Subject : 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 define in BS EN 45545-2:2013+A1:2015 at an irradiance level of 50kW/m² without a pilot flame

Method of Test : Smoke and Toxicity Assessment - BS EN 45545-2:2013+A1:2015 – Test Methods T10.01, T10.02, T10.04 & T11.01

Generic Description	Product reference	Thickness	Weight per unit area/density
Polyester fabric which the sponsor has stated is for use as a textile duct	"IFR fabric"	0.36mm	264g/m²
Please see page 3 of this test report for the full description of the product tested			

Summary of Test: Results

The average Ds(4) value determined was 129.

The average VOF4 value determined was 337.

The average Ds(max) value determined within 10 minutes was 155.

The average Ds(max) value determined within 20 minutes was 155.

The average CIT value at four minutes was 0.02.

The average CIT value at eight minutes was 0.03.

Introduction : **Setsco Services Pte Ltd** 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 reference "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 to 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.

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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.

Date to test : The test was conducted on the 20th February 2018

Provision of test specimens : The specimens were supplied by the client of the test. Setsco Services Pte Ltd was not involved in any selection or sampling procedure.

Test face : One of two identical faces of the specimens was exposed to the heating conditions.

Condition of specimen edges : Homogeneous product

Conditioning of Specimens : The specimens were condition on the 23rd January 2018.

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 system given below has been prepared from information provided by the client of the test. All values quoted are nominal, unless tolerances are given.

General description	Polyester fabric which the sponsor has stated is for use as a textile duct
Product reference	"IFR fabric"
Name of manufacturer	Total Integrated Solutions Pte Ltd
Thickness	0.36mm (stated by client) 0.33mm (determined by **Exova Warringtonfire)**
Weight per unit area	264g/m² (stated by client) 275.1g/m² (determined by **Exova Warringtonfire)**
Composition details	Flame retardant grade polyester yarn
Colour reference	"Grey Colour"
Pattern reference	
Type of weave	Plain Woven
Thread count or threads per inch (TPI)	300D
Yarn count	49S
Trade name of flame retardant	**See Note 1 Below**
Generic type of flame retardant	**See Note 1 Below**
Amount of flame retardant	6500ppm
Brief description of manufacturing process	IFR fabric produced with typical fabric weaving process, from polyester yarn which has flame retardant nano-particles added to it prior to spinning.

Note 1: The client of the test has confirmed that no flame retardant additives were utilised in the production of the product

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Applicability of Test results : The test results relate only to the behaviour of the specimens of a product under the particular conditions of the 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 reference "T10.01" requires the Ds(4) to be calculated. That is the specific optical density at 4 minutes test duration

Test method reference "T10.02" requires of 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 reference "T10.04" requires the Ds(max) 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 minutes test duration is also reported in case this is required by an alternative specification.

	Specimen 1	Specimen 2	Specimen 3	Mean Average
Ds(4)	157	109	121	129
VOF4	456	234	323	337
Ds(max) within 10 minutes	206	118	142	155
Ds(max) within 20 minutes	206	119	142	155

Toxic Gas Emission : Test method reference "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)	0.02	0.02	0.02	0.02
CIT (8 minutes)	0.03	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 Ds(4) value determined was 129.**

The average VOF4 value determined was 337.

The average Ds(max) value determined within 10 minutes was 155.

The average Ds(max) value determined within 20 minutes was 155

The average CIT value at four minutes was 0.02.

The average CIT value at eight minutes was 0.03

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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
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.

Remark : The test was conducted in collaboration with Exova Warringtonfire United Kingdom.

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	255	0.0003	74	0.0001	140	0.0001	156	0.0002
Carbon Dioxide	1770	0.0028	1600	0.0025	1763	0.0025	1711	0.0027
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	3	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/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	367	0.0004	159	0.0002	222	0.0002	249	0.0002
Carbon Dioxide	1949	0.0030	2059	0.0032	1861	0.0029	1956	0.0030
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	3	0.0000	3	0.0000	2	0.0000	3	0.0000

Where ND indicates None Detected

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Appendix I

	SPECIMEN NUMBER			Mean
	1	2	3	
Clear Beam Correction Factor (D_c)	30	22	28	
Specific Optical Density at 10 minutes D_s10)	158	118	136	137
Specimen thickness	0.33	0.34	0.33	0.33
Initial specimen weight (g)	1.6	1.6	1.6	1.6
Final specimen weight (g)	0.0	0.0	0.0	0.0
Mass Loss (g)	1.6	1.6	1.6	2.0
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	53	53	52	N/A

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)	76	96	39
Extinction time in seconds (if applicable)	118	372	109
Re-ignition time in seconds (if applicable)	*	*	*
Extinction time in seconds (if applicable)	N/A	N/A	N/A
Unusual or unexpected behavior?	N/A	N/A	N/A
Any difficulties during test?	N/A	N/A	N/A
*= Did Not Re-ignite N/A = Not Applicable			

