



HMG Powder Coatings

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European Specification EN 45545: Classification Statement Polyester Systems

Testing

This standard provides the reaction to fire classification procedure for all products used on building and transport products. The classification is achieved by carrying out three tests.

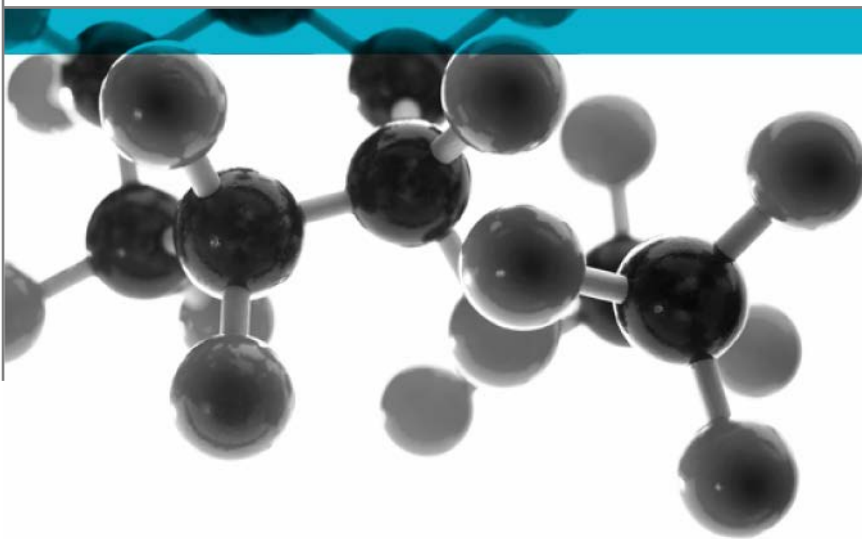
- ISO 5658-2:2006 + A1:2011 – Reaction to Fire – Spread of Flame. Lateral spread of flame test on building and transport products in vertical configuration.
- ISO 5660-1:2015 + A1:2019 – Heat Release Rate (Cone Calorimeter Method) and Smoke Production (Dynamic Measurement).
- BS EN 45545-2:2013 + A1:2015 – Smoke and Toxicity Assessment using ISO 5659-2:2017; Plastics – Smoke Generation. Part 2 Determination of Optical Density by a Single Chamber Method and Gas Analysis in the Smoke Box EN ISO 5659-2, using FTIR Technique.

HMG Powder Coatings Polyester 827, 837, 877, 916, and 924 Series were tested as indicative of the entire polyester range.

Classification

Report	Layers	Protection Requirement	Hazard Level	Test reports
509130	Single (1)	R1	HL1, HL2, HL3	507133
				507136
		R7	HL1, HL2, HL3	507139

EN 45545-2: 2013 + A1:2015



Summary Test Report – Requirement Table 5 (R1 & R7)

Test Method References “T02” (ISO 5658-2:2006+A1:2011. Spread of Flame - Lateral Spread of flame test on Building and Transport Products in Vertical Configuration), “T03.01” (ISO 5660-1: 2015+A1: 2019; Heat release rate (Cone Calorimeter Method) & Smoke Production Rate (Dynamic Measurement), “T10.01” / “T10.02” / “T10.04” (ISO 5659-2: 2017; Plastics – Smoke Generation. Part 2 Determination of Optical Density by a Single Chamber Method) and “T11.01” (Gas Analysis in the Smoke Box EN ISO 5659-2, using FTIR Technique)

A Report To: HMG Powder Coatings Limited

Document Reference: 509130

Date: 17th November 2021

Issue No.: 1

Page 1

Executive Summary

Objective To assess the results of tests performed in accordance with methods T02, T03.01, T10.01 / T10.02 / T10.04 and T11.01 as defined in EN 45545-2: 2013 + A1:2015 at an irradiance level of 50kW/m² without a pilot flame, on specimens of a product and to provide an opinion of compliance with the requirements for R1 & R7, as defined in EN 45545-2: 2013 + A1:2015.



Generic Description	Product reference	Thickness	Weight per unit area or density
Polyester powder coating on steel	"Polyester Powder Coating"	1.67mm	12589g/m ²
Individual components used to manufacture composite:			
Polyester powder coating	"827-2R905C-1456"	70±10µm	108.5±15.5g/m ²
Steel	"DD11"	1.6mm	12480g/m ²
Please see page 5 of this test report for the full description of the product tested			

Test Sponsor HMG Powder Coatings Limited, Dill Road, Castlereagh Industrial Estate, Belfast, BT6 9HU

Opinion We consider the results of the tests confirmed in reports referenced 507133, 507136 & 507139 to the test methods detailed above demonstrate that the product, as tested, complies with the requirements of R1 (detailed in Table 5 of EN 45545-2: 2013 + A1:2015) for a HL1, HL2 and HL3 Hazard Level Classification.

We consider the results of the tests confirmed in reports referenced 507133, 507136 & 507139 to the test methods detailed above demonstrate that the product, as tested, complies with the requirements of R7 (detailed in Table 5 of EN 45545-2: 2013 + A1:2015) for a HL1, HL2 and HL3 Hazard Level Classification.

Signatories

	
Responsible Officer E. Anderson * Testing Officer	Authorised T. Kinder * Senior Technical Officer

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

Report Issued: 17th November 2021

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Test Details

Terms Of Reference

To assess the results of tests performed in accordance with methods T02, T03.01, T10.01 / T10.02 / T10.04 and T11.01 as defined in EN 45545-2: 2013 + A1:2015 at an irradiance level of 50kW/m² without a pilot flame, on specimens of a product and to provide an opinion of compliance with the requirements for R1 & R7, as defined in EN 45545-2: 2013 + A1:2015.

Note – Method ‘T02’ requires testing in accordance with ISO 5658-2:2006. Warringtonfire conduct the test in accordance with the latest version of this standard (ISO 5658-2:2006 + A1:2011).

The only difference is the calculation used to determine the Qsb value. This is not required to classify in accordance with EN 45545-2:2015, and will therefore have no affect on the overall classification.

Introduction

Specimens of a product have been tested in accordance with the test methods “T02” (ISO 5658-2:2006+A1:2011. Spread of Flame - Lateral Spread of flame test on Building and Transport Products in Vertical Configuration), “T03.01” (ISO 5660-1: 2015+A1: 2019; Heat release rate (Cone Calorimeter Method) & Smoke Production Rate (Dynamic Measurement), “T10.01” / “T10.02” / “T10.04” (ISO 5659-2: 2017; Plastics – Smoke Generation. Part 2 Determination of Optical Density by a Single Chamber Method) and “T11.01” (Gas Analysis in the Smoke Box EN ISO 5659-2, using FTIR Technique) as specified in EN 45545-2:2013 + A1:2015 “Requirements for Fire Behaviour of Materials and Components”. The results of the tests are fully reported in the Warringtonfire test reports No's. 507133, 507136 & 507139.

