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## Emission measurements

(2 appendices)

### Object

One sample of a powder coating was delivered to RISE by the customer.

Product name:	<b>IGP-HWFclassic 5903</b>
Production date:	2019-10-21
Size of sample:	20 x 20 cm, thickness of powder coating 70-80 $\mu\text{m}$
Date of arrival to RISE:	2019-10-22
Date of analysis:	week 44 – 50, 2019

### Assignment

Emission measurements according to the horizontal standard EN 16516:2017 (Construction products: Assessment of release of dangerous substances – Determination of emissions into indoor air) and to the product standard EN 16402:2013 (Paints and varnishes – Assessment of emissions of substances from coatings into indoor air – Sampling, conditioning and testing). The measurements are performed after 3 and 28 days regarding volatile organic compounds (VOC and VVOC/SVOC), carcinogenic substances (VOC-substances, EU Regulation No 1272/2008 Annex VI, cat 1A and 1B) and aldehydes (ISO 16000-3:2011).

### Method

The test was started 2019-10-28 by unwrapping the test sample. Backside was sealed with and aluminum tape. The sample was placed directly into the chamber. After 3 days of conditioning in the chamber air samplings were carried out on 19-10-31. After the specimen was placed in a separate conditioning container (with air velocity of ca 0.2 m/s) in a room with controlled climate conditions of  $23 \pm 2$  °C and  $50 \pm 5$  % RH. After 25 days the specimen was placed into the chamber and after 28 days air samples were carried out on 19-11-25.

Test conditions in the chamber:	
Chamber volume:	0.03 m <sup>3</sup>
Temperature:	$23 \pm 0.5$ °C
Relative humidity:	$50 \pm 5$ % RH
Surface area of test specimen:	0.04 m <sup>2</sup>
Air exchange rate:	0.67 h <sup>-1</sup>
Area specific air flow rate:	0.50 m <sup>3</sup> /m <sup>2</sup> h.
Air velocity at specimen surface:	0.1 – 0.3 m/s

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Tenax TA was used as adsorption medium for VOC. The tubes were thermally desorbed and analysed in accordance to RISE method 0601, similar to ISO 16000-6:2011 (Determination of volatile organic compounds in indoor and test chamber air by active sampling on Tenax TA sorbent, thermal desorption and gas chromatography using MS/FID). This means an analysis in a gas chromatograph and detection with a flame ionisation detector (FID) and mass selective detector (MS). The capillary column used is coated with 5% phenyl/ 95 % methylpolysiloxane. The total volatile organic compounds (TVOC) means compounds eluting between and including n-hexane to hexadecane, having boiling points in the range of about 70-260 °C. Minimum duplicate air samples were taken and the results are mean values. Sampled volumes are 2 to 7 L.

Tenax TA was also used as adsorption medium for testing of volatile carcinogenic compounds according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), (exclusive formaldehyde), 1 µg/m<sup>3</sup> and above.

The samplings of aldehydes were carried out with DNPH samplers. The samplers were analysed according to RISE method 2302, similar to ISO 16000-3:2011(Indoor air - Part 3: Determination of formaldehyde and other carbonyl compounds – Active sampling method). This means analysis on a liquid chromatograph with absorbance detector. Duplicate air samples were taken and the results are mean values. Sampled volumes were 20-21 L.

## Results

The results relate only to the items tested.

The results in Table 1 and 2 are expressed as area specific emission rates and as concentrations in a reference room. The reference room has a base area of 3 m x 4 m and a height of 2.5 m, with an air exchange rate of 0.5 h<sup>-1</sup>. The wall area is 31.4 m<sup>2</sup>, floor area is 12 m<sup>2</sup>, small area, like a door, is 1.6 m<sup>2</sup> and very small area, like sealant, is 0.2 m<sup>2</sup>. **Wall area** is used for the calculation of the concentrations.

