

## Test Report

No. AJHL1604003938FB

Date: MAY.10, 2016

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**DONGSUNG CHEMICAL CO., LTD.**

472, SINPYEONG-DONG, SAHA-GU, BUSAN 604-030, KOREA

The following sample(s) was / were submitted and identified on behalf of the client as:

**Sample Description:** VIXUM

### **Test Requested:**

EN 45545-2:2013 Railway applications—Fire protection on railway vehicles Part 2: Requirements for fire behaviour of materials and components

- 1) ISO 5658-2:2006+A1:2011 Lateral flame spread
- 2) ISO 5660-1:2002 Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method), 50 kW/m<sup>2</sup>
- 3) EN ISO 5659-2:2012 Plastics — Smoke generation Part 2: Determination of optical density by a single chamber test, Heat flux 50 kW/m<sup>2</sup> without pilot flame and Test duration is 10 min
- 4) EN 45545-2:2013 Annex C Gas analysis in the smoke chamber EN ISO 5659-2, using FTIR technique, Heat flux 50 kW/m<sup>2</sup> without pilot flame and Test duration is 10 min

**Test Results:** -- See attached sheet --

### **Test Period:**

Sample Receiving Date : APR.22, 2016

Test Performing Date : APR.22, 2016 TO MAY.04, 2016

Signed for and on behalf of  
SGS-CSTC Co., Ltd. Anji Branch



Allen Zou  
Technical Manager



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**Sample details**

Sample description	VIXUM
Color	Grey

**I. Test conducted**

EN 45545-2:2013 Railway applications—Fire protection on railway vehicles Part 2: Requirements for fire behaviour of materials and components

- 1) ISO 5658-2:2006+A1:2011 Lateral flame spread
- 2) ISO 5660-1:2002 Reaction-to-fire tests — Heat release, smoke production and mass loss rate — Part 1: Heat release rate (cone calorimeter method), 50 kW/m<sup>2</sup>
- 3) EN ISO 5659-2:2012 Plastics — Smoke generation Part 2: Determination of optical density by a single chamber test, Heat flux 50 kW/m<sup>2</sup> without pilot flame and Test duration is 10 min
- 4) EN 45545-2:2013 Annex C Gas analysis in the smoke chamber EN ISO 5659-2, using FTIR technique, Heat flux 50 kW/m<sup>2</sup> without pilot flame and Test duration is 10 min

**II. Summary of test results**

Test method reference	Parameter Unit	Test results *
T02 ISO 5658-2	CFE kWm <sup>-2</sup>	36.95
T03.01 ISO 5660-1: 50 kWm <sup>-2</sup>	MARHE kWm <sup>-2</sup>	28.2
T10.01 EN ISO 5659-2: 50 kWm <sup>-2</sup>	Ds(4) dimensionless	91.41
T10.02 EN ISO 5659-2: 50 kWm <sup>-2</sup>	VOF <sub>4</sub> min	257.49
T11.01 EN ISO 5659-2: 50 kWm <sup>-2</sup>	CIT <sub>G</sub> dimensionless	0.08

\* For the test details, please see the appendix of this test report.

**Statements:**

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

The test results relate only to the specimens of the product in the form in which were tested.

The specimen was supplied by the sponsor and SGS-CSTC ANJI Branch was not involved in any selection or sampling procedure.

To be continued...



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**APPENDIX 1 ISO 5658-2:2006+A1:2011**

**I. Test conducted**

This test is conducted as per ISO 5658-2:2006+A1:2011 Reaction to fire tests- Spread of flame Part 2- lateral spread on building and transport products in vertical configuration.

**II. Test details**

**Conditioning:**

Prior to testing, all specimens were conditioned,

to moisture equilibrium at temperatures of 23±2°C and at a relative humidity of 50±5%.

