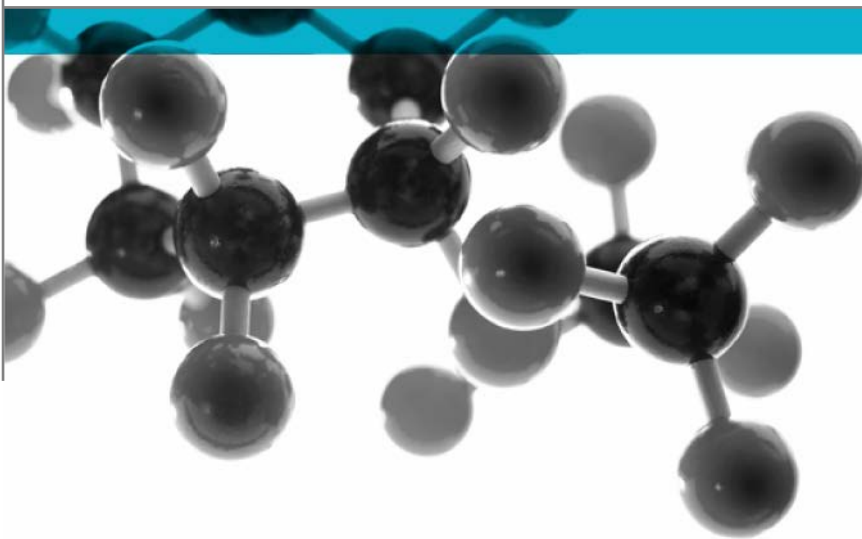


ISO 5660-1:2015+A1:2019



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

A Report To: Smyth Composites Ltd

Document Reference: 422292

Date: 13th January 2020

Issue No.: 1

Page 1



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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
Coated fibre reinforced phenolic resin sheet		"Phenclad"	3.5mm	3.4kg/m ²
Individual components used to manufacture composite:				
Coating		"AE 265/8"	Unable to provide	Unable to provide
Moulded sheet	Phenolic resin	"Cellobond"	Not applicable	Not applicable
	Fibre reinforcement	"Dong Yu"	Not applicable	2 x 600g/m ²
Please see pages 5, 6 & 7 of this test report for the full description of the product tested				

Test Sponsor Smyth Composites Ltd, Panmure Industrial Estate, Carnoustie, Angus, DD7 7NP


Test Results:


Peak Heat Release Rate	=	72.21kW/m²
Total Heat Release	=	30.4MJ/m²
MARHE	=	29.1kW/m²

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 11th December 2019

Signatories


Responsible Officer C. Jacques * Senior Technical Officer


Authorised T. Mort * Senior Technical Officer

* For and on behalf of [Warringtonfire](#).

Report Issued: 13th January 2020

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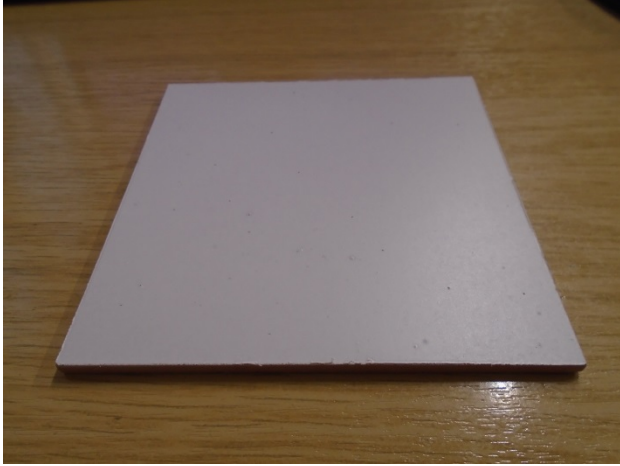
Test Details