This summary report has been prepared at the request of the sponsor and relates the results of the tests to the requirements for R1 & R7, as defined in Table 5 of EN 45545-2: 2013 + A1:2015.

This summary should be read in conjunction with, and not accepted as a substitute for the Warringtonfire test reports No's. 507133, 507136 & 507139. Those test reports may include additional information which may be relevant to the assessment of the potential fire hazard of the product. Where this assessment covers a system used on European rolling stock covered by 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.

Face subjected to tests

The specimens were mounted in the test positions such that the coated face was exposed to the heating conditions of the tests.

Results of test

The following results were obtained for the specimens, which were tested.

“T02” ISO 5658-2:2006+A1:2011

Critical flux at extinguishment (CFE) = 44.03kW/m²

Flaming droplets with sustained flaming (>10s) = No

“T03.01” ISO 5660-1: 2015+A1: 2019

MARHE = 16.1kW/m²

“T10.01” / “T10.02” / T10.04 ISO 5659-2: 2017

Ds (4) = 62.
VOF4 = 54.
Ds max. = 131.

Document No.: 509130

Author: E. Anderson

Client: HMG Powder Coatings Limited

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**“T11.01” Gas
Analysis in the
Smoke Box ISO,
Using FTIR
Technique**

CIT_{4mins} = 0.01.
CIT_{8mins} = 0.02.

**Applicability of
test results**

The test results relate only to the behaviour of the test specimens of the product under the particular conditions of the test, they are not intended to be the sole criterion for assessing the potential 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 with the specimens which were tested.

Description of Test Specimens

The description of the specimens 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 steel
Product reference of coating system		"Polyester Powder Coating"
Name of manufacturer		HMG Powder Coatings Ltd
Overall thickness		1.67mm (stated by sponsor) 1.65mm (determined by Warringtonfire)
Overall weight per unit area		12589g/m ² (stated by sponsor) 12320.16g/m ² (determined by Warringtonfire)
Final coating product (Test face)	Generic type	Polyester powder coating
	Product reference	"827-2R905C-1456"
	Name of manufacturer	HMG Powder Coatings Ltd
	Colour reference	"RAL 9005"
	Colour	Jet black
	Number of coats	One
	Thickness per coat	70±10µm
	Application rate	108.5±15.5g/m ²
	Specific gravity	1.55
	Application method	Electrostatic spray
	Flame retardant details	See Note 1 Below
	Curing process	Gas fired oven: 10 minutes at 180°C
Substrate	Generic type	Steel
	Product reference	"DD11"
	Name of manufacturer	See Note 2 Below
	Thickness	1.6mm
	Weight per unit area / density	12480g/m ²
Flame retardant details		The product is inherently flame retardant
Brief description of manufacturing process of coatings		Dry mixing, extrusion and milling of a mixture of resins, pigments and additives

Note 1: The sponsor of the test has confirmed that no flame retardant additives were utilised in the production of the component.

Note 2: The sponsor was unwilling to provide this information.

Classification

Opinion

We consider the results of the tests confirmed in reports referenced 507133, 507136 & 507139 to the test methods detailed above demonstrate that the product, as tested, complies with the requirements of R1 (detailed in Table 5 of EN 45545-2: 2013 + A1:2015) for a HL1, HL2 and HL3 Hazard Level Classification.

We consider the results of the tests confirmed in reports referenced 507133, 507136 & 507139 to the test methods detailed above demonstrate that the product, as tested, complies with the requirements of R7 (detailed in Table 5 of EN 45545-2: 2013 + A1:2015) for a HL1, HL2 and HL3 Hazard Level Classification.

Validity of opinion

This opinion is based on the requirements of EN 45545-2: 2013 + A1:2015 at the date of this report. If EN 45545-2 is revised or amended in any way subsequent to that date, care must be taken to ensure that this opinion is not invalidated by those revisions or amendments.

The opinion has been formulated on the assumption that the specimens are representative of the product in practice. Warringtonfire was not involved in any sampling or selection procedures which would confirm this or in any audit testing which would provide confidence in the consistency of the product in the tests.

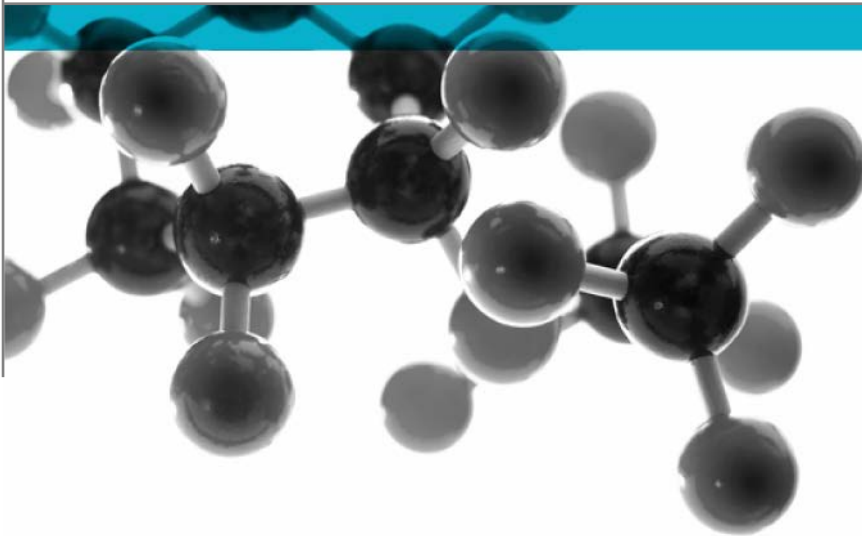
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Revision History

Issue No :	Re - Issue Date:
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Reason for Revision:	

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

ISO 5658-2:2006+A1:2011



Reaction to Fire Tests – Spread of Flame - Lateral Spread of flame test on Building and Transport Products in Vertical Configuration

A Report To: HMG Powder Coatings Limited

Document Reference: 507133

Date: 20th September 2021

Issue No.: 1

Page 1



0249

Executive Summary

Objective To determine the performance of the following product when tested in accordance with ISO 5658-2:2006+A1:2011

Generic Description	Product reference	Thickness	Weight per unit area or density
Polyester powder coating on steel	"Polyester Powder Coating"	1.67mm	12589g/m ²
Individual components used to manufacture composite:			
Polyester powder coating	"827-2R905C-1456"	70±10µm	108.5±15.5g/m ²
Steel	"DD11"	1.6mm	12480g/m ²
Please see page 5 of this test report for the full description of the product tested			

Test Sponsor HMG Powder Coatings Limited, Dill Road, Castlereagh Industrial Estate, Belfast, BT6 9HU

Summary of Test Results:



