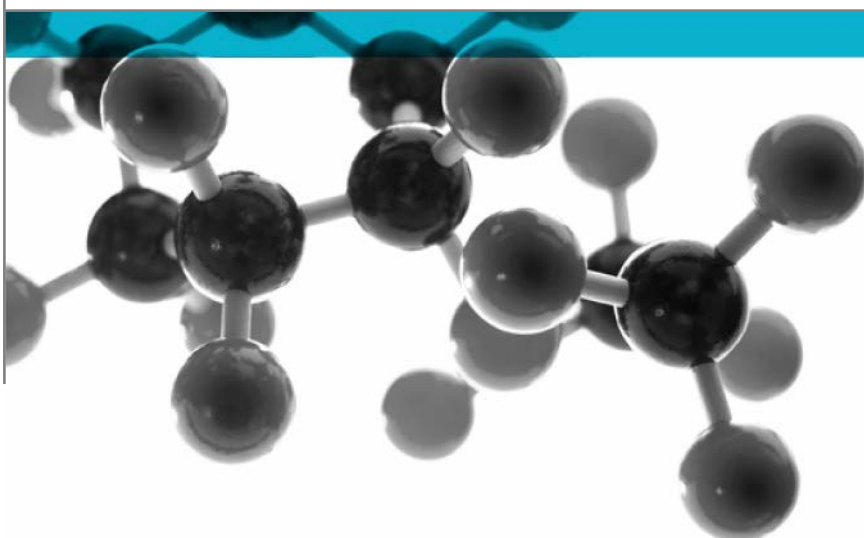


# IMO Resolution MSC 307(88) (2010 FTP Code): Annex 1: Part 2



## Smoke & Toxicity

A Report To: Active Composite Technologies

Document Reference: 432995

Date: 9<sup>th</sup> October 2020

Issue No.: 1

Expiry Date: 4<sup>th</sup> October 2035

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## Executive Summary

**Objective** To determine the performance of the following product when tested in accordance with IMO Resolution MSC 307(88): Annex 1: Part 2.


Generic Description	Product reference	Thickness	Weight per unit area or specific gravity
Gel-coated glass reinforced product	"A1 IMO"	4mm	7.5kg/m <sup>2</sup>
<b>Individual components used to manufacture composite:</b>			
Gel-coat	"A1"	1mm	1.75kg/ltr
Resin	"A1"	Not applicable	1.75kg/ltr
Glass reinforcement	"A1 triaxial fiber"	Not applicable	4 x 160g/m <sup>2</sup>
<b>Please see page 5 of this test report for the full description of the product tested</b>			


**Test Sponsor** Active Composite Technologies, Nijverheidsweg 15a, 3251LP Stellendam, The Netherlands

**Summary of Test Results:** The specimens meet all the criteria for smoke generation and toxicity for bulkhead, wall and ceiling, floorcovering & primary deck covering products as specified in the Resolution.

**Date of Test** 5<sup>th</sup> & 6<sup>th</sup> October 2020

### Signatories


Responsible Officer K. Deluce * Technical Officer


Authorised T. Deluce * Senior Technical Officer

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

Report Issued: 9 <sup>th</sup> October 2020
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## Test Details

