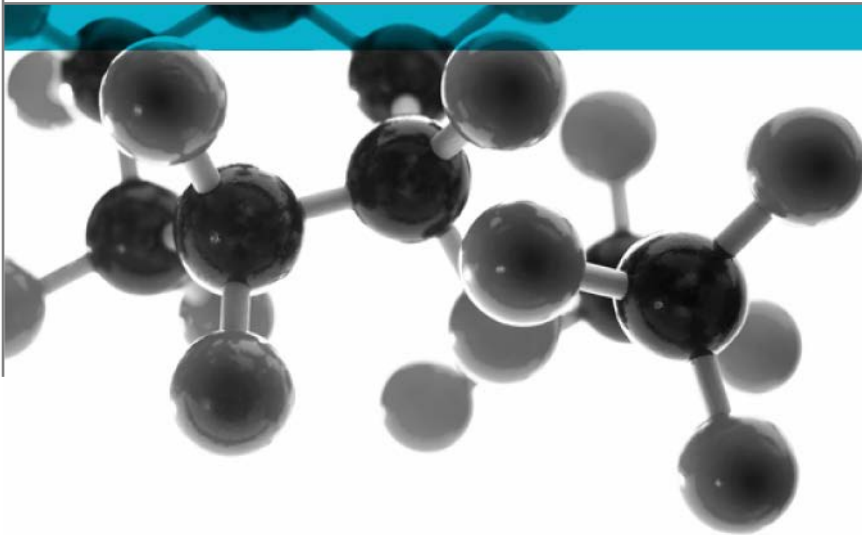


BS EN 45545-2:2013+A1:2015 – Test Methods T10.01, T10.02, T10.04 & T11.01



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: IGP Pulvertechnik AG

Document Reference: 503850

Date: 22nd June 2021

Issue No.: 1

Page 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 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 page 5 of this test report for the full description of the product tested			

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

Summary of Test Results:

The average $D_s(4)$ value determined was 111.

The average VOF4 value determined was 134.

The average D_s max value determined within 10 minutes was 145.


The average D_s max value determined within 20 minutes was 145.

The average CIT value at four minutes was 0.01.


The average CIT value at eight minutes was 0.01.

Date of Test 7th June 2021

Signatories



Responsible Officer
K. Deluce *
Testing Officer



Authorised
J. Lucas-Cox *
Operations Manager

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

Report Issued: 22nd June 2021

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Document No.: 503850
Author: K. Deluce
Client: IGP Pulvertechnik AG

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Issue Date: 22nd June 2021
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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/m^2 . 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.

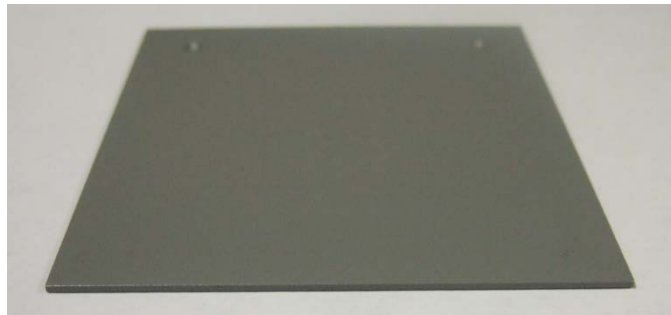
Instruction to test The test was conducted on the 7th June 2021 at the request of IGP Pulvertechnik AG, the sponsor of the test.

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.

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

Condition of specimen edges Coating applied to test face, including the edges.

Photograph of specimen



Conditioning of specimens The specimens were received on the 4th May 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 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

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
$D_s(4)$	93	135	104	111
VOF4	98	180	123	134
D_{smax} within 10 minutes	131	156	150	145
D_{smax} within 20 minutes	131	156	150	145

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)	0.01	0.01	0.01	0.01

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 111.

The average VOF4 value determined was 134.

The average D_{smax} value determined within 10 minutes was 145.

The average D_{smax} value determined within 20 minutes was 145.