Parameter	Units	Specimen Number			Average
		1	2	3	
Heat for Sustained Burning (Q _{sb})	MJm ⁻²	*	*	5.88	5.88
Critical flux at Extinguishment (CFE)	kW/m ² (±4%)	50.00	50.00	32.10	44.03
Flaming droplets with sustained flaming (>10s)	N/A	No	No	No	N/A

* Unable to calculate due to insufficient flame travel

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k=2, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Date of Test 9th August 2021

Signatories

	
Responsible Officer E. Anderson * Testing Officer	Authorised T. Kinder * Senior Technical Officer

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

Report Issued: 20th September 2021

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Document No.: 507133

Page No.: 2 of 8

Author: E. Anderson

Issue Date: 20th September 2021

Client: HMG Powder Coatings Limited

Issue No.: 1



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Test Details

Introduction

A test has been conducted in accordance with the procedure specified in ISO 5658-2:2006+A1:2011 Reaction to Fire Tests – Spread of Flame – Part 2: Lateral Spread on Building and Transport Products in Vertical Configuration on the specimens detailed in this report. The test was conducted using an impinging propane flame. It is advised that this report is read in conjunction with the aforementioned document.

Scope of test

ISO 5658-2:2006+A1:2011 specifies a method of test for measuring the lateral spread of flame along the surface of a specimen of a product orientated in the vertical position. It provides data suitable for comparing the performance of essentially flat materials, composites or assemblies, which are used primarily as the exposed surfaces of walls.

Instruction to test

The test was conducted on the 9th August 2021 at the request of HMG Powder Coatings Limited, the sponsor of the test.

Conditioning of specimens

The specimens were received on the 29th July 2021.

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 $50 \pm 5\%$.

Exposed face

The coated face of the specimens was exposed to the radiant heat of the test when the specimens were mounted in the test position.

Condition of specimen edges

Coating applied to test face, including the edges.

Photograph of specimen



Substrate

The coatings were applied to a 1.6mm thick steel substrate.

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.

Description of Test Specimens

The description of the specimens 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 steel
Product reference of coating system		"Polyester Powder Coating"
Name of manufacturer		HMG Powder Coatings Ltd
Overall thickness		1.67mm (stated by sponsor) 1.65mm (determined by Warringtonfire)
Overall weight per unit area		12589g/m ² (stated by sponsor) 12320.16g/m ² (determined by Warringtonfire)
Final coating product (Test face)	Generic type	Polyester powder coating
	Product reference	"827-2R905C-1456"
	Name of manufacturer	HMG Powder Coatings Ltd
	Colour reference	"RAL 9005"
	Colour	Jet black
	Number of coats	One
	Thickness per coat	70±10µm
	Application rate	108.5±15.5g/m ²
	Specific gravity	1.55
	Application method	Electrostatic spray
	Flame retardant details	See Note 1 Below
	Curing process	Gas fired oven: 10 minutes at 180°C
Substrate	Generic type	Steel
	Product reference	"DD11"
	Name of manufacturer	See Note 2 Below
	Thickness	1.6mm
	Weight per unit area / density	12480g/m ²
	Flame retardant details	The product is inherently flame retardant
Brief description of manufacturing process of coatings		Dry mixing, extrusion and milling of a mixture of resins, pigments and additives

Note 1: The sponsor of the test has confirmed that no flame retardant additives were utilised in the production of the component.

Note 2: The sponsor was unwilling to provide this information.

Test Results

Applicability of test results

The test results relate only to the behaviour of the specimens of the product under the particular conditions of the 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 manufactured product in the form in which they are tested. Small differences in the composition or thickness of the product may significantly affect the performance during the test and may therefore invalidate the test results. Care should be taken to ensure that any product which is supplied or used is fully represented by the specimens which were tested.

The test results relating to the spread of flame parameters for the individual specimens together with observations made during the test and comments on any difficulties encountered during the test are given in Table 1.

Test results

A total of three specimens were tested and the following results were obtained

Parameter	Units	Specimen Number			Average
		1	2	3	
Heat for Sustained Burning (Q_{sb})	MJm ⁻²	*	*	5.88	5.88
Critical flux at Extinguishment (CFE)	kW/m ² (±4%)	50.00	50.00	32.10	44.03
Flaming droplets with sustained flaming (>10s)	N/A	No	No	No	N/A

* Unable to calculate due to insufficient flame travel

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k=2$, providing a coverage probability of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

Validity

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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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Client: HMG Powder Coatings Limited

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Appendix 1 – Observations during test

Specimen No:	1		Heat for Sustained Burning (MJ/m ²)	2		Heat for Sustained Burning (MJ/m ²)	3		Heat for Sustained Burning (MJ/m ²)
Time to Ignition: (min:sec)	01:37			01:39			01:14		
Time to Travel	min	sec		min	sec		min	sec	
50mm	01	45	5.30				01	21	4.09
100mm							01	35	4.70
150mm							02	02	5.75
200mm							02	12	5.69
250mm							02	44	6.20
300mm									
350mm									
400mm									
450 mm									
500mm									
550mm									
600mm									
650mm									
700mm									
750mm									
800mm									
Duration of Test (min:sec)	13:42			12:52			13:48		
Final Travel (mm)	50			30			290		
C.F.E. (kw/m ²)	50.00			50.00			32.10		

OBSERVATIONS:

None.

Revision History

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507133

Page No.:

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Author:

E. Anderson

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20th September 2021

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HMG Powder Coatings Limited

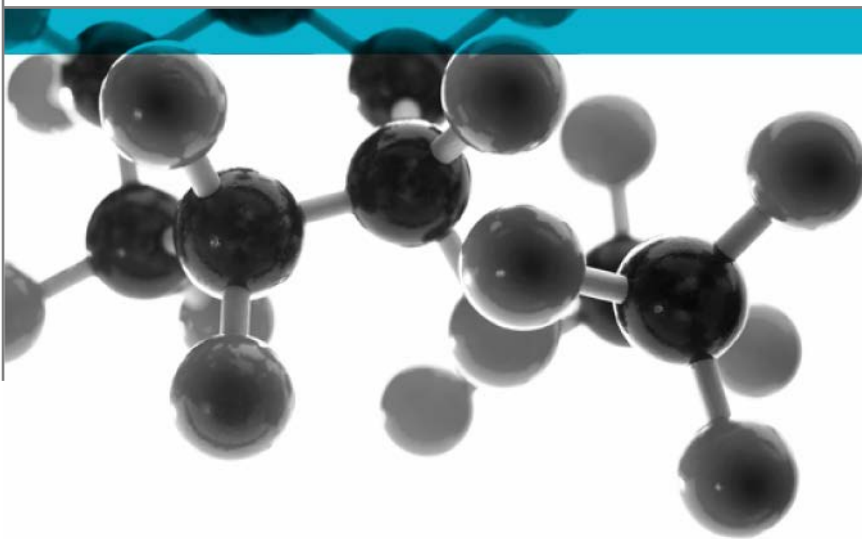
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ISO 5660-1:2015+A1:2019