**Exposed Face:**

One face of the specimen

**Size of specimen:**

800 mm x 155 mm x 50 mm

**III. Test results**

Specimen No.:	1		Heat for Sustained Burning (MJ/m <sup>2</sup> )	2		Heat for Sustained Burning (MJ/m <sup>2</sup> )	3		Heat for Sustained Burning (MJ/m <sup>2</sup> )
	0:01			0:01			0:01		
	min	sec		min	sec		min	sec	
50 mm	0	1	0.05	0	1	0.05	0	1	0.05
100 mm	0	1	0.05	0	1	0.05	0	1	0.05
150 mm	0	2	0.09	0	2	0.09	0	2	0.09
200 mm	0	3	0.13	0	2	0.09	0	2	0.13
250 mm	-	-	-	0	3	0.12	0	3	0.12
300 mm	-	-	-	-	-	-	-	-	-
350 mm	-	-	-	-	-	-	-	-	-
400 mm	-	-	-	-	-	-	-	-	-
450 mm	-	-	-	-	-	-	-	-	-
500 mm	-	-	-	-	-	-	-	-	-
550 mm	-	-	-	-	-	-	-	-	-
600 mm	-	-	-	-	-	-	-	-	-
650 mm	-	-	-	-	-	-	-	-	-
700 mm	-	-	-	-	-	-	-	-	-
750 mm	-	-	-	-	-	-	-	-	-
800 mm	-	-	-	-	-	-	-	-	-

To be continued...



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Duration of Test (min:sec)	11:50	11:46	11:56
Final Travel (mm)	240	270	275
CFE (kW/m <sup>2</sup> )	39.86	35.88	35.10

**Observations during test:** None

Calculated from the data in above table for each specimen for each of the parameters

PARAMETER	SPECIMEN No.			AVERAGE
	1	2	3	
Average Heat for Sustained Burning (Qsb) (MJ/m <sup>2</sup> )	0.11	0.10	0.11	0.11
Critical Heat Flux at Extinguishment (CFE) (kW/m <sup>2</sup> )	39.86	35.88	35.10	36.95

## APPENDIX 2 ISO 5660-1: 2002

### I. Test conducted

This test is conducted accordance with ISO 5660-1:2002 Reaction-to-fire tests -- Heat release, smoke production and mass loss rate -- Part1: Heat release rate (cone calorimeter method).

### II. Test details

#### Conditioning:

The samples have been preconditioned at 23°C and 50% RH for 48 hours until the sample mass varied less than 0.1gram.

**Size of specimen:** 100mm x 100mm

### III. Test results

Serial number	1	2	3	Average value
Items				
Thickness /mm	48.3	48.2	49.3	48.6
Heat flux/ (kw/m <sup>2</sup> )	50	50	50	50
Initial Mass /g	4.3	4.5	4.4	4.4
Remained mass /g	0.1	0.1	0.1	0.1
Time to ignition /s	2	2	2	2
Mean MLR /(g/s)	0.9	0.8	0.8	0.8

To be continued...



