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BRE Global Test Report

EN 45545-2: 2013 specific tests for requirement set R1 on Blocksil CP Nano on metal substrate

Prepared for: Blocksil Ltd

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1 Objective

To evaluate the sample described in Section 2 when subjected to the tests required in Table 5 – Requirement Set R1 of EN 45545-2: 2013 Railway applications – Fire protection on railway vehicles – Part 2: Requirements for the fire behaviour of materials and components(1).

2 Sample

2.1 Traceability

The test samples were supplied by the test sponsor. BRE Global was not involved in the sample selection process and therefore cannot comment upon the relationship between samples supplied for test and the product supplied to market.

2.2 Sample Details

Unless otherwise stated all measurements are nominal.

Test Sponsor	Blocksil Limited, Cathedral House, 5 Beacon Street, Lichfield, Staffordshire, WS13 7AA
Manufacturer of sample	Blocksil Limited, Cathedral House, 5 Beacon Street, Lichfield, Staffordshire, WS13 7AA
Sample name/reference	Blocksil CP Nano
Sample description (as provided by test sponsor/manufacturer)	A Nano particle size keep clean coating
Description of specimens (as received)	White coating on metal
Mean thickness (mm)	2.95 including metal substrate
Mean weight per unit area (kg/m^2)	7.8 including metal substrate
Test face	Coated face
Sample receipt date	02 February 2017

3 Conditioning

The specimens were conditioned as required by the standards.

4 ISO 5658-2 Spread of flame test

4.1 Objective

To determine the lateral spread of flame characteristics of the sample described in Section 2, in accordance with the test method defined in ISO 5658-2[(2)] as specified in EN 45545-2 test ref. T02.

4.2 Details of test

Test Date	23 March 2017
Test format	No Air Gap
BRE specimen No.	E9720

4.3 Results

4.3.1 Flame spread data

Observed ignition time, extinction time, duration of test, final spread of flame for each specimen and time to reach each reference point.

	Flame spread times:					
	Test 1		Test 2		Test 3	
Flame spread distance (mm)	minutes	seconds	minutes	seconds	minutes	seconds
50 100 150 200 250 300 350						
Maximum flame spread (mm)	0		0		0	
Time to ignition (minutes : seconds)	4	00	4	40	3	53
Flaming ceased (minutes : seconds)	5	39	5	59	5	29
Test stopped (minutes : seconds)	15	39	15	59	15	29

4.3.2 Observations

Run 1 –	4:00 – Small flame at base of sample 5:39 – Flameout
Run 2 –	4:40 – Small flame at base of sample Flaking and discolouration up to 200mm 5:59 - Flameout
Run 3 –	3:53 – Small flame at base of sample Light flashing on surface up to 150mm Flaking and discolouration up to 250mm 5:29 - Flameout

4.4 Derived fire characteristics

Derived fire characteristics for each specimen as defined in the objective.

Criteria		Specimen			
		1	2	3	Average
Critical Flux at Extinguishment (kW/m^2)	***CFE***	**50.00**	**50.00**	**50.00**	**50.00**
Average Heat for sustained burning (MJ/m^2)	*Qsb*	Not defined	Not defined	Not defined	Not defined

NOTE – If the heat of sustained burning is undefined for all three specimens, Qsb is undefined and the criterion of *Qsb* is deemed to have been met

5 ISO 5660-1 Heat release rate (cone calorimeter method) test

5.1 Objective

To assess the performance of the sample described in Section 2 when subjected to the heat release rate (cone calorimeter method) test specified in ISO 5660-1[3] as specified in EN 45545-2 test ref. T03.01.

5.2 Details of test

Test Date	17 February 2017
Specimen preparation	The sample was prepared in accordance with the test standard.
Description of substrate and fixing:	None
Jointing details	None

5.3 Results

5.3.1 Ambient laboratory conditions

Run number	BRE specimen No.	Relative humidity (%)	Ambient temperature (°C)
1	E9721-1	37.4	22.2
2	E9721-2	36.5	22.5
3	E9721-3	35.4	22.0

5.3.2 Tabulated data

Face subjected to test: Coated face

Wire grid used: No

Test orientation: Horizontal

Retainer frame used: Yes

Exposed specimen area: 0.008836m²

Exhaust system flow rate (Nominal): 0.024 m³/s

Frequency of measurement: 2s

Orifice constant, C: 0.0442702 $m^{½}.g^{½}.K^{½}$

Operator: M J Walford

Distance between the bottom surface of the cone heater and the top of the specimen: 25 mm