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

A Report To: HMG Powder Coatings Limited

Document Reference: 507136

Date: 24th September 2021

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 or density
Polyester powder coating on steel	"Polyester Powder Coating"	1.67mm	12589g/m ²
Individual components used to manufacture composite:			
Polyester powder coating	"827-2R905C-1456"	70±10µm	108.5±15.5g/m ²
Steel	"DD11"	1.6mm	12480g/m ²
Please see page 6 of this test report for the full description of the product tested			

Test Sponsor HMG Powder Coatings Limited, Dill Road, Castlereagh Industrial Estate, Belfast, BT6 9HU


Test Results:


Peak Heat Release Rate	=	83.02kW/m²
Total Heat Release	=	4.00MJ/m²
MARHE	=	16.1kW/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 16th August 2021

Signatories


Responsible Officer D. Roberts * Testing Officer


Authorised C. Jacques * Senior Technical Officer

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

Report Issued: 24 th September 2021
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Author: D. Roberts

Issue Date: 24th September 2021

Client: HMG Powder Coatings Limited

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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 $100\text{mm} \times 100\text{mm}$ 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.

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.

Instruction to test

The test was conducted on the 16th August 2021 at the request of HMG Powder Coatings limited, 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.

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D. Roberts

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24th September 2021

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HMG Powder Coatings Limited

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The specimens were prepared in accordance with EN 45545-2: 2013+A1:2015 Annex D.

Conditioning of specimens

The specimens were received on the 29th July 2021.

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 decorative face of each specimen was exposed to the igniting flame.

Condition of specimen edges

Coating applied to all faces, including the edges.

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

0.04229

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

Document No.:

507136

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Author:

D. Roberts

Issue Date:

24th September 2021

Client:

HMG Powder Coatings Limited

Issue No.:

1



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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 steel
Product reference of coating system		"Polyester Powder Coating"
Name of manufacturer		HMG Powder Coatings Ltd
Overall thickness		1.67mm (stated by sponsor) 1.63mm (determined by Warringtonfire)
Overall weight per unit area		12589g/m ² (stated by sponsor) 12128g/m ² (determined by Warringtonfire)
Final coating product (Test face)	Generic type	Polyester powder coating
	Product reference	"827-2R905C-1456"
	Name of manufacturer	HMG Powder Coatings Ltd
	Colour reference	"RAL 9005"
	Colour	Jet black
	Number of coats	One
	Thickness per coat	70±10µm
	Application rate	108.5±15.5g/m ²
	Specific gravity	1.55
	Application method	Electrostatic spray
	Flame retardant details	See Note 1 Below
Curing process		Gas fired oven: 10 minutes at 180°C
Substrate	Generic type	Steel
	Product reference	"DD11"
	Name of manufacturer	See Note 2 Below
	Thickness	1.6mm
	Weight per unit area / density	12480g/m ²
Flame retardant details		The product is inherently flame retardant
Brief description of manufacturing process of coatings		Dry mixing, extrusion and milling of a mixture of resins, pigments and additives

Note 1: The sponsor of the test has confirmed that no flame retardant additives were utilised in the production of the component.

Note 2: The sponsor was unwilling 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.

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Author:

D. Roberts

Issue Date:

24th September 2021

Client:

HMG Powder Coatings Limited

Issue No.:

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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	115	123	113	124	123	116	119	
Test duration seconds	1200	1200	1200	1200	1200	1200	1200	
Peak heat release rate \dot{q}_{max} kWm ⁻²	84.32	71.64	87.62	82.58	79.3	92.65	83.02	
Time to peak heat release rate seconds	124	128	120	134	128	122	126	
Total heat release \dot{q}_{tot} MJm ⁻²	5.35	4.28	4.13	2.8	3.25	4.3	4.00	
Average ϕ'' for 180 sec after ignition $\dot{q}_{A,180}$ kWm ⁻²	16.39	13.93	17.27	14.10	15.66	15.48	15.47	
Average ϕ'' for 300 sec after ignition $\dot{q}_{A,300}$ kWm ⁻²	10.41	8.85	10.76	7.91	9.43	9.71	9.51	
Initial specimen mass $m_{initial}$ g	123.23	122.78	123.46	123.83	122.71	122.56	123.10	
Final specimen mass m_{final} g	120.93	120.89	121.4	121.89	120.69	120.65	121.08	
Mass loss g/m ²	222	171.4	197.5	183.9	196.4	165.5	189.5	
Average mass loss rate between ignition and end of test m_A g m ⁻² s ⁻¹	0.21	0.16	0.18	0.16	0.18	0.15	0.17	
Average mass loss rate between 10-90% of mass loss g m ⁻² s ⁻¹	0.35	0.54	0.85	0.590	0.95	0.810	0.68	
Mass at sustained flaming g	122.9	122.41	123.15	123.52	122.43	122.12	122.8	
Smoke production non flaming phase dimensionless (m ² /m ²)	S_1''	17.9	21.8	22.3	21.90	24.5	19.80	21.4
Smoke production flaming phase dimensionless (m ² /m ²)	S_2''	39.9	30.4	59	41.90	39.1	47.20	42.9
Total smoke production dimensionless (m ² /m ²)	$S_1'' + S_2''$	57.8	52.2	81.2	63.80	63.6	67.00	64.3
CO₂ Yield kg/kg	1.32	1.33	1.46	1.30	1.66	1.54	1.44	
CO Yield kg/kg	0.0418	0.1639	0.1872	0.03	0.0448	0.06	0.0881	

Supplementary calculations

Maximum average heat release (MARHE)	kW/m ²	17	14	18	14.90	16	16.70	16.1
Time to MARHE	seconds	162	174	164	172	180	166	170

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Client: HMG Powder Coatings Limited