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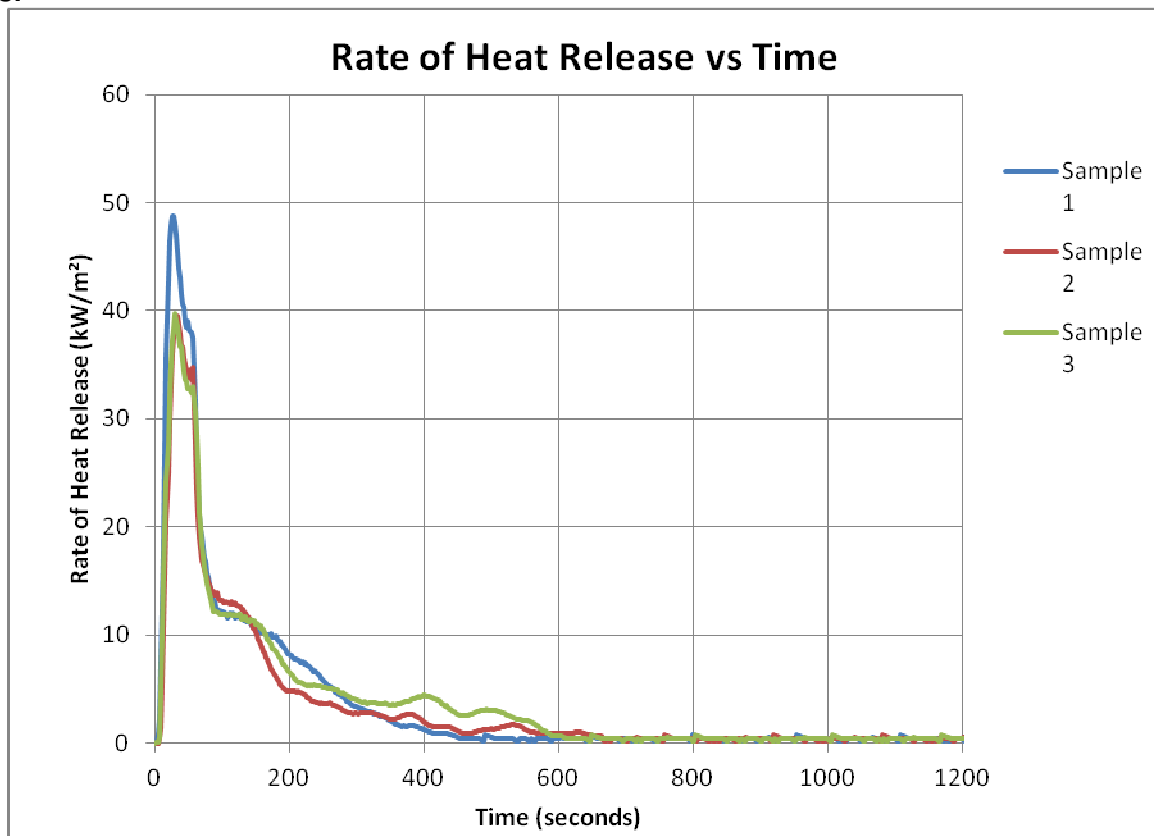
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Peak HRR / (kW/m <sup>2</sup> )	48.8	39.5	39.8	42.7
Time to Peak HRR / s	26	34	30	30
Average HRR(180s)/ (kW/m <sup>2</sup> )	19.5	17	17.5	18
Average HRR(300s)/ (kW/m <sup>2</sup> )	14.2	11.8	12.6	12.9
Total heat release / (MJ/m <sup>2</sup> )	4.6	4.1	4.7	4.5
Average Δhc, eff / (MJ/kg)	10.5	8.9	10.7	10
MARHE / kWm <sup>2</sup>	32.4	25.8	26.4	28.2
Test duration / s	1200	1200	1200	1200

Remark: 1. The orifice constant is 0.041; the exhaust flow rate is 0.024 m<sup>3</sup>/s; 3 specimens are tested under the same conditions.  
2. The HRR curves of specimens are given bellow.

### Curves:



To be continued...



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**APPENDIX 3 EN ISO 5659-2 Optical density\***

**I. Test conducted**

This test was conducted accordance with EN ISO 5659-2:2012 Plastics— Smoke generation — Part 2: Determination of optical density by a single- chamber test.

**II. Test details**

**Conditioning:**

Precondition	Temperature (°C)	Humidity (%)	Duration (h)
Specimens	23 ± 2	50 ± 10	88 *
Backing boards	23 ± 2	50 ± 10	88

\* Until the mass keeping constant as the standard required.

**Size of specimen:** 75mm x 75mm

**III. Test Results**

Test mode: Irradiance 50 kW/m<sup>2</sup>, without pilot flame, Test duration is 10 min

Test specimen	1	2	3	Average value
D <sub>s (1.5)</sub>	60.92	64.50	61.37	62.26
D <sub>s (4)</sub>	93.04	90.70	90.48	91.41
VOF <sub>4</sub>	250.28	263.74	258.44	257.49
D <sub>s max</sub>	98.26	94.67	92.44	95.12
T (D <sub>s max</sub> )	04min40s	04min52s	04min32s	---

Remark: \*---The test was performed by SGS internal laboratory.