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<b>Purpose of test</b>	<p>This test method, adopted by the International Maritime Organisation, specifies a procedure for qualifying smoke generation and toxic potency of products and thus their suitability for use in maritime construction.</p> <p>The test was performed in accordance with the procedure specified in IMO Resolution MSC 307(88): Annex 1, Part 2 and it is advised that this report is read in conjunction with this document.</p>
<b>Scope of test</b>	<p>International Maritime Organisation Resolution MSC 307(88): Annex 1, Part 2 incorporates the following methods:</p> <p>Appendix 1 – Test procedure for smoke generation</p> <p>Appendix 2 – Test procedure for gas measuring</p> <p>The Resolution details a classification system based on the maximum specific optical density of smoke occurring during the test, averaged over three replicate tests, carried out in each of the three test conditions.</p> <p>In addition, the Resolution specifies limits for seven toxic gases which must not be exceeded in any of the three test conditions.</p>
<b>Fire test study group/EGOLF</b>	<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>
<b>Instruction to test</b>	<p>The test was conducted on the 5<sup>th</sup> &amp; 6<sup>th</sup> October 2020 at the request of Active Composite Technologies, the sponsor of the test.</p>
<b>Conditioning of specimens</b>	<p>The specimens were received on the 9<sup>th</sup> September 2020.</p> <p>Prior to test the specimens were conditioned to constant mass at a temperature of <math>23 \pm 2^{\circ}\text{C}</math> and a relative humidity of <math>50 \pm 5\%</math>.</p>
<b>Test apparatus data</b>	<ul style="list-style-type: none"><li>• Inner volume of the gas cell = 0.2 Litres</li><li>• Inner volume of gas sampling line = 0.1 Litres</li><li>• Length of gas sampling line = 2 metres</li><li>• Max capacity of gas sampling pump = 4.5L/min</li></ul>
<b>Exposed face</b>	<p>The gel coated face of the specimens was exposed to the radiant heat of the test when the specimens were mounted in the test position.</p>
<b>Substrate</b>	<p>The specimens were tested with a 12mm thick calcium silicate based backing board present.</p>
<b>Provision of test specimens</b>	<p>The specimens were supplied by the sponsor of the test. <a href="#">Warringtonfire</a> was not involved in any selection or sampling procedure. The results stated in this report apply to the samples as received.</p>

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Client: Active Composite Technologies

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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		Gel-coated glass reinforced product
Product reference		"A1 IMO"
Name of manufacturer		Acrylic Composites BV
Colour reference		"Off White"
Overall thickness		4mm (stated by sponsor) 4.77mm (determined by <a href="#">Warringtonfire</a> )
Overall weight per unit area		7.5kg/m <sup>2</sup> (stated by sponsor) 6.74kg/m <sup>2</sup> (determined by <a href="#">Warringtonfire</a> )
Gel-coat	Generic type	Two-component material consisting of a mineral powder and a water-borne acrylic resin
	Product reference	"A1"
	Name of manufacturer	Acrylic Composites BV
	Colour reference	"Off White"
	Number of coats	1
	Application thickness	1mm
	Specific gravity	1.75kg/ltr
	Application method	Brushing
	Trade name of flame retardant	"ATP"
	Generic type of flame retardant	ATH (aluminium trihydrate)
	Amount of flame retardant	7%
Curing process	At room temperature	
Resin	Generic type	Two-component material consisting of a mineral powder and a water-borne acrylic resin
	Product reference	"A1"
	Name of manufacturer	Acrylic Composites BV
	Trade name of flame retardant	"ATP"
	Generic type of flame retardant	ATH (aluminium tri-hydrate)
Amount of flame retardant	7%	
Glass reinforcement	Type	Glass fabric
	Product reference	"A1 triaxial fiber"
	Number of layers	4
	Weight per unit area per layer	160g/m <sup>2</sup>
Name of manufacturer	Acrylic Composites BV	
Resin to glass ratio (by weight)		10:1
Percentage glass reinforcement (by weight)		9%
Curing process (duration and temperature)		20 minutes @ 23 °C
Brief description of manufacturing process		Laminated A1 IMO panels reinforced with A1 triaxial fiber. "gelcoat" layer and reinforced layers are the same product. To prevent print thru of the triaxial fiber in case of working in moulds, it is advised to wait with the second layers until the gelcoat layer starts to cure. Always apply the triaxial fiber between layers of A1 IMO. Application can be done by brush, roller or spray equipment.

## Test Results

### Test procedure

A 75mm x 75mm specimen is mounted horizontally inside a smoke chamber of the design specified in ISO 5659 Part 2, 25mm below a cone shaped, radiant electric heater capable of producing a uniform irradiance of 50kW/m<sup>2</sup> on the specimen surface. A premixed propane/air pilot flame of length 30mm may be applied 10mm above the specimen surface.

Three replicate specimens are tested in each of the following three test conditions at a mounted specimen distance of either 25mm or 50mm below the cone radiant heater:

1. Irradiance of 25kW/m<sup>2</sup> in the presence of pilot flame.
2. Irradiance of 25kW/m<sup>2</sup> in the absence of pilot flame.
3. Irradiance of 50kW/m<sup>2</sup> in the absence of pilot flame.