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Figure 1

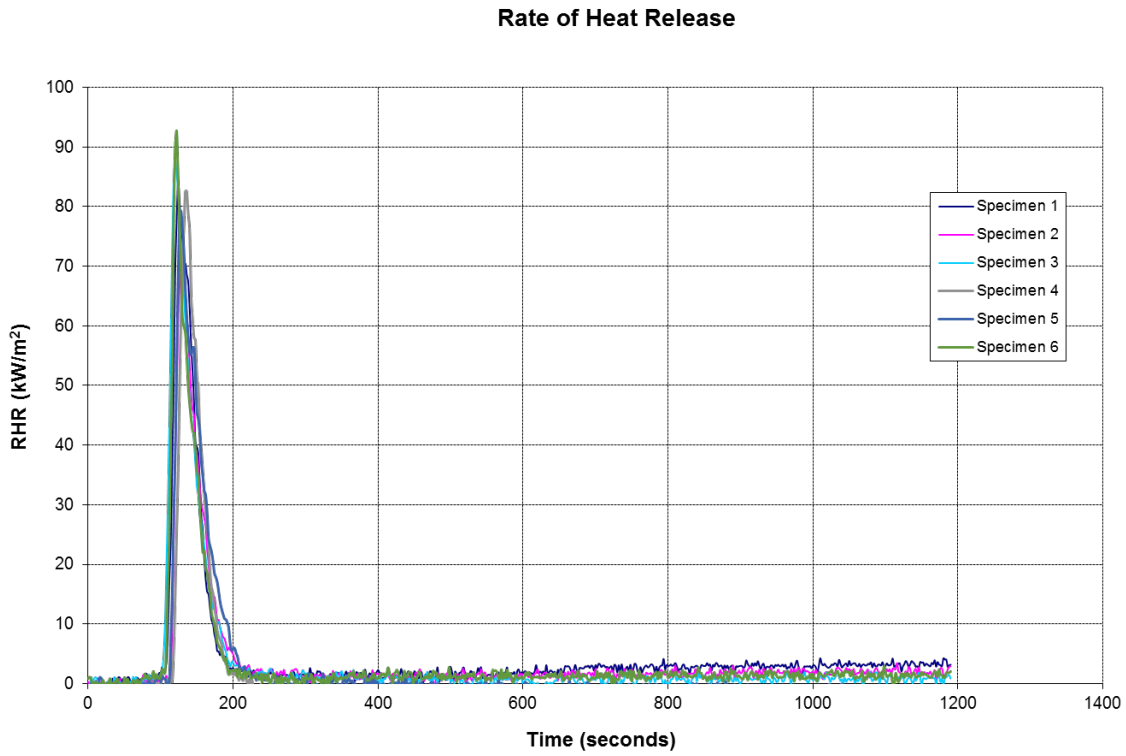


Figure 2

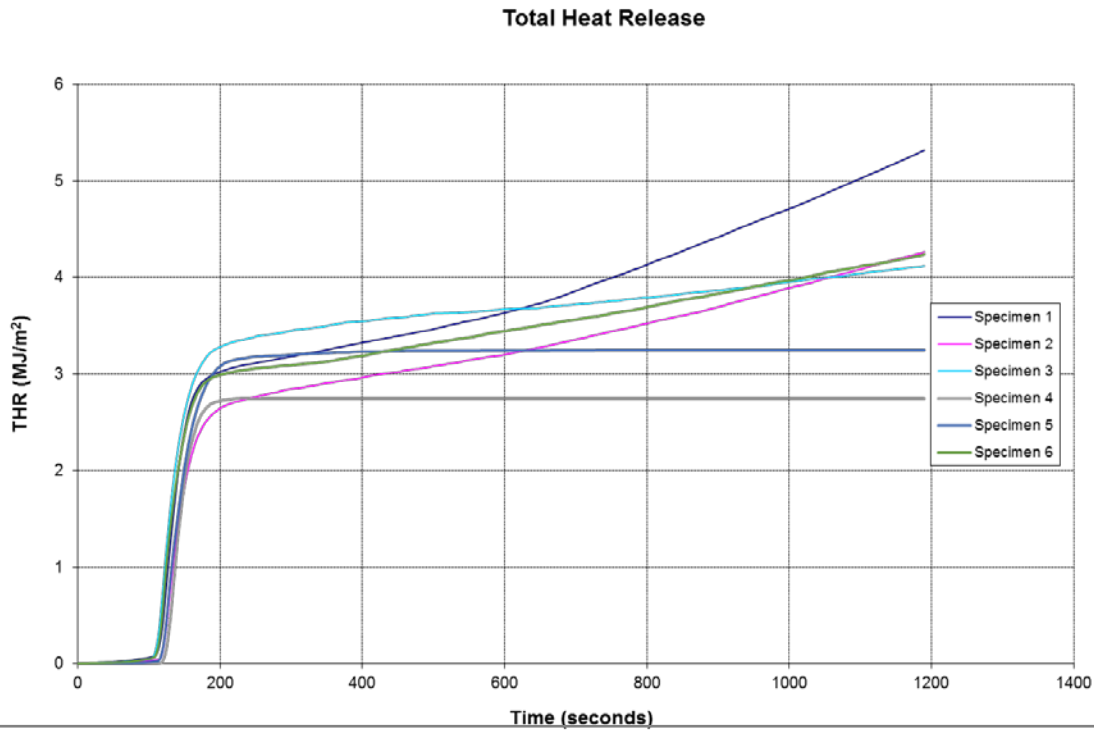


Figure 3

Rate of Smoke Production

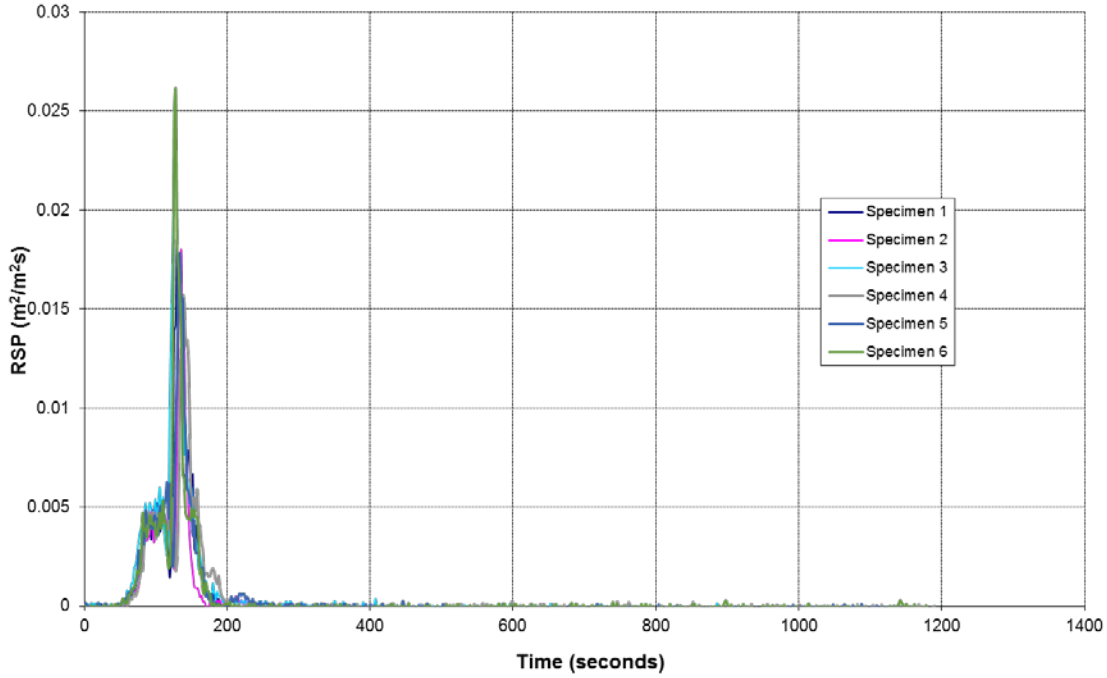


Figure 4

Total Smoke Production

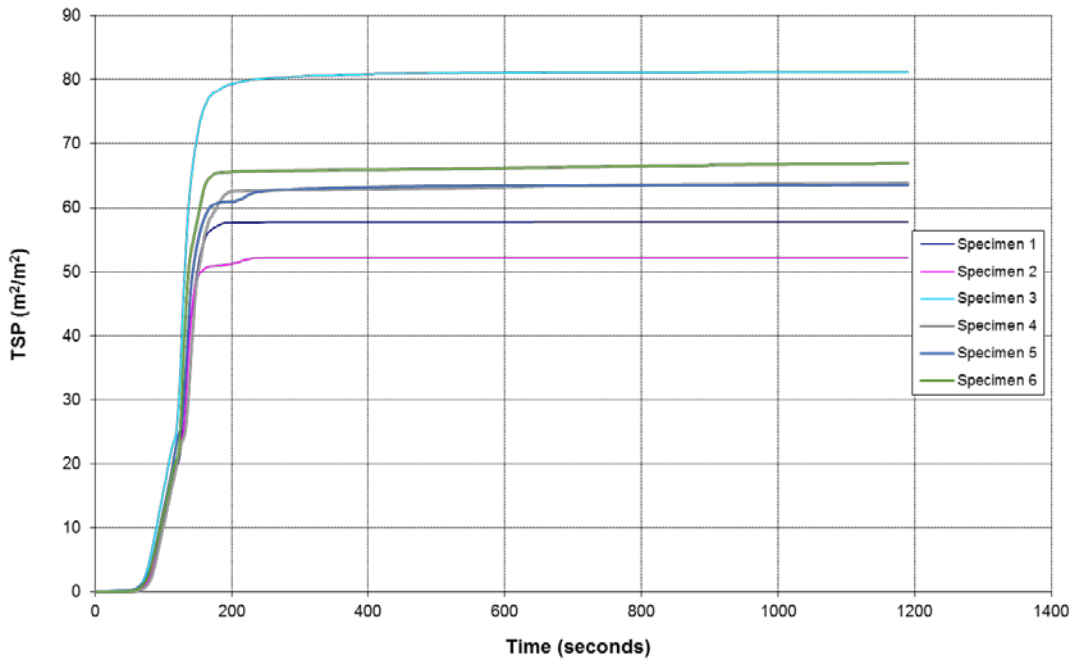
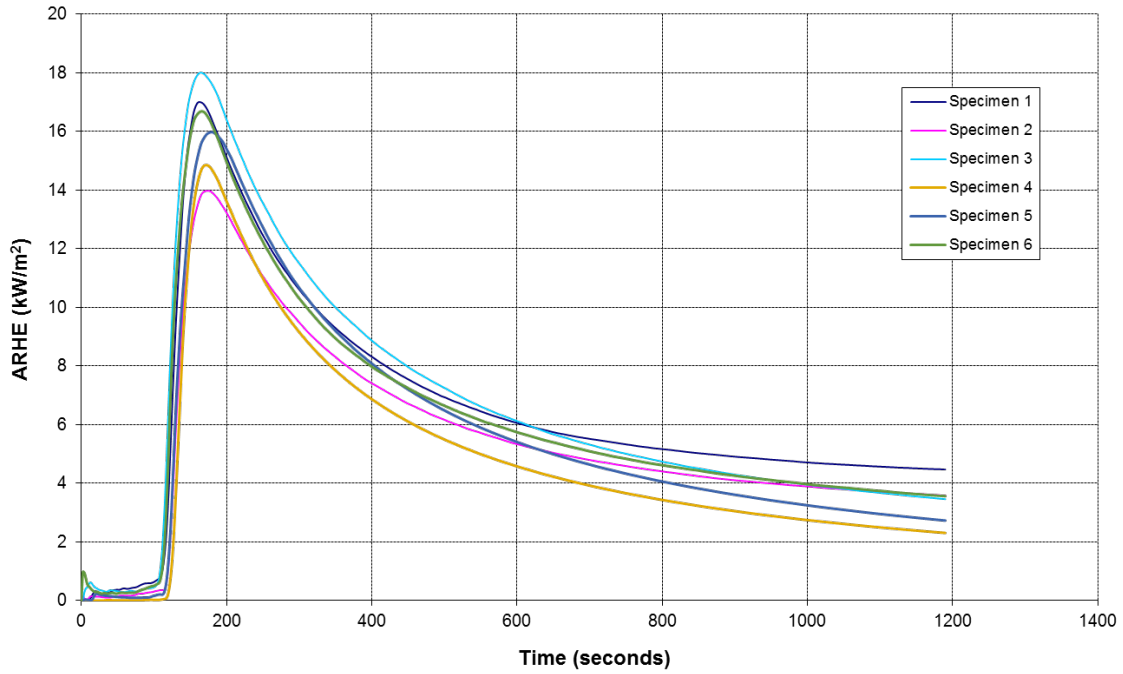


Figure 5

Average Rate of Heat Release



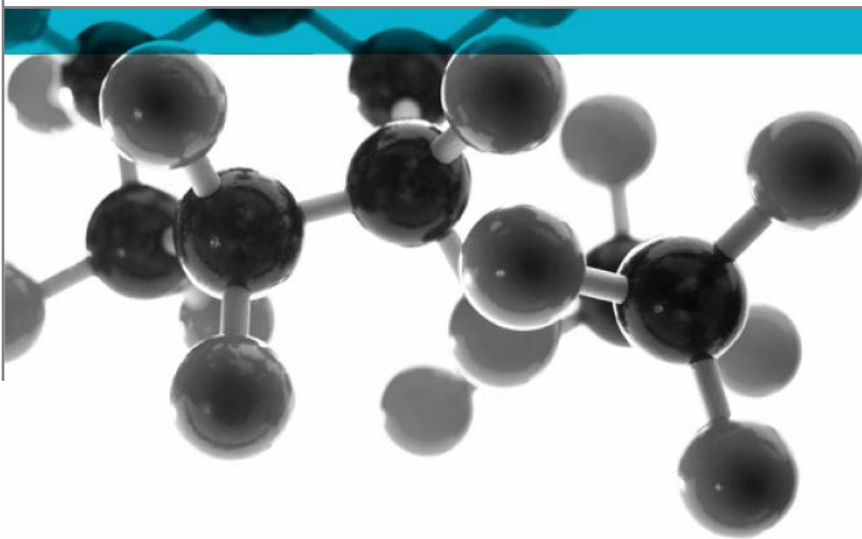
Revision History

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Reason for Revision:	



BS EN 45545-2:2013+A1:2015 – Test Methods T10.01, T10.02, T10.04 & T11.01



Smoke and Toxicity Assessment

Test Method References “T10.01” / “T10.02” / “T10.04” (ISO 5659-2: 2017; Plastics – Smoke Generation. Part 2 Determination of Optical Density by a Single Chamber Method) and “T11.01” (Gas Analysis in the Smoke Box EN ISO 5659-2, using FTIR Technique)

A Report To: HMG Powder Coatings Limited

Document Reference: 507139

Date: 12th January 2022

Issue No.: 1

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Executive Summary

Objective To determine the toxic fume and optical density produced from the following product when tested in accordance with methods T10.01, T10.02, T10.04 and T11.01 as defined in BS EN 45545-2:2013+A1:2015 at an irradiance level of 50kW/m² without a pilot flame.