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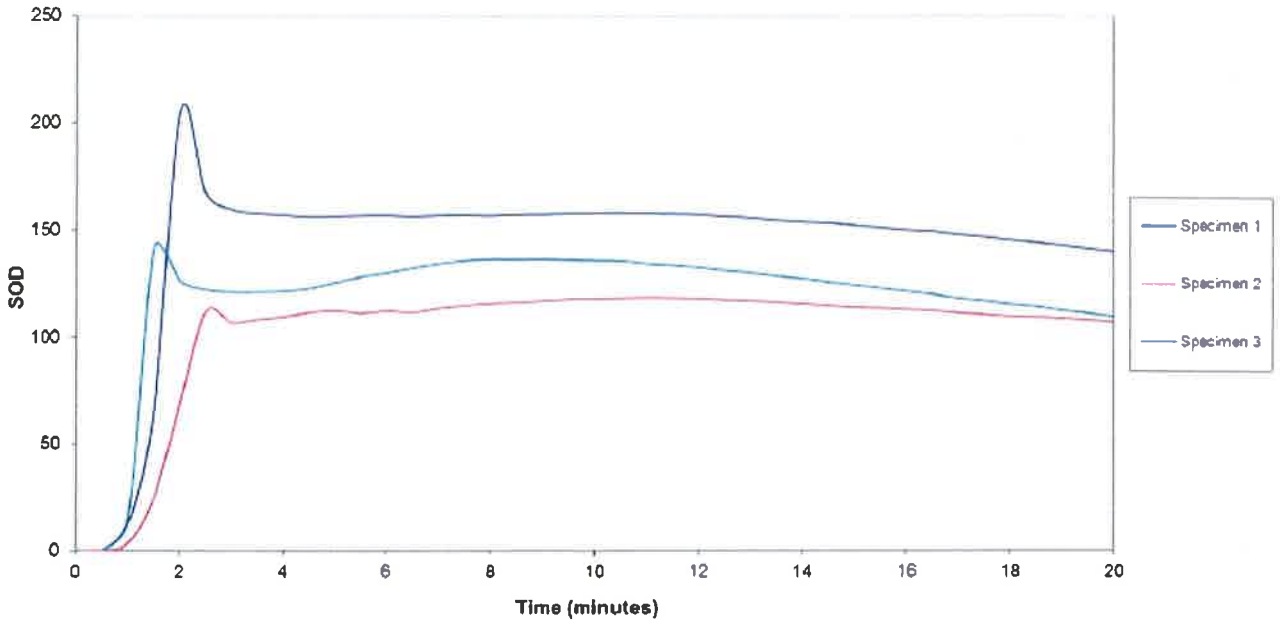
Appendix II

50kW/m² in the absence of a pilot flame



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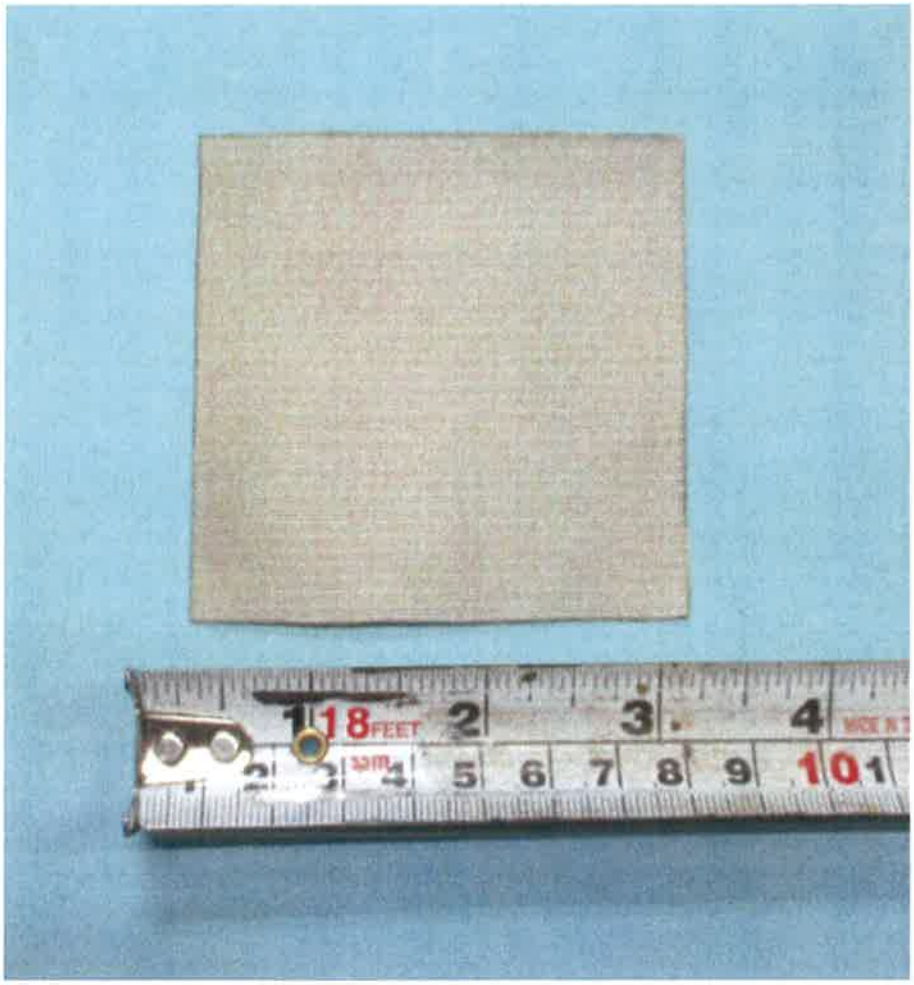
Appendix III



Photograph1 Specimen as received

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