**NOTE:**

D<sub>s (n)</sub> is the optical density in the test chamber n min into the test multiplied by a factor, which depends on the instrument and on the specimen size.

VOF<sub>4</sub> is the cumulative value of specific optical densities in the first 4 min of the test.

D<sub>s max</sub> is the maximum optical density in the test chamber. Test duration is 10 min.

To be continued...



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**APPENDIX 4 EN 45545-2:2013 Annex C**

**I. Test conducted**

The test was performed in accordance with the procedure specified in EN 45545-2:2013 Annex C Testing methods for determination of toxic gases from railway products- Method 1, gas analysis in the smoke box EN ISO 5659-2, Heat flux 50 kW/m<sup>2</sup> & without pilot flame.

**II. Test details**

**Conditioning**

Prior to testing, the sample was conditioned,

To constant mass at temperatures of 23±2°C and at a relative humidity of 50±5%

At time to testing, Temperature between 15°C ~ 35°C and Relative humidity between 20% ~ 80%

**III. Test results**

1) 4 min after the test start

Gas	Specimen 1	Specimen 2	Specimen 3	Average
Carbon Dioxide (CO <sub>2</sub> )	2640.91	2993.03	2993.03	2875.66
Carbon Monoxide (CO)	35.85	42.57	51.54	43.32
Hydrogen Fluoride (HF)	ND	ND	ND	--
Hydrogen Chloride (HCl)	ND	ND	ND	--
Hydrogen Bromide (HBr)	ND	ND	ND	--
Hydrogen Cyanide (HCN)	12.96	12.96	15.13	13.68
Nitrogen Oxides (NO <sub>x</sub> )	5.52	3.68	9.20	6.13
Sulphur Dioxide (SO <sub>2</sub> )	2.56	2.56	2.56	2.56

2) 8 min after the test start

Gas	Specimen 1	Specimen 2	Specimen 3	Average
Carbon Dioxide (CO <sub>2</sub> )	4929.70	5457.88	5633.94	5340.51
Carbon Monoxide (CO)	67.22	89.63	100.83	85.89
Hydrogen Fluoride (HF)	ND	ND	ND	--
Hydrogen Chloride (HCl)	ND	ND	ND	--
Hydrogen Bromide (HBr)	ND	ND	ND	--
Hydrogen Cyanide (HCN)	21.61	23.77	27.01	24.13
Nitrogen Oxides (NO <sub>x</sub> )	12.88	11.04	18.41	14.11
Sulphur Dioxide (SO <sub>2</sub> )	2.56	2.56	5.12	3.41

To be continued...



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Where, ND indicates Non-detected.

Note: All values given are in mg/m<sup>3</sup>.

### Calculation of $CIT_G$

Gas component	Reference concentration; mg/m <sup>3</sup>
Carbon Dioxide (CO <sub>2</sub> )	72 000
Carbon Monoxide (CO)	1 380
Hydrogen Fluoride (HF)	25
Hydrogen Chloride (HCl)	75
Hydrogen Bromide (HBr)	99
Hydrogen Cyanide (HCN)	55
Nitrogen Oxides (NO <sub>x</sub> )	38
Sulphur Dioxide (SO <sub>2</sub> )	262

$$CIT_G = 0.0805 \cdot \sum_{i=1}^{i=8} \frac{c_i}{C_i}$$

Where,

$CIT_G$  – Conventional Index of Toxicity;

$c_i$  – Concentration of the  $i^{\text{th}}$  gas;

$C_i$  – Reference concentration of the  $i^{\text{th}}$  gas.

/	Sample 1	Sample 2	Sample 3	Average
CITG (4min)	0.04	0.03	0.05	0.04
CITG (8min)	0.07	0.07	0.09	0.08

To be continued...



