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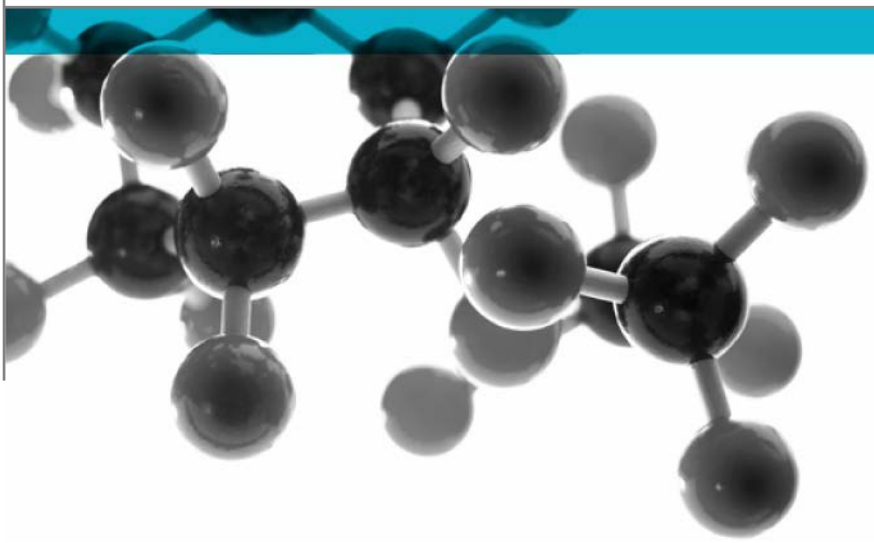
BS EN 45545-2:2013+A1:2015 – Test Methods T10.01, T10.02, T10.04 & T11.01



Smoke and Toxicity Assessment

Test Method References "T10.01" / "T10.02"/ "T10.04" (ISO 5659-2: 2012; 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: 3M Deutschland GmbH

Document Reference: 385400

Date: 15th August 2017

Issue No.: 1

Testing
Advising
Assuring

Registered Office: Exova (UK) Ltd, Lochend Industrial Estate, Newbridge, Midlothian EH28 8PL United Kingdom. Reg No.SC 70429

UKAS TESTING
0249

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/m^2 without a pilot flame.

Generic Description		Product reference	Thickness	Weight per unit area or density
Four layers of polyester film with acrylic PSA (pressure-sensitive adhesive) applied to a 4mm thick annealed glass substrate		Not stated	4.51mm	9.90kg/m²*
Individual components used to manufacture composite:				
Self-adhesive film	Film	"3M™ Scotchgard™ Multi-Layer Protective Film 1004"	4 x 4 mils	Unwilling to provide
	Adhesive	Unwilling to provide	4 x 1 mil	Unwilling to provide
Substrate		Unwilling to provide	4mm	Unwilling to provide
***Determined by Exova Warringtonfire**				
Please see page 5 of this test report for the full description of the product tested				

Test Sponsor

3M Deutschland GmbH, Industrial Tapes & Adhesives Division, Carl-Schurz-Str. 1, 41453 Neuss.

Summary of Test Results:

The average Ds(4) value determined was 104.

The average VOF4 value determined was 102.

The average Ds(max) value determined within 10 minutes was 215.

The average CIT value at four minutes was 0.01.

The average CIT value at eight minutes was 0.01.

Date of Test

2nd August 2017

Signatories

	
Responsible Officer B, Dean Technical Leader	Authorised S. Deeming * Business Unit Head

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

Report Issued: 15th August 2017

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Test Details

Introduction

Exova 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: 2012. 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 Exova 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 2nd August 2017 at the request of 3M Deutschland GmbH, the sponsor of the test.

Provision of test specimens	The specimens were supplied by the sponsor of the test. **Exova Warringtonfire** was not involved in any selection or sampling procedure.
Test face	The film face of the specimen was exposed to the heating conditions.
Condition of specimen edges	Film applied to test face only, not applied to edges.
Conditioning of specimens	The specimens were received on the 23rd June 2017. The specimens were conditioned at temperatures of 23 ± 2°C and a relative humidity of 50 ± 5% RH, for a minimum period of 24 hours prior to testing.

Description of Test Specimens

The description of the specimens given below has been prepared from information provided by the sponsor of the test. All values quoted are nominal, unless tolerances are given.

General description			Four layers of polyester film with acrylic PSA (pressure-sensitive adhesive) applied to a 4mm thick annealed glass substrate
Overall thickness			4.51mm (stated by sponsor) 4.02mm (determined by **Exova Warringtonfire**)
Overall weight per unit area			9.90kg/m² (determined by **Exova Warringtonfire**)
Self-adhesive film	Product reference		"3M™ Scotchgard™ Multi-Layer Protective Film 1004"
	Thickness per layer		5 mils (0.127mm)
	Density / weight per unit area		**See Note 1 below**
	Number of layers		4
	Film	Generic type	Polyester
		Product reference	**See Note 1 below**
		Name of manufacturer	3M Company
		Weight per unit area	**See Note 1 below**
		Thickness	4 mils per layer
		Colour	"Transparent"
		Flame retardant details	**See Note 2 below**
	Adhesive	Generic type	Acrylic
		Product reference	**See Note 1 below**
		Name of manufacturer	3M Company
		Application thickness	1 mil per layer
		Application method	**See Note 1 below**
		Flame retardant details	**See Note 2 below**
Substrate		Generic type	Annealed glass
		Name of supplier	**See Note 1 below**
		Thickness	4mm
		Weight per unit area	**See Note 1 below**
		Flame retardant details	**See Note 2 below**
Brief description of manufacturing process			**See Note 1 below**

Note 1. The sponsor was unwilling to provide this information.