The average CIT value at four minutes was 0.01.

The average CIT value at eight minutes was 0.01.

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	42	0.0000	59	0.0001	50	0.0000	50	0.0000
Carbon Dioxide	95	0.0001	230	0.0004	197	0.0003	174	0.0003
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	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen Oxides	2	0.0000	2	0.0000	2	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	94	0.0001	106	0.0001	106	0.0001	102	0.0001
Carbon Dioxide	287	0.0004	424	0.0006	382	0.0006	364	0.0006
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	ND	ND	ND	ND	ND	ND	ND	ND
Nitrogen Oxides	2	0.0000	2	0.0000	2	0.0000	2	0.0000

Where ND indicates None Detected

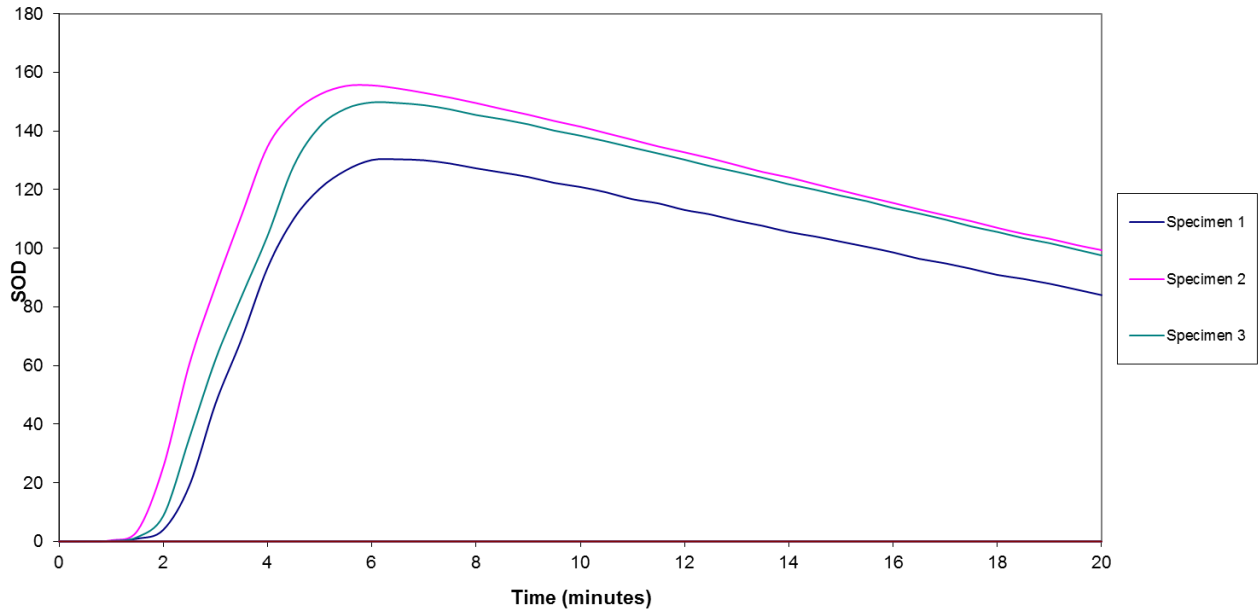
	SPECIMEN NUMBER			Mean
	1	2	3	
Clear Beam Correction Factor (D_c)	12	15	16	
Specific Optical Density at 10 minutes (D_{s10})	121	142	138	134
Specimen thickness	1.14	1.13	1.16	1.14
Initial specimen weight (g)	16.24	16.37	16.40	16.34
Final specimen weight (g)	13.74	12.97	13.40	13.37
Mass Loss (g)	2.50	3.40	3.00	2.97
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	58	56	55	N/A
Test Operator	D. Richardson			

Observations:

	50kW/m ² In The Absence Of A Pilot Flame		
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
Unusual or unexpected behavior	No	No	No
Difficulties experienced during test	No	No	No
N/A = Not Applicable			

Appendix II

50kW/m² in the absence of a pilot flame



Revision History

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

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