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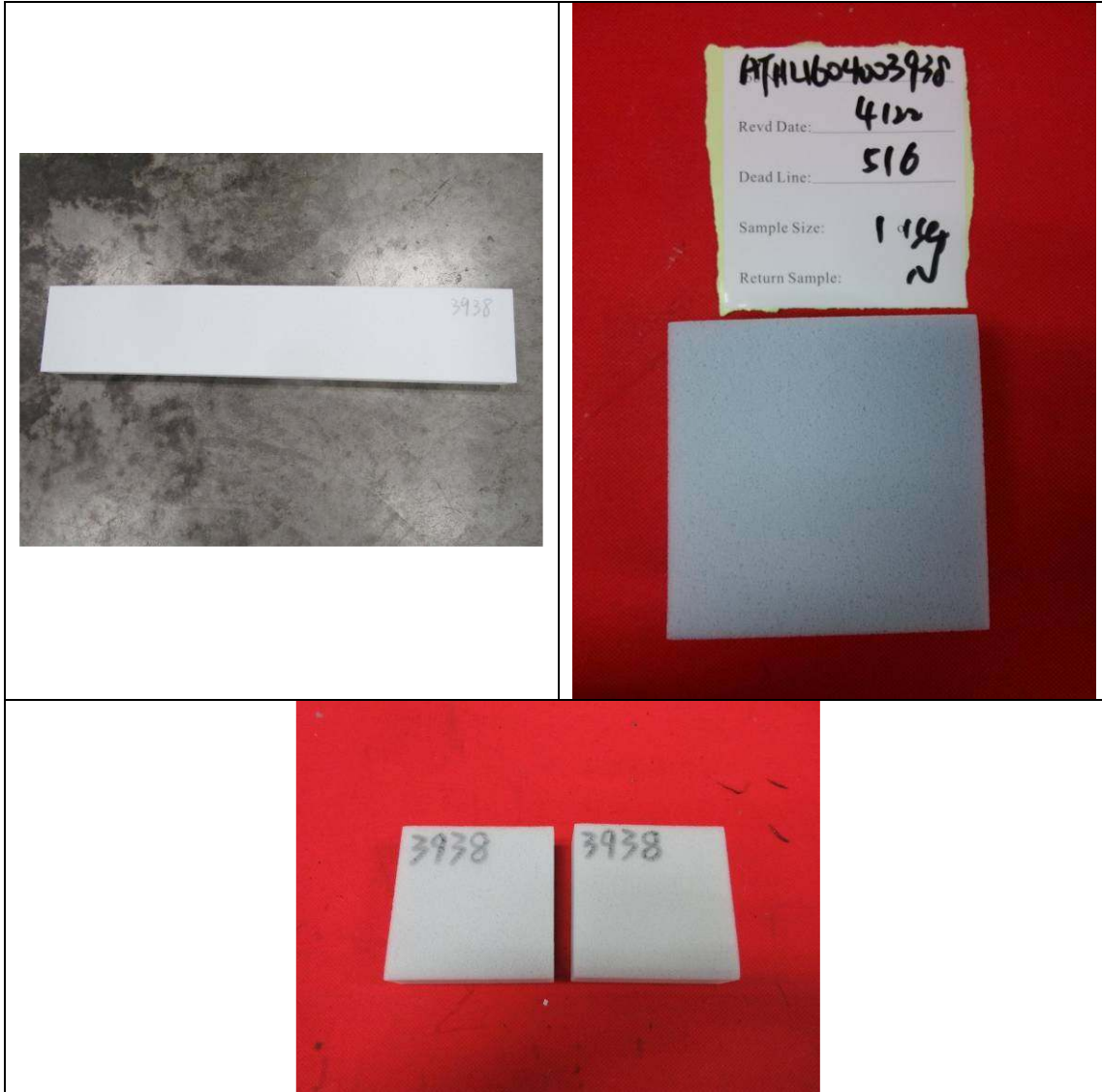
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