Purpose of test	<p>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)”.</p> <p>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.</p> <p>This test was conducted under the requirements of our UKAS flexible scope of accreditation.</p>
Scope of test	<p>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.</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>
Fire test study group/EGOLF	<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>
Test procedure	<p>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 $100\text{mm} \times 100\text{mm}$ specimen, situated on a load cell. The heater is controlled by a temperature controller capable of holding the element temperature steady to within $\pm 2^\circ\text{C}$. 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.</p> <p>The heat release rate is calculated using the relationship that approximately $13.1 \times 10^3\text{kJ}$ 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>
Instruction to test	<p>The test was conducted on the 12th December 2019 at the request of Smyth Composites Ltd, the sponsor of the test.</p>
Provision of test specimens	<p>The specimens were supplied by the sponsor of the test. Warringtonfire was not involved in any selection or sampling procedure. The specimens were prepared in accordance with EN 45545-2: 2013+A1:2015 Annex D.</p>

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Conditioning of specimens	The specimens were received on the 2 nd December 2019. 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 $50 \pm 5\%$.
Test face	The smooth face of each specimen was exposed to the igniting flame.
Condition of specimen edges	Homogeneous product
Photograph of specimen	
Specimen preparation	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.
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	0.04307
Exhaust system flow rate	The exhaust flow rate was set to $0.024 \pm 0.002 \text{m}^3/\text{s}$.
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		Coated fibre reinforced phenolic resin sheet	
Product reference		"Phenclad"	
Name of manufacturer		Smyth Composites	
Colour		"White"	
Thickness		3.5mm (stated by sponsor) 3.83mm (determined by Warringtonfire)	
Weight per unit area		3.4kg/m ² (stated by sponsor) 4.77kg/m ² (determined by Warringtonfire)	
Coating	Generic type	2 pack polyurethane	
	Product reference	"AE 265/8"	
	Name of manufacturer	"Trimite"	
	Number of layers	See Note 1 Below	
	Specific gravity	See Note 1 Below	
	Application method	Spray	
	Colour reference	"Ral 9010" "White" (observed by Warringtonfire)	
	Flame retardant details	See Note 1 Below	
Moulded sheet	Resin	Generic type	Phenolic
		Product reference	"Cellobond"
		Name of manufacturer	Hexion
		Specific gravity/density	See Note 1 Below
		Flame retardant details	See Note 2 Below
	Glass reinforcement	Generic type	Powder bound chopped strand matt
		Product reference	"Dong Yu"
		Number of layers	2
		Weight per unit area of each layer	600g/m ²
		Configuration of glass reinforcement	See Note 1 Below
	Name of manufacturer		Dong Yu
	Resin to glass ratio (by weight)		2.7:1
	Percentage glass reinforcement (by weight)		27%
	Curing process (duration and temperature)		2 hours at 90°C
Brief description of manufacturing process		Hand lay	

Note 1: The sponsor of the test was unable to provide this information.

Note 2: The sponsor of the test has confirmed that no flame retardants were used in the production of this 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.

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.