Generic Description	Product reference	Thickness	Weight per unit area or density
Polyester powder coating on steel	"Polyester Powder Coating"	1.67mm	12589g/m ²
Individual components used to manufacture composite:			
Polyester powder coating	"827-2R905C-1456"	70±10µm	108.5±15.5g/m ²
Steel	"DD11"	1.6mm	12480g/m ²
Please see page 6 of this test report for the full description of the product tested			

Test Sponsor HMG Powder Coatings Limited, Dill Road, Castlereagh Industrial Estate, Belfast, BT6 9HU

Summary of Test Results:

The average $D_s(4)$ value determined was 62.

The average VOF4 value determined was 54.

The average D_s max value determined within 10 minutes was 131.



The average D_s max value determined within 20 minutes was 131.

The average CIT value at four minutes was 0.01.

The average CIT value at eight minutes was 0.02.

Date of Test 26th & 31st August 2021

Signatories

	
Responsible Officer K. Deluce * Testing Officer	Authorised J. Lucas-Cox * Operations Manager

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

Report Issued: 12th January 2022

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Test Details

Introduction

Warringtonfire was commissioned to carry out an area based smoke and toxicity test in accordance with the method recommended in BS EN 45545-2:2013+A1:2015. This standard recommends that the test is carried out using the apparatus and procedures detailed in ISO 5659-2:2017. The standard provides equations which should be calculated in relation to the smoke density. In addition to this the quantitative determination of the gases emitted should be carried out in accordance with the procedure specified in EN 45545 Annex C, Method 1 (Smoke Chamber).

The test was performed in accordance with the procedures specified in EN 45545 and EN ISO 5659-2 and this report should be read in conjunction with these and other related standards.

Test method

The principle of the test methods referenced "T10.01", "T10.02", "T10.04" and "T11.01" is to expose a material to specified thermal conditions of pyrolysis and combustion in a continuous procedure.

The test was conducted in an "ISO 5659-2 Smoke Chamber" supplied by Concept (operated with "Concept" software), in combination with an "IGS FTIR Analyser" supplied by Thermo Scientific (operated with Thermo "Result" software).

Specimens were tested in the non-flaming mode in a horizontal position by exposure to the heating arrangement specified in ISO 5659-2. The heat flux was 50kW/m². The change in optical density of the smoke produced when dispersed within a fixed volume of air is recorded throughout the period of test utilising the Concept software in order to determine information relating to the smoke density.

Quantitative determination of toxic gases emitted is carried out using Fourier Transform Infra Red (FT-IR) analysis and the TQ Analyst software. The FT-IR has been calibrated, the calibration spectra were produced by the FTIR supplier (Thermo) using bottled gases and library spectrum, plus Warringtonfire using bottles gases and calibrated solutions via an evaporator.

In all cases, the sample gases are taken from 300mm from the centre of the top of the chamber with sample lines being kept as short as possible to minimise sample losses.

The test method provides a means for the comparative assessment of products, however, it does not model a real fire situation and the results cannot therefore be used to describe the fire hazard of materials under actual fire conditions.

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 have 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.

Instruction to test The test was conducted on the 26th & 31st August 2021 at the request of HMG Powder Coatings Limited, 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.

Test face The coated face of the specimens was exposed to the heating conditions.

Condition of specimen edges Coating applied to all faces, including the edges

Photograph of specimen



Conditioning of specimens

The specimens were received on the 29th July 2021.

The specimens were conditioned at temperatures of $23 \pm 2^\circ\text{C}$ and a relative humidity of $50 \pm 5\%$ RH, for a minimum period of 24 hours prior to testing.

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 steel
Product reference of coating system		"Polyester Powder Coating"
Name of manufacturer		HMG Powder Coatings Ltd
Overall thickness		1.67mm (stated by sponsor) 1.65mm (determined by Warringtonfire)
Overall weight per unit area		12589g/m ² (stated by sponsor) 12320.16g/m ² (determined by Warringtonfire)
Final coating product (Test face)	Generic type	Polyester powder coating
	Product reference	"827-2R905C-1456"
	Name of manufacturer	HMG Powder Coatings Ltd
	Colour reference	"RAL 9005"
	Colour	"Jet Black"
	Number of coats	One
	Thickness per coat	70±10µm
	Application rate	108.5±15.5g/m ²
	Specific gravity	1.55
	Application method	Electrostatic spray
	Flame retardant details	See Note 1 Below
Curing process	Gas fired oven: 10 minutes at 180°C	
Substrate	Generic type	Steel
	Product reference	"DD11"
	Name of manufacturer	See Note 2 Below
	Thickness	1.6mm
	Weight per unit area / density	12480g/m ²
Flame retardant details	The product is inherently flame retardant	
Brief description of manufacturing process of coatings		Dry mixing, extrusion and milling of a mixture of resins, pigments and additives

Note 1: The sponsor of the test has confirmed that no flame retardant additives were utilised in the production of the component.

Note 2: The sponsor was unwilling to provide this information.

Test Results

Applicability of test results

The test results relate only to the behaviour of the specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential smoke and toxicity 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 with the specimens which were tested.

Smoke Density

Test method referenced "T10.01" requires the $D_s(4)$ to be calculated. That is the specific optical density at 4 minutes test duration.

Test method referenced "T10.02" requires the VOF4 to be calculated. That is the area under the D_s vs. time curve during the period zero minutes to four minutes. This is calculated utilising the trapezium rule equation (assuming a finite element (t) of one minute):

$$VOF_4 = D_1 + D_2 + D_3 + \frac{D_4}{2}$$

Test method referenced "T10.04" requires the D_{smax} to be calculated. That is the maximum specific optical density within the first 10 minutes test duration.

The maximum specific optical density within the complete 20 minute test duration is also reported in case this is required by an alternative specification.

	Specimen 1	Specimen 2	Specimen 3	Mean Average
$D_s(4)$	73	51	60	62
VOF4	65	44	52	54
D_{smax} within 10 minutes	143	132	118	131
D_{smax} within 20 minutes	143	132	118	131

Toxic Gas Emission

Test method referenced "T11.01" required the CIT to be calculated. That is the conventional index of toxicity, a summation term from the analysis of gases taken at four minutes and eight minutes test duration.