The attenuation of a light beam passing through the evolved smoke is measured and the results are reported in terms of the maximum Specific Optical Density attained during the test, given by the equation:

$$D_s = (V/(A*L)) * \log_{10} (100/T)$$

Where:

V	=	total volume of the chamber (m <sup>3</sup> )
A	=	exposed area of the specimen (m <sup>2</sup> )
L	=	optical length (m) of smoke measurement
T	=	% light transmitted.

The initial test at each test condition is twenty minutes to verify the possible existence of a second minimum transmittance value. If the minimum transmittance value is shown by the initial test to occur within the first ten minutes, then subsequent tests for that test condition may have an exposure of 10 minutes. Otherwise, the tests shall last twenty minutes.

In the case of intumescent materials, a preliminary test at each test condition is performed with the specimen mounted horizontally inside the chamber 25mm below the cone shaped, radiant electric heater. In accordance with ISO 5659-2, if the specimen should intumesce more than 10mm during these preliminary tests, the mount distance of the specimen is to increase from 25mm to 50mm below the radiant heater.

The sampling of the fire effluent created in the chamber during the test for the analysis of the concentration of the seven different gases for which criteria are given is conducted using Fourier Transform Infra Red (FT-IR) analysis. The FT-IR has been calibrated by the analyser manufacturer (Thermo) using library spectrum and bottled gases.

In all cases, the sample is taken from the geometric centre of the chamber and sample lines are kept as short as possible to minimise sample losses.

The gas measurement in each case is carried out when the maximum smoke density is obtained called Dm Sampling Time (DmST). This time is determined by the initial smoke density measurement test performed at each test condition.

Sampling Response Period (SRP) is the minimum time necessary during the sampling period to completely load the FT-IR gas cell including the time to transfer the effluents flow from the smoke chamber into the cell. Sampling commences at DmST – (SRP x 0.5) seconds.

## Test Results

The test results relating to smoke production are detailed in Appendix I of this report.

The test results relating to toxicity production are detailed in Appendix II of this report.

Observations recorded during the tests are detailed in Appendix III of this report.

## Summary of Results

**The specimens meet all the for smoke generation and toxicity for bulkhead, wall and ceiling, floorcovering & primary deck covering products as specified in the Resolution.**

## Validity

This report is valid for a period of fifteen years from the date of test.

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The tests results relate only to the specimens of the product in the form in which they are tested, they are not intended to be the sole criterion for assessing the potential fire hazard of the product in use. 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 that were tested.

The quantity of each specific toxic gas species generated is dependant upon the fire model used and the burning behaviour of the specimen during each individual fire test. The quantitative determination of combustion products therefore relates only to the specimens tested under the conditions stated and when combustion occurs as described in this test report.

## References

1. IMO Resolution MSC 307(88): Annex 1, Part 2: Smoke And Toxicity Test.
2. ISO 5659-2: 2017 Plastics - Smoke Generation - Part 2: Determination of Optical Density by a Single Chamber Test.

## Appendix I – Smoke production during test

Condition		25kW/m <sup>2</sup> In The Presence Of A Pilot Flame	25kW/m <sup>2</sup> In The Absence Of A Pilot Flame	50kW/m <sup>2</sup> In The Absence Of A Pilot Flame	
Maximum Specific Optical Density	Specimen 1	Ds (max)	8	60	66
		Time to Ds (max)	1193	1183	666
		D (Clear beam)	0	0	1
	Specimen 2	Ds (max)	8	58	61
		Time to Ds (max)	1160	1173	740
		DmST**	1193	1183	666
		D (Clear beam)	0	1	0
	Specimen 3	Ds (max)	7	72	54
		Time to Ds (max)	1198	1167	694
		DmST**	1193	1183	666
		D (Clear beam)	1	0	0
	Sampling Response Time (SRP) (Secs)		10	10	10
Averaged Ds (max)		8	63	60	
Limit		*	*	*	

Where \* indicates the SOD must be ≤500 for floor coverings, ≤400 primary deck coverings, ≤400 plastic pipes and ≤200 for bulkhead, wall and ceiling linings.