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Table 1

PARAMETER		Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Mean
Time to sustained flaming	seconds	246	130	99	202	222	116	169
Test duration	seconds	1200	1200	1200	1200	1200	1200	1200
Peak heat release rate	\dot{q}_{max} kWm ⁻²	72.88	78.68	67.52	74.44	60.27	79.47	72.21
Time to peak heat release rate	seconds	380	266	294	214	240	284	280
Total heat release	\dot{q}_{tot} MJm ⁻²	32.15	29.81	27.92	34.40	26.47	31.50	30.39
Average $\dot{\phi}''$ for 180 sec after ignition	$\dot{q}_{A,180}$ kWm ⁻²	60.54	22.35	4.13	49.13	43.17	15.98	32.63
Average $\dot{\phi}''$ for 300 sec after ignition	$\dot{q}_{A,300}$ kWm ⁻²	56.62	33.65	19.24	53.12	43.90	34.01	40.09
Initial specimen mass	$m_{initial}$ g	47.69	47.87	47.88	47.39	47.16	47.70	47.62
Final specimen mass	m_{final} g	24.17	25.28	25.31	23.87	24.76	24.49	24.65
Mass loss	g/m ²	1896.4	2055.6	2227.3	1873.5	1810.6	2140.4	2000.6
Average mass loss rate between ignition and end of test	m_A g m ⁻² s ⁻¹	1.99	1.93	2.03	1.89	1.86	1.99	1.95
Average mass loss rate between 10-90% of mass loss	g m ⁻² s ⁻¹	2.07	2.02	2.21	1.94	1.94	2.14	2.05
Mass at sustained flaming	g	40.93	43.45	45.01	40.43	40.77	43.41	42.30
Smoke production non flaming phase	S_1'' dimensionless (m ² /m ²)	181.4	64.0	24.4	35.1	144.5	71.2	86.8
Smoke production flaming phase	S_2'' dimensionless (m ² /m ²)	2095.5	2014.4	1995.4	1237.4	1976.5	2522.7	1973.7
Total smoke production	$S_1'' + S_2''$ dimensionless (m ² /m ²)	2276.9	2078.4	2019.8	1272.6	2120.9	2593.9	2060.4
CO ₂ Yield	kg/kg	1.20	1.05	0.91	1.42	1.06	1.07	1.12
CO Yield	kg/kg	0.2514	0.2581	0.2234	0.2400	0.2617	0.2500	0.2486

Supplementary calculations

Maximum average heat release (MARHE)	kW/m ²	32.4	27.7	23.8	33.6	26.6	30.4	29.1
Time to MARHE	seconds	576	638	970	598	634	620	673