Any special mounting procedures: None

Deviations from the test standard: None

Difficulties encountered in testing: None

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Table 1: Irradiance 50 kW/m² (3 test runs)

Specimen number	Thickness (mm)	Time to ignition t_{ig} (s)	Time to end of test (s)	Test Duration (s)	Total HRR $Q_{A,tot}$ (MJ/m²)	MARHE (kW/m²)
1	2.9	143	1200	1057	1.0	5.29
2	3.0	142	1200	1058	0.8	4.24
3	2.9	155	1200	1045	1.0	2.89
Mean Value	**2.9**	**147**	**1200**	**1053**	**0.9**	**4.14**

Specimen number	60s mean $\dot{q}_{A,60}$ (kW/m²)	180s mean HRR $\dot{q}_{A,180}$ (kW/m²)	300s mean HRR $\dot{q}_{A,300}$ (kW/m²)	Maximum HRR $\dot{q}_{A,\max}$ (kW/m²)	Average $\Delta h_{c,eff}$ (MJ/kg)	Average MLR between 10 and 90 % mass loss $\dot{m}_{A,10-90}$ (g/m²s)
1	15.26	5.67	3.24	40.44	25.68	1.62
2	13.20	4.13	1.82	35.50	10.04	0.66
3	9.16	3.03	1.51	25.44	34.12	1.49
Mean value	**12.54**	**4.28**	**2.19**	**33.79**	**23.28**	**1.26**

Specimen number	Initial Mass m (g)	Mass at sustained flaming m_s (g)	Final Mass m_f (g)	Total mass Loss Δm (g/m²)	Average rate of mass loss $\dot{m}$ (g/m²s)	Total of Mass Pyrolysed (%)
1	77.75	76.90	76.54	41	0.04	2
2	77.81	77.00	76.28	81	0.08	2
3	77.52	76.40	76.14	30	0.03	2
Mean value	**77.69**	**76.77**	**76.32**	**51**	**0.05**	**2**

MAHRE = 4.14 kW/m²

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Key to symbols

t_{ig} Time to ignition (onset of sustained flaming), expressed in seconds.

$Q_{A,tot}$ Total heat released per unit area during the entire test, expressed in mega joules per square metre.

ARHE The average rate of heat emission at time t, expressed in kilowatts per unit area. Calculated as the cumulative heat emission from t = 0 to t = t divided by t and given by the following equation (reference EN 45545-2 Clause 5).

$$ARHE(t_n) = \frac{\sum_{2}^{n} (t_n - t_{n-1}) X \frac{\dot{q}_n + \dot{q}_{n-1}}{2}}{t_n - t_{n-1}}$$

Where $\dot{q}$ is the heat release per unit area and t is the time.

MARHE The maximum value of ARHE, expressed in kilowatts per unit area.

$\dot{q}_{A,60}$, $\dot{q}_{A,180}$ and $\dot{q}_{A,300}$ Average heat release rate per unit area over a period starting at t_{ig} and ending 60 s, 180 s or 300 s later respectively, expressed in kilowatts per square metre.

$\dot{q}_{A,\max}$ Maximum value of the heat release rate per unit area, expressed in kilowatts per square metre.

$\Delta h_{c,eff}$ Effective net heat of combustion expressed in mega joules per kilogram.

$\dot{m}_{A,10-90}$ Average mass loss rate per unit area between 10 % and 90 % of mass loss, expressed in grams per square metre seconds.

