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Test Report No: ICL/H20/12909 Rev 1

ISO 5660-1:2015+A1:2019

**Reaction-to-fire tests — Heat release, smoke production and mass loss rate —
Part 1: Heat release rate (cone calorimeter method) and smoke production rate
(dynamic measurement)**

Sponsored By

Hanwha Techwin Co., Ltd
6, Pangyo-ro 319beon-gil, Bundang-gu,
Seongnam-si, Gyeonggi-do, 13488, Korea

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1. Purpose of Test

To determine the performance of a specimen of a product when it is subjected to the conditions of test specified in ISO 5660-1: 2019 Reaction-to-fire tests- Heat release, smoke production and mass loss rate - Part 1: Heat release rate (cone calorimeter method) and smoke production rate (dynamic measurement)

The results are used to determine compliance with the criteria given in EN 45545-2 Table 5 R 1.

2. Scope of Test

ISO 5660-1: 2015 +A1:2019 Reaction-to-fire tests- Heat release, smoke production and mass loss rate- Part 1 details a test procedure to determine the rate of heat release, smoke production and mass loss. The heat release values are expressed on area bases and smoke and mass loss values are expressed on mass bases. ARHE values are calculated from the data and MARHE value is reported.

3. Description of Test Specimen

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

The test specimens consisted of 1.2mm thick steel plate (density 7.8g/cm³) coated on one face with paint EMS BLACK MATT(MNC)-1 manufactured by Akzonobel applied at 15-20um thickness

The sponsor of the test has not supplied additional information relating to the product that was tested.

The specimens were received on 8th September 2020.

4. Conditioning of Test Specimens

The sample was conditioned to constant mass at a temperature of 23±2°C and a relative humidity of 50±5% in accordance with ISO 554.

5. Date of Test

The test was performed on 18th September 2020.

6. Test Procedure

The test was performed in accordance with the procedure specified in ISO 5660-1 and this report should be read in conjunction with that Standard.

7. Exposed Face

The black face was exposed to the heating conditions (50kW/m²) of the test.

8. Test Results

The test results apply to the sample as received tested after conditioning. The test results relate only to the behaviour of the specimens of the product under the conditions of 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 they were tested. 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, which were tested. Uncertainty measurement has not been taken into account when presenting the test results.

The results of six specimens tested are given in table below:

Parameter	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average
Specimen thickness (mm)	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Specimen Initial mass (g)	93.99	93.84	94.25	93.31	93.69	94.4	93.9
Time to ignition (s)	91	84	70	82	78	72	79.5
Total heat release (MJ/m ²)	0.6	5.4	6.6	0.4	0.1	6.5	3.3
Mass loss between Ign & Ext (g)	0.9	0.7	1.1	1.1	0.6	0.9	0.9
pK HRR (kW/m ²)	5.9	10.9	48.5	5.9	5.8	57.5	22.4
pk Effective heat of combustion (MJ/kg)	72.0	79.8	62.0	58.4	9.4	69.4	58.5
Average values HRR							
HRR (kW/m ²) over Ign 60 sec from ign	5.24	5.80	28.86	1.22	1.03	29.53	11.9
HRR (kW/m ²) over Ign 120 sec from ign	2.90	4.97	17.35	0.60	0.50	17.19	7.3
HRR (kW/m ²) over Ign 180 sec from ign	1.93	5.00	13.31	0.40	0.32	12.93	5.6
HRR (kW/m ²) over Ign 240 sec from ign	1.45	5.02	10.68	0.30	0.23	10.79	4.7
HRR (kW/m ²) over Ign 300 sec from ign	1.24	5.02	9.17	0.25	0.18	9.51	4.2
HRR (kW/m ²) over Ign 360 sec from ign	1.06	4.83	7.74	0.21	0.15	8.66	3.8

Parameter	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Average
Average values EHC (MJ/kg)							
EHC (MJ/kg) over Ign 60 sec from ign	14.37	24.50	25.84	6.33	3.06	31.61	17.6
EHC (MJ/kg) over Ign 120 sec from ign	21.80	50.18	30.74	2.81	2.89	33.51	23.7
EHC (MJ/kg) over Ign 180 sec from ign	12.57	43.77	28.55	2.59	2.35	32.02	20.3
EHC (MJ/kg) over Ign 240 sec from ign	12.69	53.42	33.62	2.71	1.72	32.12	22.7
EHC (MJ/kg) over Ign 300 sec from ign	11.50	56.48	34.92	2.30	1.66	36.08	23.8
EHC (MJ/kg) over Ign 360 sec from ign	8.44	79.27	34.23	1.96	1.44	36.79	27.0
MARHE (kW/m ²)	3.24	5.53	14.87	2.20	1.22	16.68	7.3

HRR and ARHE charts and given in Appendix 1.

