years or the test reports must have been reviewed within the last five years. 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	Test 4	Test 5	Test 6	Mean
Time to sustained flaming		seconds	64	53	68	61	64	56	61
Test duration		seconds	1200	1200	1200	1200	1200	1200	1200
Peak heat release rate	$\dot{q}_{max}$	kWm^{-2}	191.81	253.08	179.40	212.82	170.26	243.89	208.54
Time to peak heat release rate		seconds	66	60	68	64	66	60	64
Total heat release	$\dot{q}_{tot}$	MJm^{-2}	3.95	5.17	3.00	3.00	3.06	3.4	3.60
Average $\dot{q}''$ for 180 sec after ignition	$\dot{q}_{A,180}$	kWm^{-2}	15.59	20.81	11.56	12.38	12.01	15.93	14.71
Average $\dot{q}''$ for 300 sec after ignition	$\dot{q}_{A,300}$	kWm^{-2}	9.68	15.91	6.33	6.82	7.26	9.63	9.27
Initial specimen mass	$m_{initial}$	g	29.2	29.37	29.44	29.34	29.33	29.47	29.36
Final specimen mass	m_{final}	g	27.19	27.09	27.39	27.41	27.44	27.55	27.35
Mass loss		g/m^2	191.1	245.3	198.7	189.3	175.6	193.2	198.9
Average mass loss rate between ignition and end of test	m_A	$g\ m^{-2}\ s^{-1}$	0.16	0.19	0.18	0.15	0.15	0.16	0.17
Average mass loss rate between 10-90% of mass loss		$g\ m^{-2}\ s^{-1}$	0.59	0.72	0.56	0.69	0.44	0.77	0.63
Mass at sustained flaming		g	28.88	29.26	29.15	29.09	29.03	29.26	29.10
Smoke production non flaming phase	S_1''	dimensionless (m^2/m^2)	7.9	1.9	13.2	8.8	9.6	2.1	7.3
Smoke production flaming phase	S_2''	dimensionless (m^2/m^2)	69.6	83.3	81.3	118.6	71.8	62.0	81.1
Total smoke production	$S_1'' + S_2''$	dimensionless (m^2/m^2)	77.5	85.2	94.5	127.4	81.4	64.1	88.4

Supplementary calculations

Maximum average heat release (MARHE)	kW/m^2	31.4	45.3	29.7	33.1	27.2	36.3	33.8
Time to MARHE	seconds	86	78	90	82	84	76	83