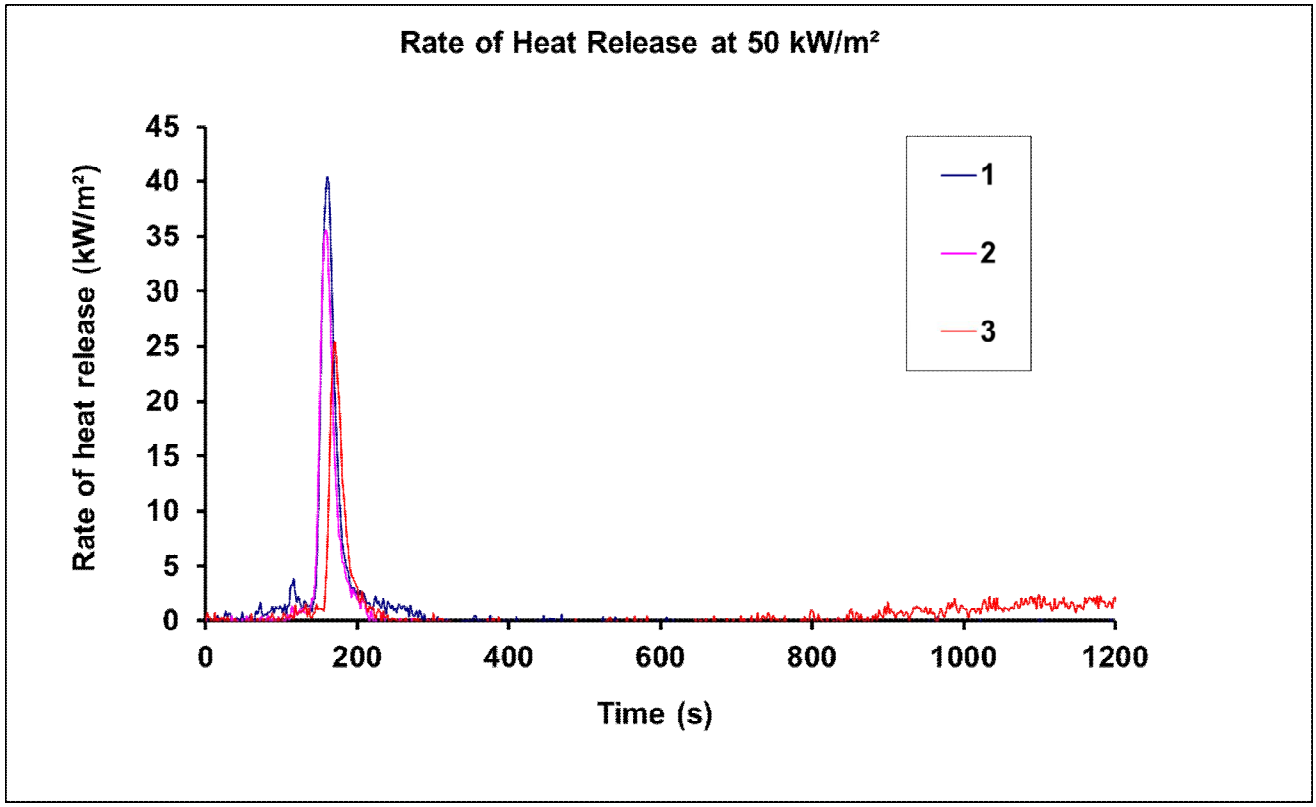
m_s Mass at sustained flaming, expressed in grams.

m_f Mass remaining after the test, expressed in grams.

Δm Sample mass loss, expressed in grams per square metre.

$\dot{m}$ Average rate of specimen mass loss calculated between t_{ig} and the end of the test, expressed in grams per square metre seconds.

5.3.3 Graphical data



5.3.4 Observations

Specimen No.	Additional observations
E9721-1	50s – Smoke produced 120s – Brief flash of flaming 143s – Very shallow ignition 165s - Flameout
E9721-2	55s – Smoke produced 121 and 137s – Brief flash of flaming 142s – Very shallow ignition, weak flaming at edges 161s - Flameout
E9721-3	50s – Smoke produced 143s – Brief flash of flaming 155s – Very shallow ignition 171s - Flameout

6 EN ISO 5659-2 Smoke and Toxicity Tests

6.1 Objective

To assess the performance of the sample described in Section 2 when subjected to smoke and toxicity test specified in EN 45545-2 Annex C Method 1 and EN ISO 5659-2[(4)].

6.2 Details of test

The test was conducted in accordance with the procedures specified in EN 45545-2: Annex C Method 1 and EN ISO 5659-2 as specified in EN 45545-2 test refs T10.01, T10.02 and T11.1.

All gas concentrations were determined by an FTIR system, as described in Annex C of EN 45545 2.

One sample measuring 75mm x 75mm was tested at irradiance 50kW/m^2 in non-flaming mode only. The sampling of the evolved gases was undertaken at 4 minutes and 8 minutes.