Calculation of the concentration from the emission rate:

$$C = \frac{E_a \times A}{n \times V}$$

C = concentration of VOC in the reference room, in µg/m<sup>3</sup>

E<sub>a</sub> = area specific emission rate, in µg/m<sup>2</sup>h

A = surface area of product in reference room, in m<sup>2</sup>

n = air exchange rate, in changes per hour, here 0.5 h<sup>-1</sup>

V = volume of the reference room, in m<sup>3</sup>, here 30 m<sup>3</sup>

**Table 1.**  
Emission results of **IGP-HWFclassic 5903** after 3 days

Volatile organic compounds	CAS number	Retention time (min)	ID <sup>1</sup>	Emission rate (µg/m <sup>2</sup> h)	Concentration in reference room (µg/m <sup>3</sup> )
<b>TVOC (C<sub>6</sub> – C<sub>16</sub>)</b>	--	6.9 – 39	B	< 10	< 10
<b>Volatile Carcinogens<sup>2</sup></b>		6.9 – 39			
No substances detected	--	--	B	< 1	< 1
<b>VOC with LCI<sup>3</sup></b>		6.9 – 39			
No substances detected	--	--	A	< 2	< 5
<b>∑ VOC with LCI</b>	--	--	A	< 2	< 5
<b>VOC without LCI<sup>4</sup></b>		6.9 – 39			
No substances detected	--	--	B	< 2	< 5
<b>∑ VOC without LCI</b>	--	--	B	< 2	< 5
<b>SVOC (C<sub>16</sub> – C<sub>22</sub>)<sup>5</sup></b>		39 - 52			
No substances detected	--	--	B	< 2	< 5
<b>∑ SVOC</b>	--	--	B	< 2	< 5
<b>VVOC (&lt; C<sub>6</sub>)<sup>6</sup></b>		5.5 – 6.9			
Formaldehyde <sup>7</sup>	50-00-0	--	A	< 2	< 5
Acetaldehyde <sup>7</sup>	75-07-0	--	A	< 2	< 5
<b>∑ VVOC</b>	--	--	A	< 2	< 5

<sup>1</sup>) ID: A = quantified compound specific, B = quantified as toluene-equivalent

<sup>2</sup>) Volatile carcinogens = VOCs according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B

<sup>3</sup>) VOC with LCI = identified VOC-compound with LCI-value according to EU-LCI, July 2018

<sup>4</sup>) VOC without LCI = VOC-compound without LCI-value or not identified.

<sup>5</sup>) SVOC = semi-volatile organic compounds, as defined in ISO 16000-6 (not part of accreditation)

<sup>6</sup>) VVOC = very volatile organic compounds, as defined in ISO 16000-6 (not part of accreditation)

<sup>7</sup>) VVOC-aldehydes measured with DNPH samplers (ISO 16000-3)

**Table 2.**  
Emission results of **IGP-HWFclassic 5903** after 28 days

Volatile organic compounds	CAS number	Retention time (min)	ID <sup>1</sup>	Emission rate (µg/m <sup>2</sup> h)	Concentration in reference room (µg/m <sup>3</sup> )	LCI <sub>i</sub> (µg/m <sup>3</sup> )	R <sub>i</sub> (c <sub>i</sub> /LCI <sub>i</sub> )
<b>TVOC (C<sub>6</sub> – C<sub>16</sub>)</b>	--	6.9 – 39	B	< 10	< 10	--	--
<b>Volatile Carcinogens <sup>2</sup></b>		6.9 – 39					
No substances detected	--	--	B	< 1	< 1	--	--
<b>VOC with LCI <sup>3</sup></b>		6.9 – 39					
No substances detected	--	--	A	< 2	< 5	--	--
<b>∑ VOC with LCI</b>	--	--	A	< 2	< 5	--	--
<b>VOC without LCI <sup>4</sup></b>		6.9 – 39					
No substances detected	--	--	B	< 2	< 5	--	--
<b>∑ VOC without LCI</b>	--	--	B	< 2	< 5	--	--
<b>SVOC (C<sub>16</sub> – C<sub>22</sub>) <sup>5</sup></b>		39 - 52					
No substances detected	--	--	B	< 2	< 5	--	--
<b>∑ SVOC</b>	--	--	B	< 2	< 5	--	--
<b>VVOC (&lt; C<sub>6</sub>) <sup>6</sup></b>		5.5 – 6.9					
Formaldehyde <sup>7</sup>	50-00-0	--	A	< 2	< 5	100	--
Acetaldehyde <sup>7</sup>	75-07-0	--	A	< 2	< 5	1200	--
<b>∑ VVOC</b>	--	--	A	< 2	< 5	--	--
<b>R = ∑ C<sub>i</sub> / LCI<sub>i</sub> <sup>8</sup></b>	--	--	--	--	--	--	< 0.01

<sup>8)</sup> All VVOC, VOC, SVOC and carcinogens with LCI

Only VOC-compounds with an emission rate higher than 2 µg/m<sup>2</sup>h are listed in Table 2 and 3, carcinogenic compounds ≥ 1 µg/m<sup>2</sup>h. Only the compounds with a concentration in the reference room > 5 µg/m<sup>3</sup> after 28 days are evaluated based on LCI (= lowest concentration of interest). TVOC expressed in µg/m<sup>3</sup> is the sum of all individual substances with concentrations ≥ 5 µg/m<sup>3</sup> (in toluene equivalents).