9 **Requirements**

The following requirements are given in Table 5 of EN 45545-2 for R1

Test Method	Parameter	Requirements	HL1	HL2	HL3
T03.01 ISO 5660-1: 50 kWm-2	MARHE kWm-2	Maximum	a -	90	60

a If flaming droplets/particles are reported according to 5.3.7 during the test ISO 5658-2, or for the special case of materials which do not ignite in ISO 5658-2 and are additionally reported as unclassifiable, the following requirements shall be added:

Test to the requirements of EN ISO 11925-2 with 30 s flame application.

The acceptance requirements are:

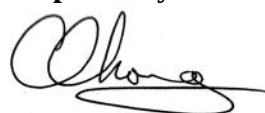
- flame spread < 150 mm within 60 s;
- no burning droplets/particle

10. **Conclusion**

The average MARHE value specimens tested was calculated to be 7.3 kW/m²

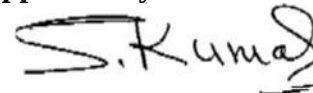
The product tested therefore satisfies the MARHE requirements given in EN 45545-2 Table 5 R 1 for HL2 and HL3. There is no MARHE requirement for HL1.

Prepared by



C. B. Chong
Fire Scientist

Approved by



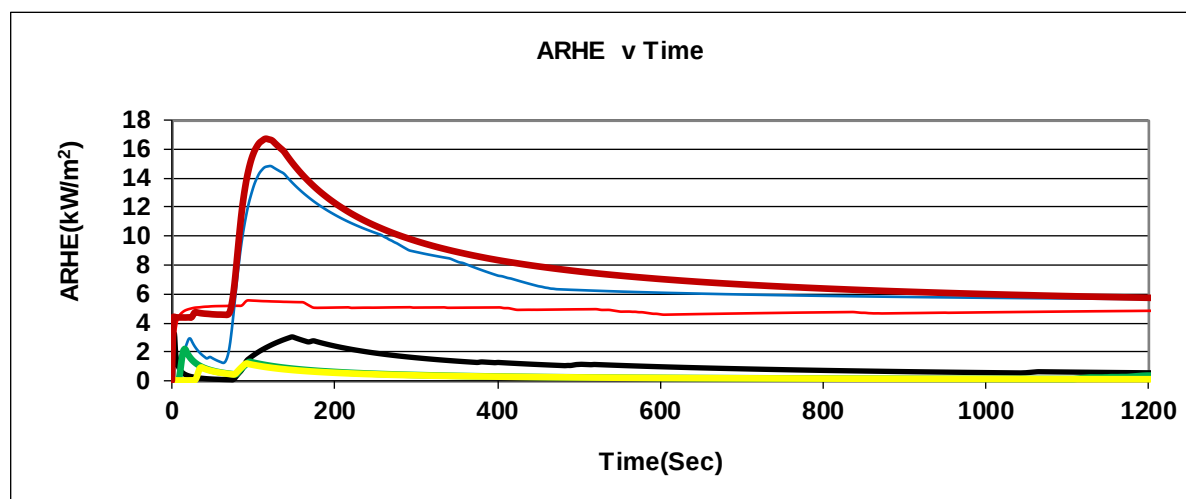
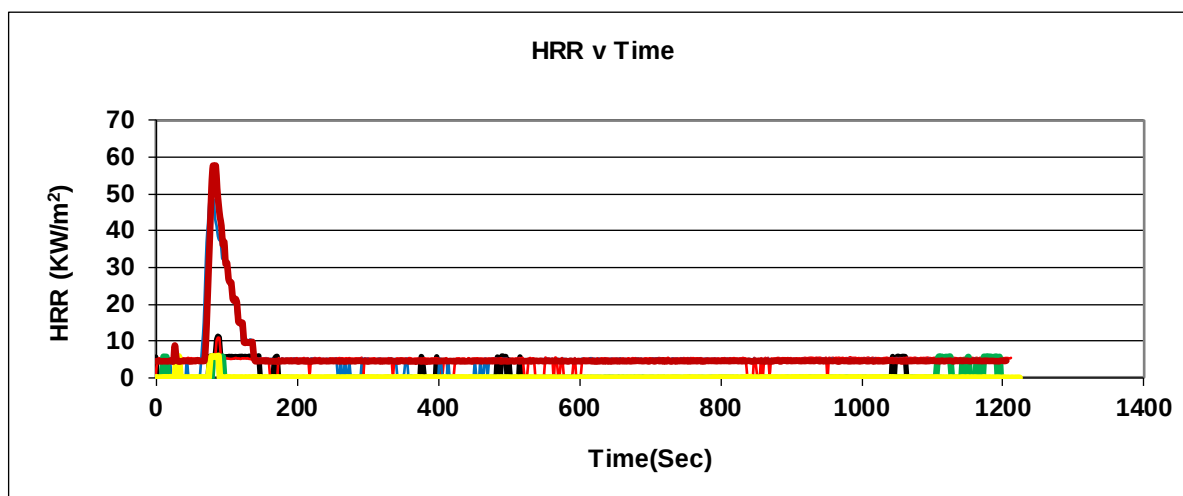
S. Kumar
Technical Manager