Test Date	16 February 2017
BRE Sample ref.	E9722

6.3 Equipment identification

Smoke Chamber IN3714, FT-IR Omnic and TQ Analyst Software

6.4 Results

Condition: 50kW/m² no flame

6.4.1 Toxicity results at 4 minutes (EN 45545-2 Annex C Method 1)

Gases	Measured [1] Conc. (ppm)	Calculated [2] C_n (kg/m³)	Ref. Conc. [3] C_i (mg/m³)	Individual* CIT_G
HCl	0	0.0000000	75	0.000
HCN	7	0.0000064	55	0.009
HBr	0	0.0000000	99	0.000
HF	0	0.0000000	25	0.000
SO_2	0	0.0000000	262	0.000
NO_X [4]	0	0.0000000	38	0.000
CO	34	0.0000330	1380	0.002
CO_2	0	0.0000000	72000	0.000
			CIT_G =	**0.01**

6.4.2 Toxicity results at 8 minutes (EN 45545-2 Annex C Method 1)

Gases	Measured [1] Conc. (ppm)	Calculated [2] C_n (kg/m³)	Ref. Conc. [3] C_i (mg/m³)	Individual* CIT_G
HCl	0	0.0000000	75	0.000
HCN	16	0.0000152	55	0.022
HBr	0	0.0000000	99	0.000
HF	0	0.0000000	25	0.000
SO_2	0	0.0000000	262	0.000
NO_X [4]	0	0.0000000	38	0.000
CO	96	0.0000929	1380	0.005
CO_2	262	0.0003961	72000	0.000
			CIT_G =	**0.03**

[1] Concentration measured in the EN ISO 5659-2 chamber at 4 minutes
[2] Concentration adjusted for pressure/temperature, calculated in accordance with EN 45545-2 Clause C.9 used to calculate CIT_G in Clause C.16.2
[3] Reference concentrations given in EN 45545-2 Table C.1
[4] NO_x includes both NO_2 and NO quoted as NO_2
The Limit of Quantification (LOQ) for CO_2 = 150 PPM
The Limit of Quantification (LOQ) for CO = 20 PPM
The Limit of Quantification (LOQ) for HF and SO2 = 5 PPM
The Limit of Quantification (LOQ) for HBr and NO = 15 PPM
The Limit of Quantification (LOQ) for HCN and HCl = 10 PPM
The Limit of Quantification (LOQ) for NO_2= 10 PPM

6.4.3 Smoke results at 50kW/m^2 no pilot flame (EN ISO 5659-2)

Test	$D_S max$	$D_S(1)$	$D_S(2)$	$D_S(3)$	**$D_S(4)$**	**VOF_4**
1	41.91	0.00	2.50	17.0	**37.1**	**38.05**
2	40.76	0.12	5.99	20.7	**38.8**	**46.21**
3	37.96	0.00	2.40	16.2	**36.3**	**36.75**
Average	40.21				**37.4**	**40.3**

6.4.4 Observations during Test

Test	**Initial specimen mass (g)**	**Observations**
1	43.40	Sample did not ignite
2	43.66	Sample did not ignite
3	43.73	Sample did not ignite

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7 Criteria

The specification given in of Table 5 of EN 45545-2 for Material Requirement Set R1 are:

Test method (EN 45545-2 Test ref.)	Parameter and unit	Maximum or minimum	HL1	HL2	HL3
ISO 5658-2 (T02)	CFE kWm^{-2}	Minimum	20	20	20
ISO 5660-1 50kW/m^2 (T03.01)	MARHE kWm^{-2}	Maximum	-	90	60
EN ISO 5659-2 50kW/m^2 (T10.01)	$D_s(4)$ dimensionless	Maximum	600	300	150
EN ISO 5659-2 50kW/m^2 (T10.02)	VOF_4 min	Maximum	1200	600	300
EN ISO 5659-2 50kW/m^2 (T11.01)	CIT_G dimensionless	Maximum	1.2	0.9	0.75

8 Conclusion

The sample described in Section 2 of this report, when subjected to the tests required for Material Requirement Set R1 as given in of Table 5 of EN 45545-2: 2013 satisfied the criteria for:

Hazard Level HL3

9 Validity

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

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 5 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 practise, and if required may endorse the test report.

10 References

1 EN 45545-2: 2013 Railway applications - Fire protection of railway vehicles - Part 2: Requirements for fire behaviour of materials and components. CEN Avenue Marnix 17, B-1000 Brussels, Belgium.

2 ISO 5658-2: 2006. Reaction to fire tests - Spread of flame - Part 2: Lateral spread on building and transport products in vertical configuration. ISO, Geneva, Switzerland.

3 ISO 5660-1: 2015. Reaction to fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method). ISO, Geneva, Switzerland.

4 EN ISO 5659-2: 2012 (Incorporating corrigendum March 2013) Plastics - Smoke generation: Part 2: Determination of optical density by a single–chamber test. CEN Avenue Marnix 17, B-1000 Brussels, Belgium.

Report Ends