Figure 1

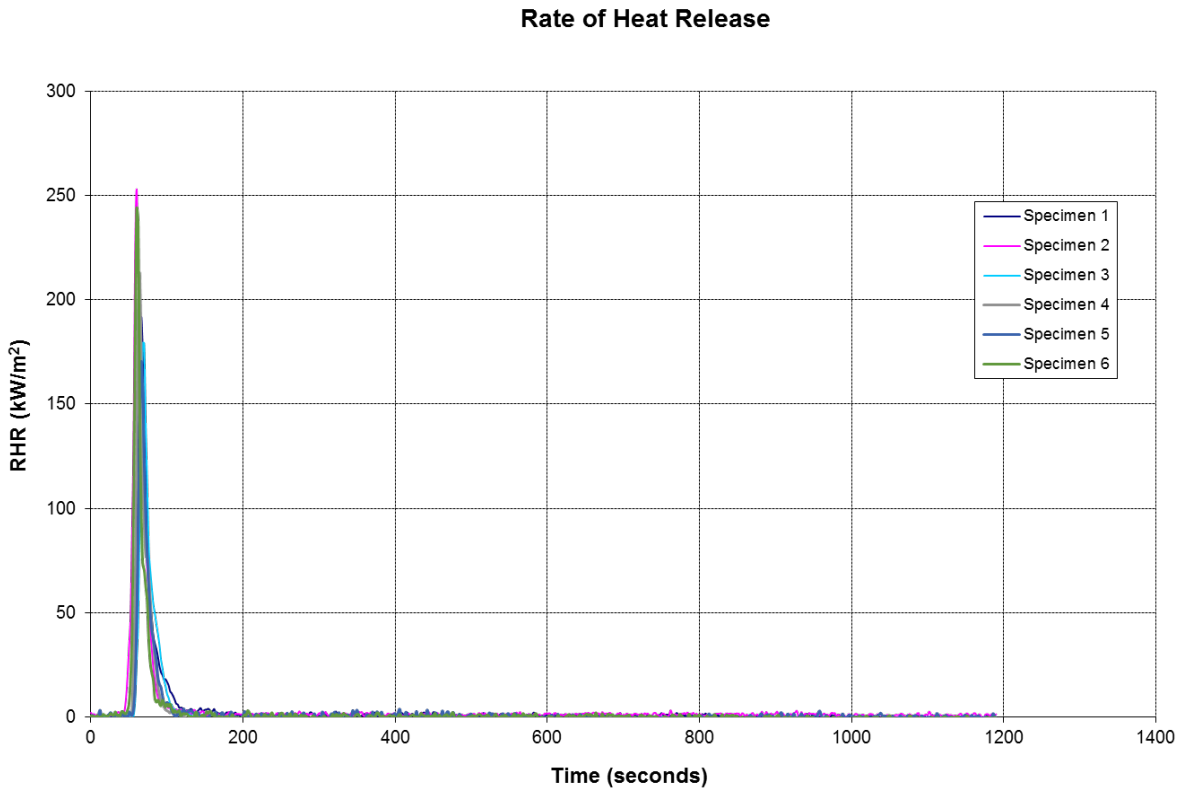


Figure 2

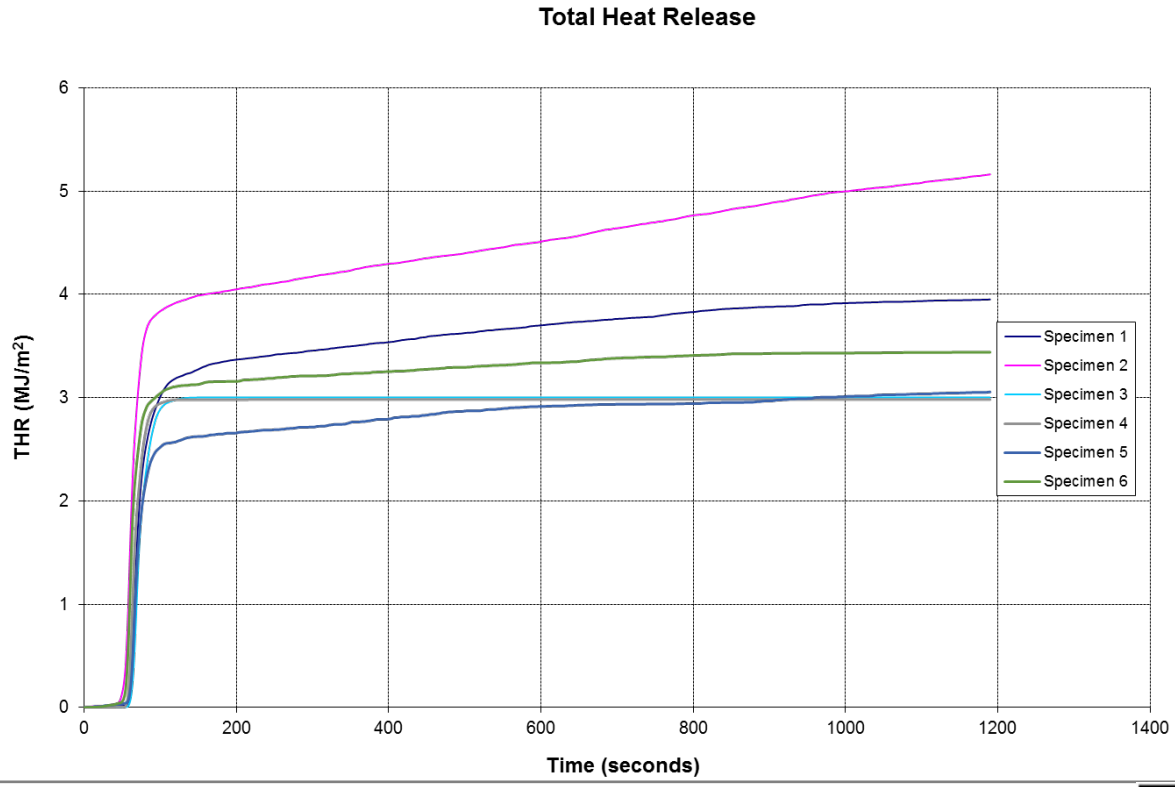


Figure 3

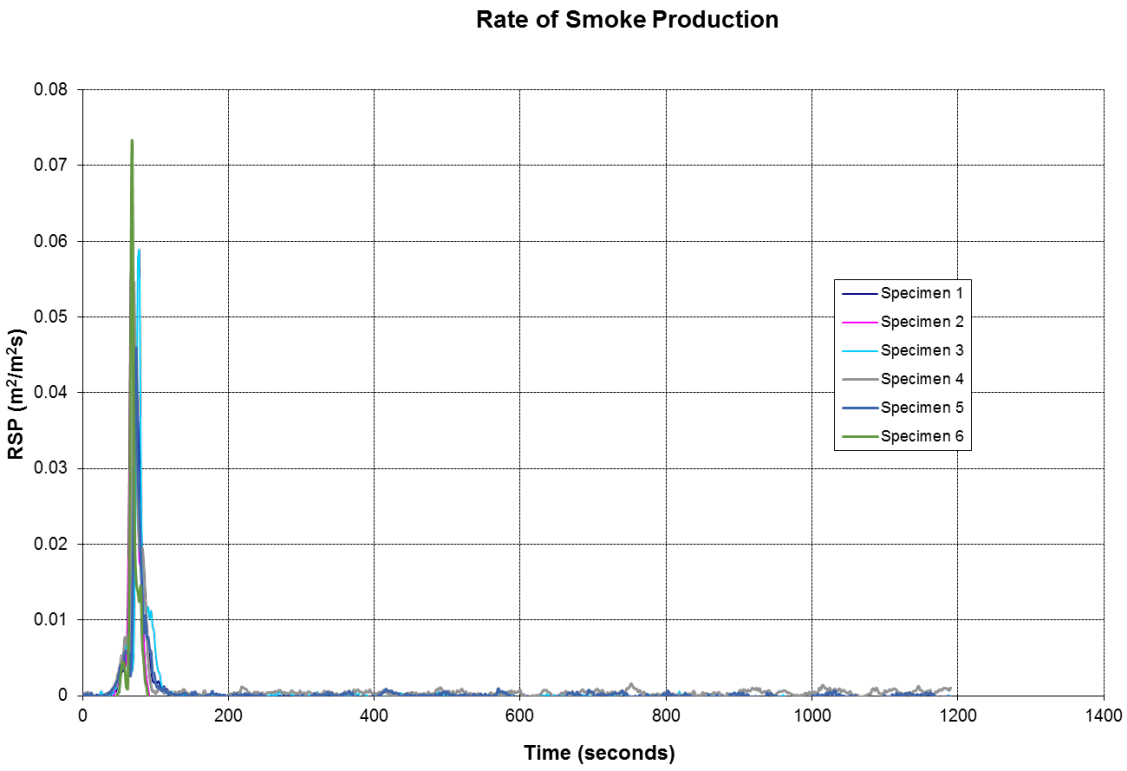


Figure 4

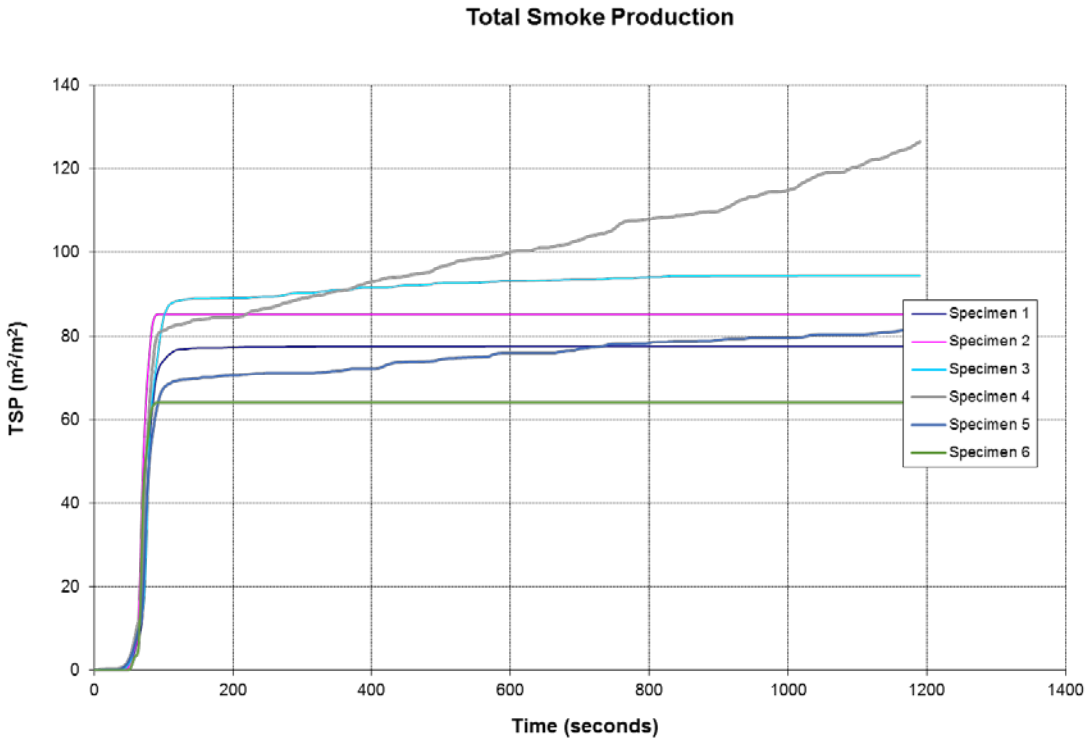