Figure 1

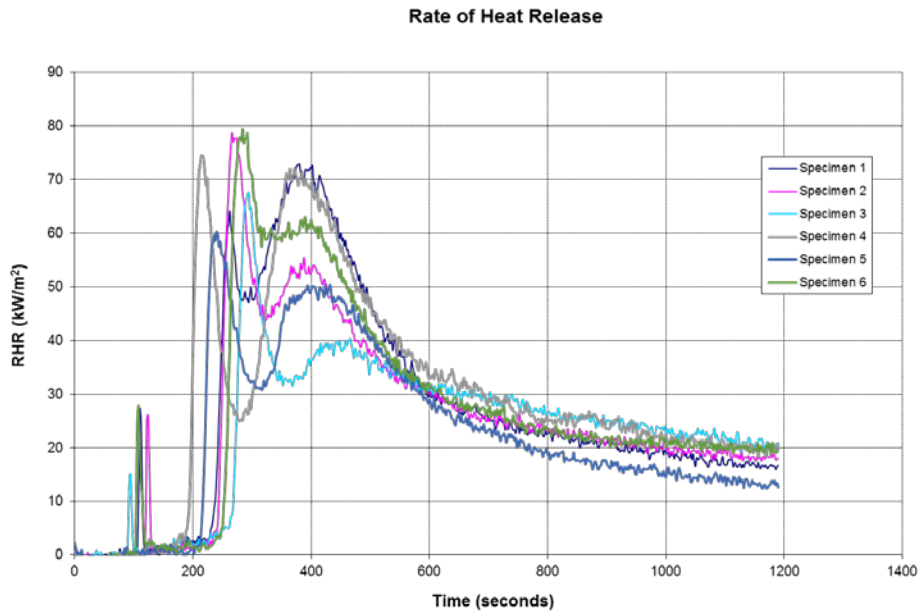


Figure 2

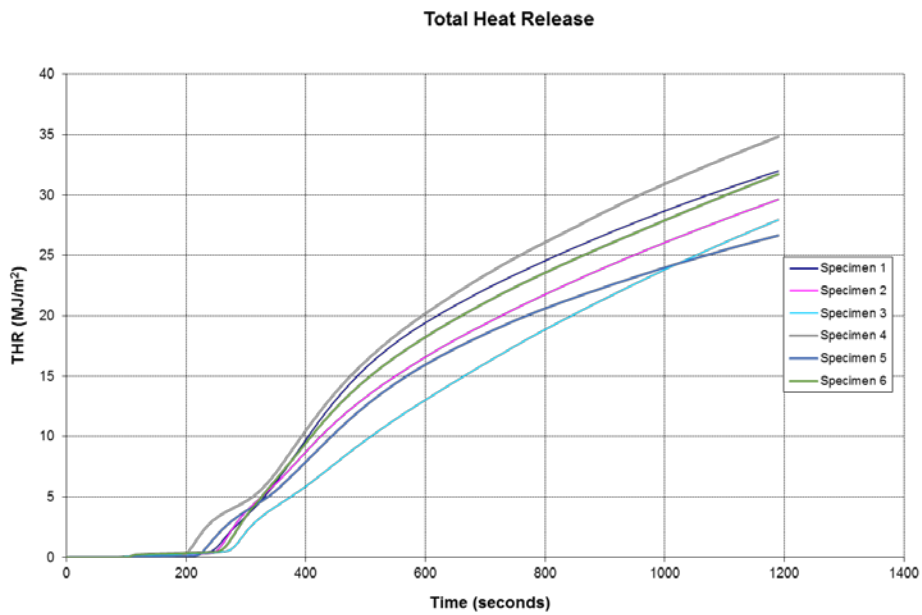


Figure 3

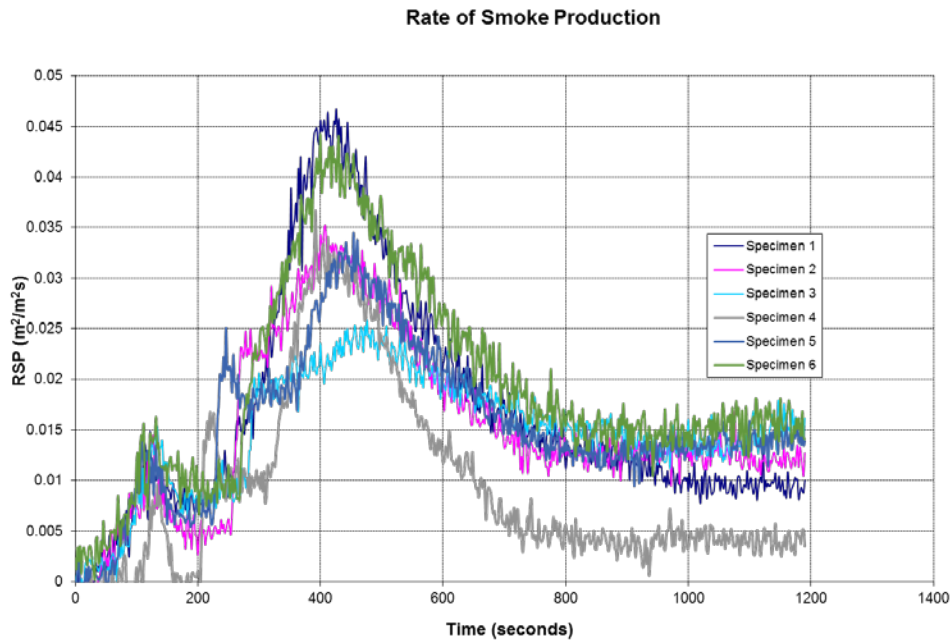


Figure 4

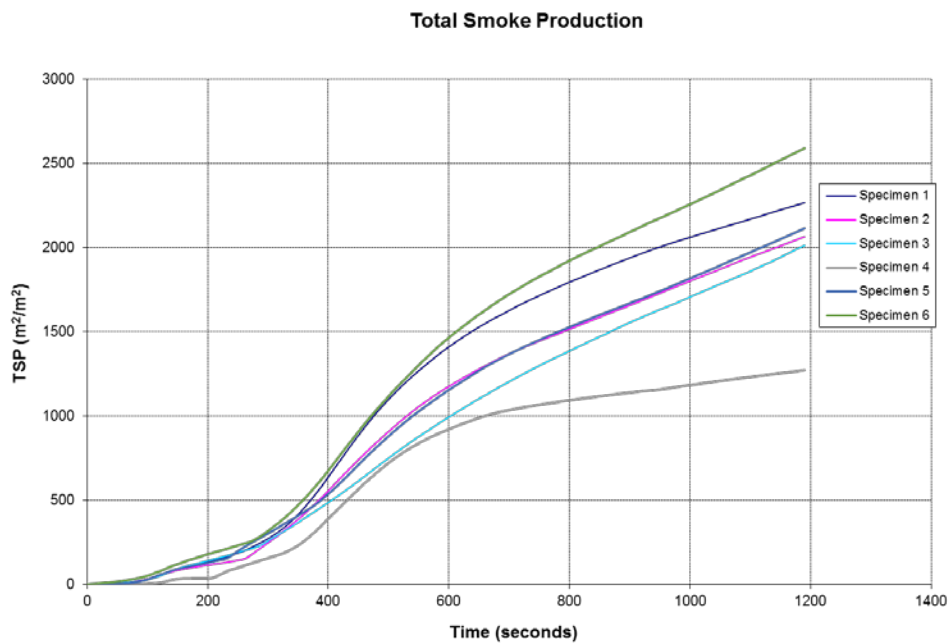