\*\* indicates time the maximum smoke density determined by the initial smoke density measurement test performed in each test condition. The gas measurement in each case is conducted at this pre-determined time.



## Appendix II – Toxicity production during test

**TOXICITY DATA** Irradiance level of 25kW/m<sup>2</sup> in the presence of a pilot flame.

GAS		Maximum Gas Concentration C (ppm)		Average (ppm)	Limit (ppm)
		1	2		
Carbon Monoxide	CO	270	299	284	1450
Hydrochloric Acid	HCl	ND	ND	ND	N/A
	Correction Factor (Cca)	1	1	1	
	Corrected max. conc.	1	1	1	
Hydrogen Bromide	HBr	ND	ND	ND	600
Hydrogen Fluoride	HF	ND	ND	ND	600
Hydrogen Cyanide	HCN	ND	ND	ND	140
Nitrous Fumes	NO <sub>x</sub>	5	6	5	350
Sulphur Dioxide	SO <sub>2</sub>	ND	ND	ND	*

**TOXICITY DATA** Irradiance level of 25kW/m<sup>2</sup> in the absence of a pilot flame.

GAS		Maximum Gas Concentration C (ppm)		Average (ppm)	Limit (ppm)
		1	2		
Carbon Monoxide	CO	368	403	385	1450
Hydrochloric Acid	HCl	ND	ND	ND	N/A
	Correction Factor (Cca)	1	1	1	
	Corrected max. conc.	1	1	1	
Hydrogen Bromide	HBr	ND	ND	ND	600
Hydrogen Fluoride	HF	ND	ND	ND	600
Hydrogen Cyanide	HCN	ND	ND	ND	140
Nitrous Fumes	NO <sub>x</sub>	ND	ND	ND	350
Sulphur Dioxide	SO <sub>2</sub>	ND	ND	ND	*

**TOXICITY DATA** Irradiance level of 50kW/m<sup>2</sup> in the absence of a pilot flame.

GAS		Maximum Gas Concentration C (ppm)		Average (ppm)	Limit (ppm)
		1	2		
Carbon Monoxide	CO	577	741	659	1450
Hydrochloric Acid	HCl	ND	ND	ND	N/A
	Correction Factor (Cca)	1	1	1	
	Corrected max. conc.	1	1	1	600
Hydrogen Bromide	HBr	ND	ND	ND	600
Hydrogen Fluoride	HF	ND	ND	ND	600
Hydrogen Cyanide	HCN	ND	ND	ND	140
Nitrous Fumes	NO <sub>x</sub>	ND	ND	ND	350
Sulphur Dioxide	SO <sub>2</sub>	21	24	22	*

Key:

ND indicates non-detected.

\* indicates the SO<sub>2</sub> must be ≤200 for floor coverings and the SO<sub>2</sub> must be ≤120 for other applications.

***NB. Correction factor is the concentration of HCl gas retained on the filter throughout the complete test duration.***

## Appendix III – Observations during test

Specimen No.	25kW/m <sup>2</sup> In The Presence Of A Pilot Flame			25kW/m <sup>2</sup> In The Absence Of A Pilot Flame			50kW/m <sup>2</sup> In The Absence Of A Pilot Flame		
	1	2	3	4	5	6	7	8	9
Colour of smoke produced	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark	Dark
Expansion distance towards heater (mm)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ignition time in seconds	N/A	658	647	N/A	N/A	N/A	N/A	N/A	N/A
Extinction time in seconds	N/A	882	862	N/A	N/A	N/A	N/A	N/A	N/A
Re-ignition time in seconds	N/A	*	*	N/A	N/A	N/A	N/A	N/A	N/A
Extinction time in seconds	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mass Loss (g)	13.9	13.1	12.7	13.5	12.9	14.2	12.6	14.9	13.2
Time to Ds (max)	1193	1160	1198	1183	1173	1167	666	740	694
Ds (max)	8	8	7	60	58	72	66	61	54
D (Clear beam)	0	0	1	0	1	0	1	0	0
Test duration in seconds	1200	1200	1200	1200	1200	1200	1200	1200	1200
* = Did not re-ignite      N/A = Not Applicable									

## Revision History

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

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Revised By:	Approved By:
Reason for Revision:	