	Specimen 1	Specimen 2	Specimen 3	Mean Average
CIT (4 minutes)	0.01	0.01	0.01	0.01
CIT (8 minutes)	0.02	0.02	0.02	0.02

Additional Test Data

Additional test data relating to the smoke & toxicity performance of the product is detailed in Appendix I of this report.

A graph of the results obtained is illustrated in Appendix II.

Summary of results The average $D_s(4)$ value determined was 62.

The average VOF4 value determined was 54.

The average D_{smax} value determined within 10 minutes was 131.

The average D_{smax} value determined within 20 minutes was 131.

The average CIT value at four minutes was 0.01.

The average CIT value at eight minutes was 0.02.

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.

These results relate only to the behaviour of the specimens of the product under the particular conditions of test; they are not intended to be the sole criterion for assessing the potential smoke obscuration hazard of the product in use.

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Appendix I

Gas Concentration At Four Minutes:

The concentration of each gas species for which analysis was conducted for at the four minute sampling point (expressed in ppm and kg/m³) is provided in the below table:

Gas	Specimen 1		Specimen 2		Specimen 3		Mean Average	
	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³
Carbon Monoxide	51	0.0001	29	0.0000	46	0.0000	42	0.0000
Carbon Dioxide	209	0.0003	123	0.0002	143	0.0002	159	0.0002
Sulphur Dioxide	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Chloride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Bromide	ND	ND	1	0.0000	ND	ND	ND	ND
Hydrogen Fluoride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen cyanide	1	0.0000	ND	ND	1	0.0000	ND	ND
Nitrogen Oxides	2	0.0000	1	0.0000	1	0.0000	2	0.0000

Where ND indicates None Detected

Gas Concentration At Eight Minutes:

The concentration of each gas species for which analysis was conducted for at the eight minute sampling point (expressed in ppm and kg/m³) is provided in the below table:

Gas	Specimen 1		Specimen 2		Specimen 3		Mean Average	
	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³	ppm	kg/m ³
Carbon Monoxide	148	0.0001	140	0.0001	131	0.0001	140	0.0001
Carbon Dioxide	612	0.0009	587	0.0009	504	0.0008	567	0.0009
Sulphur Dioxide	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Chloride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Bromide	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen Fluoride	ND	ND	ND	ND	ND	ND	ND	ND
Hydrogen cyanide	2	0.0000	1	0.0000	2	0.0000	2	0.0000
Nitrogen Oxides	2	0.0000	2	0.0000	2	0.0000	2	0.0000

Where ND indicates None Detected

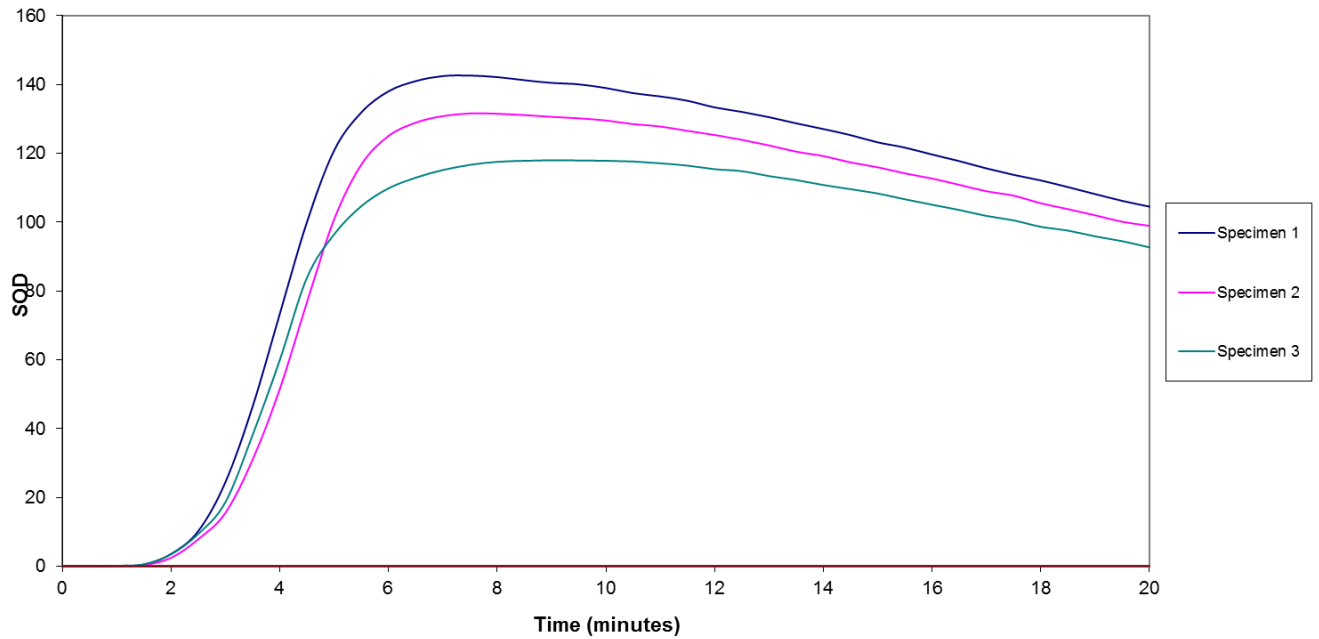
	SPECIMEN NUMBER			Mean
	1	2	3	
Clear Beam Correction Factor (D_c)	15	11	12	
Specific Optical Density at 10 minutes (D_{s10})	139	130	118	129
Specimen thickness	1.66	1.65	1.66	1.66
Initial specimen weight (g)	69.6	69.8	69.7	69.7
Final specimen weight (g)	66.79	65.95	67.14	66.62
Mass Loss (g)	2.8	3.8	2.6	3.066
Wire Grid	N/A	N/A	N/A	N/A
Neutral-density correction factor (C_f)	N/A	N/A	N/A	N/A
Test Duration (s)	1200	1200	1200	1200
Chamber back wall temperature	52	54	52	N/A
Test Operator	DR			

Observations:

	50kW/m ² In The Absence Of A Pilot Flame		
	1	2	3
Specimen No.	1	2	3
Colour of smoke produced	Light	Light	Light
Expansion distance towards heater (mm)	N/A	N/A	N/A
Ignition time in seconds	N/A	N/A	N/A
Extinction time in seconds	N/A	N/A	N/A
Re-ignition time in seconds	*	*	*
Extinction time in seconds	N/A	N/A	N/A
Re-ignition time in seconds	*	*	*
Extinction time in seconds	N/A	N/A	N/A
Unusual or unexpected behavior	N/A	N/A	N/A
Difficulties experienced during test	N/A	N/A	N/A
* = Did Not Re-ignite N/A = Not Applicable			

Appendix II

50kW/m² in the absence of a pilot flame



Revision History

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Reason for Revision:	

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