Date of Issue: 25th September 2020.

Date of issue Revision 1: 28th September 2020.

Appendix 1

Run 1	Black	Run 2	Red	Run 3	Blue
Run 4	Green	Run 5	Yellow	Run 6	Brown



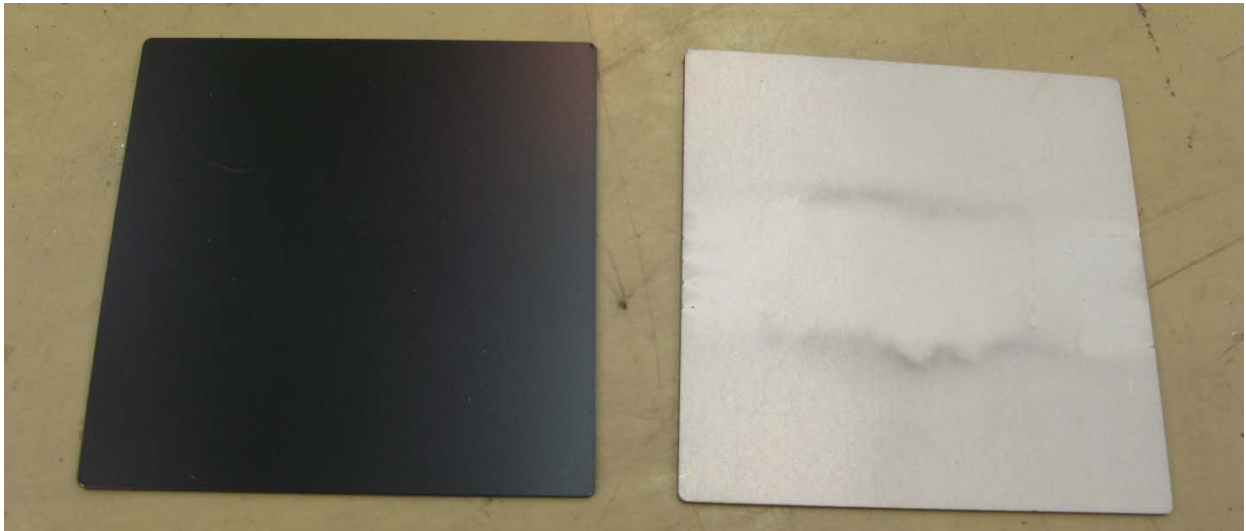


Photo 1: Specimens as received left exposed face right rear face



Photo 2: Samples before test (from left to right 1,2 and 3)



Photo 3: Samples after test (from left to right 1,2 and 3)



Photo 4: Samples before test (from left to right 4,5 and 6)



Photo 5: Samples after test (from left to right 4,5 and 6)