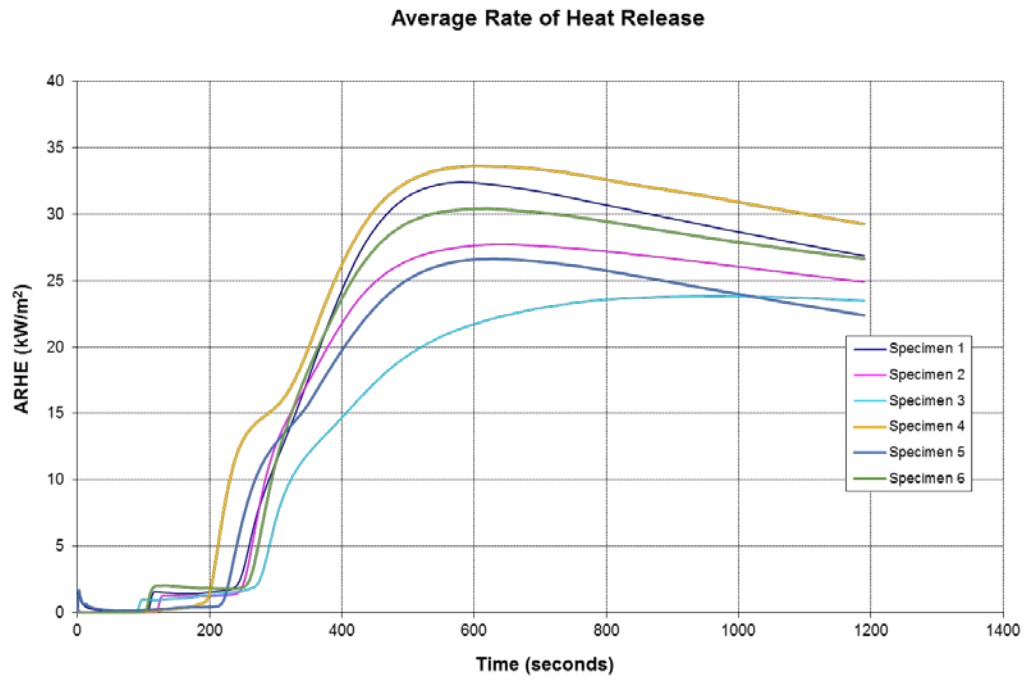


Figure 5



Revision History

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

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Revised By:	Approved By:
Reason for Revision:	