Note 2. The sponsor of the test has confirmed that no flame retardant additives were utilised in the production of the component.

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 Ds(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 Ds 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 Ds(max) to be calculated. That is the maximum specific optical density within the first 10 minutes test duration.

	Specimen 1	Specimen 2	Specimen 3	Mean Average
Ds(4)	77	164	72	104
VOF4	69	171	66	102
Ds(max)	179	306	159	215

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	0.00	0.01
CIT (8 minutes)	0.01	0.02	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 Ds(4) value determined was 104.

The average VOF4 value determined was 102.

The average Ds(max) value determined within 10 minutes was 215.

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. 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.

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/m^3) 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	54	0.0001	99	0.0001	38	0.0000	63	0.0001
Carbon Dioxide	133	0.0002	153	0.0002	103	0.0002	130	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	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	1	0.0000	1	0.0000	ND	ND	1	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/m^3) 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	152	0.0002	363	0.0004	160	0.0002	225	0.0002
Carbon Dioxide	291	0.0005	497	0.0008	301	0.0005	363	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	1	0.0000	ND	ND	ND	ND	0	0.0000

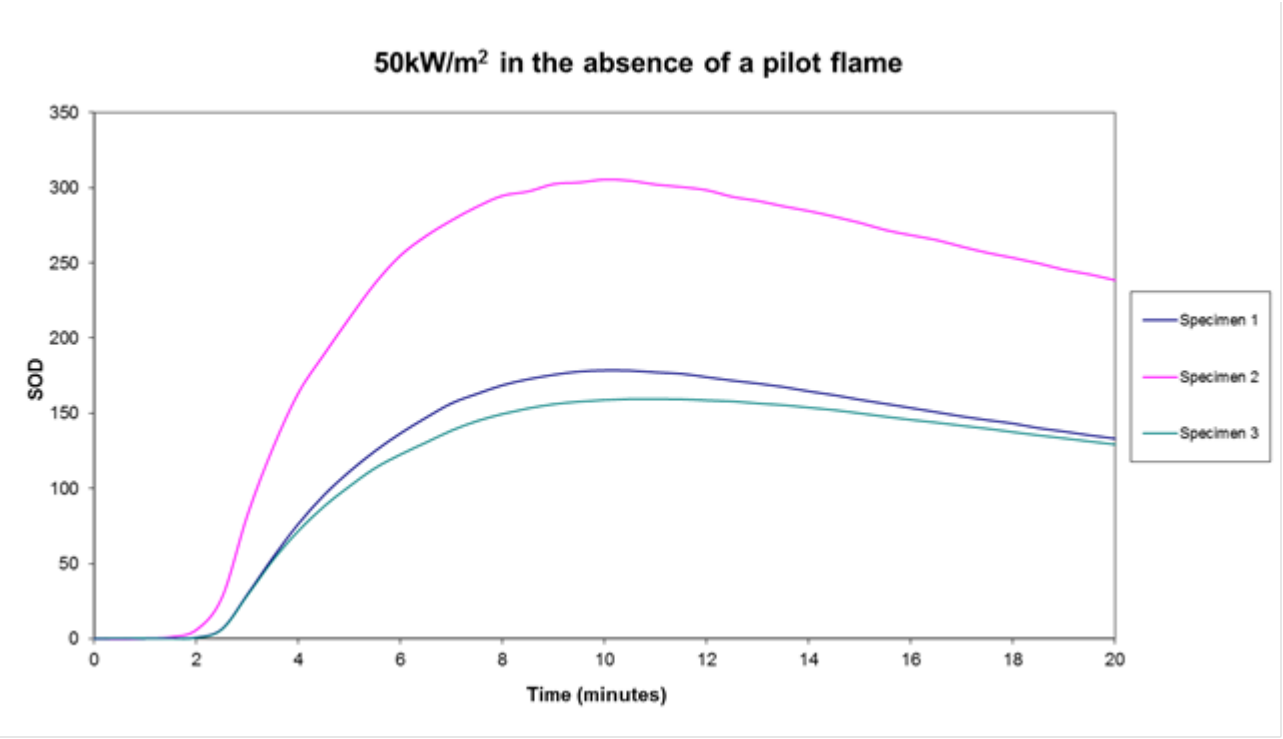
Where ND indicates None Detected

	SPECIMEN NUMBER			Mean
	1	2	3	
Clear Beam Correction Factor (D_c)	20	31	20	
Specific Optical Density at 10 minutes (D_s10)	178	305	159	214
Specimen thickness	3.95	4.13	4.00	4.03
Initial specimen weight (g)	53.66	55.15	54.14	54.3
Final specimen weight (g)	51.36	52.95	52.24	52.183
Mass Loss (g)	2.3	2.2	1.9	2.133333333
Wire Grid (if applicable)	N/A	N/A	N/A	N/A
Neutral-density correction factor (C_f) (if applicable)	N/A	N/A	N/A	N/A
Test Duration (s)	1200	1200	1200	1200
Chamber back wall temperature	54	55	56	55
Test Operator	Kyle Deluce	Kyle Deluce	Kyle Deluce	Kyle Deluce

Observations:

	50kW/m² 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 (if applicable)	N/A	N/A	N/A
Usual or unexpected behavior?	N/A	N/A	N/A
Any difficulties during test?	N/A	N/A	N/A
N/A = Not Applicable			

Appendix II


50kW/m2 in the absence of a pilot flame
SOD
Time (minutes)
Specimen 1
Specimen 2
Specimen 3
0
50
100
150
200
250
300
350
0
2
4
6
8
10
12
14
16
18
20

Revision History

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

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