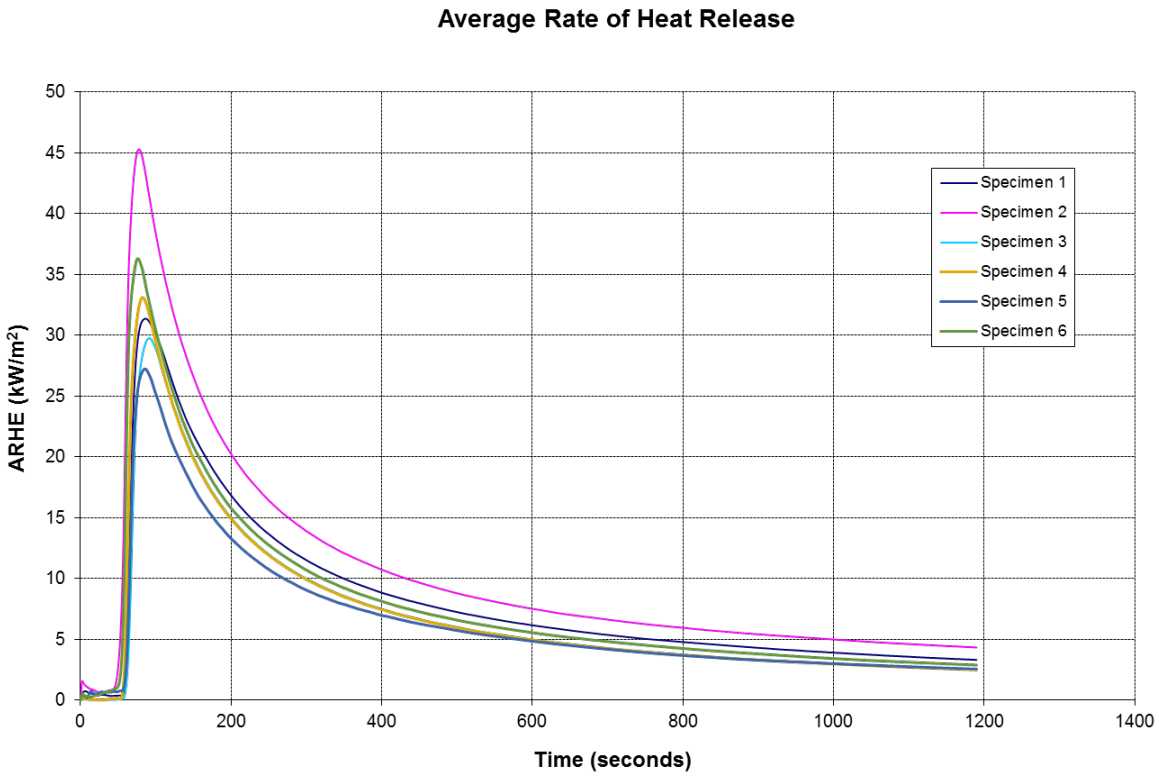


Figure 5


Average Rate of Heat Release
ARHE (kW/m²)
Time (seconds)
0
5
10
15
20
25
30
35
40
45
50
0
200
400
600
800
1000
1200
1400
Specimen 1
Specimen 2
Specimen 3
Specimen 4
Specimen 5
Specimen 6

Revision History

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

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