Quantification limit for TVOC is 10 µg/m<sup>2</sup>h. Measurement uncertainty for VOC is 15 % (rel) and for formaldehyde 30 % (rel). Background of TVOC in the empty chamber was below 10 µg/m<sup>3</sup> and is subtracted.

See Appendix 1 for a gas chromatogram (FID spectra) and Appendix 2 for a photo of the test specimen.

## Summary of the test results

The test results are summarized in Table 3 and 4.

**Table 3.**

Summary of the emission results after 3 days of **IGP-HWFclassic 5903**

Compounds	Emission rate ( $\mu\text{g}/\text{m}^2\text{h}$ )	Concentration in reference room ( $\mu\text{g}/\text{m}^3$ )
TVOC	< 10	< 10
$\Sigma$ Carcinogenic VOCs	< 1	< 1
$\Sigma$ VOC with LCI	< 2	< 5
$\Sigma$ VOC without LCI	< 2	< 5
$\Sigma$ VVOC	< 2	< 5
Formaldehyde	< 2	< 5
$\Sigma$ SVOC	< 2	< 5
$R = \Sigma C_i / LCI_i$	< 0.01	

**Table 4.**

Summary of the emission results after 28 days of **IGP-HWFclassic 5903**

Compounds	Emission rate ( $\mu\text{g}/\text{m}^2\text{h}$ )	Concentration in reference room ( $\mu\text{g}/\text{m}^3$ )
TVOC	< 10	< 10
$\Sigma$ Carcinogenic VOCs	< 1	< 1
$\Sigma$ VOC with LCI	< 2	< 5
$\Sigma$ VOC without LCI	< 2	< 5
$\Sigma$ VVOC	< 2	< 5
Formaldehyde	< 2	< 5
$\Sigma$ SVOC	< 2	< 5
$R = \Sigma C_i / LCI_i$	< 0.01	

## Evaluation of the test results

Byggarubedömningen has criteria regarding Emissions to indoor environment. The emissions are to be measured according to a standard method such as ISO 16000-9 after 28 days regarding VOC and formaldehyde. The requirements for the *Recommended class* is that the requirements to one of the following systems are being met: Emission EC1, Emission EC1<sup>PLUS</sup>, Blue Angel, M1 (RTS) or GUT.

The results of the tested sample are compared to M1 and AgBB.

Decision rule: When comparing the measured results and requirement level, the average value of the measured results has been compared with the requirement level. No account is taken to the measurement uncertainty.

**Table 5.**

The test results after 28 days of **IGP-HWFclassic 5903** are compared to the relevant requirements in M1

Compounds	Requirement M1 (mg/m <sup>2</sup> h)	Test Results (mg/m <sup>2</sup> h)	Pass / Fail
TVOC	< 0.2	< <b>0.010</b>	<b>PASS</b>
Formaldehyde	< 0.05	< <b>0.002</b>	<b>PASS</b>
CMR 1A+1B	< 0.001	< <b>0.001</b>	<b>PASS</b>
Single VOC (µg/m <sup>3</sup> )	≤ EU-LCI	≤ EU-LCI	<b>PASS</b>
Ammonia	< 0.03	not measured	--
Odour	≥ 0.0	not measured	--

The test results are in compliance with the tested requirements of M1 and meet the requirements for the *Recommended class*.

**Table 6.**  
Comparison of the criteria according to **AgBB (ver Aug 2018)** and **IGP-HWFclassic 5903** test results

<b>Volatile organic compound</b>	<b>Criteria according to AgBB (mg/m<sup>3</sup>)</b>	<b>Test Results (mg/m<sup>3</sup>)</b>	<b>Pass / Fail</b>
<b>After 3 days:</b>			
TVOC <sub>spez3</sub>	≤ 10	< <b>0.010</b>	<b>PASS</b>
∑ Carcinogens	≤ 0.01	< <b>0.001</b>	<b>PASS</b>
<b>After 28 days:</b>			
TVOC <sub>spez28</sub>	≤ 1	< <b>0.010</b>	<b>PASS</b>
∑ Carcinogens	≤ 0.001	< <b>0.001</b>	<b>PASS</b>
∑ VOC without LCI	≤ 0.1	< <b>0.005</b>	<b>PASS</b>
∑ SVOC	≤ 0.1	< <b>0.005</b>	<b>PASS</b>
$R = \sum C_i / LCI_i$	≤ 1	< <b>0.01</b>	<b>PASS</b>

$$TVOC_{spez} = \sum \text{VOC with LCI} + \sum \text{VOC without LCI}$$

The test results are in compliance with the requirements in AgBB (Feb 2018) 3 + 28 days.

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**Appendices**

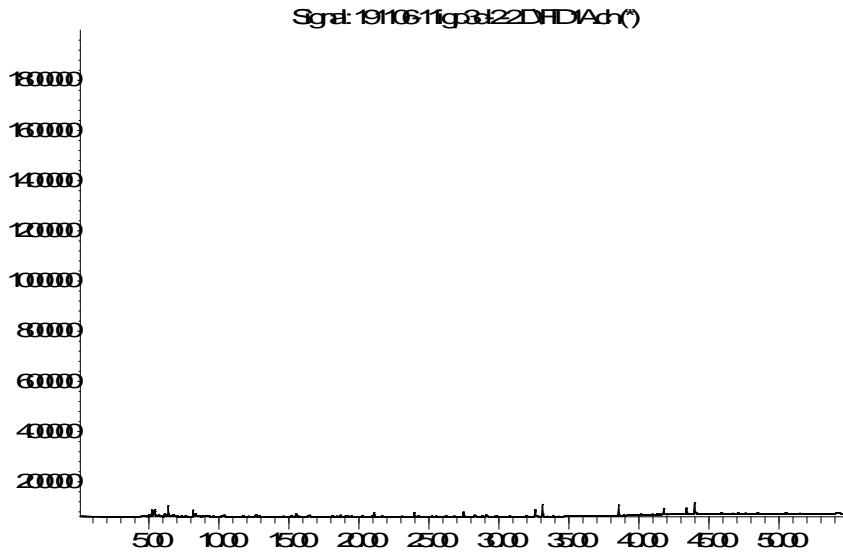
1. Gas Chromatograms
2. Photo of the test specimen

Appendix 1

Gas chromatograms

IGP-HWFclassic 5903, after 3 days:

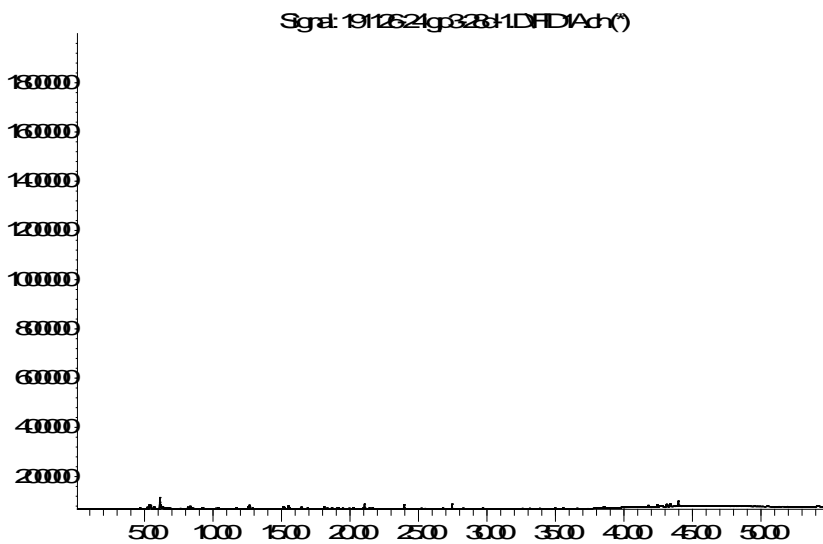
Aundance



Time->

IGP-HWFclassic 5903, after 28 days:

Aundance



Time->

TVOC between C<sub>6</sub> and C<sub>16</sub>, means compounds eluting between 6.9 and 39 minutes.



## Appendix 2

**Photo of the test specimen**