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## Emission measurements after 28 days

(2 appendices)

### Object

One sample of panel for a bathroom wall was delivered to RISE by the customer.

Product name:	<b>3091-F00 HG Denver White</b>
Production date:	2019-02-14
Size of sample:	500 x 500 x 11 mm
Date of sampling:	2019-02-14
Date of arrival to RISE:	2019-02-25
Date of analysis:	week 9 – 17, 2019

### Assignment

Emission measurement according to ISO 16000-9:2006 (Indoor air – Part 9: Determination of the emission of volatile organic compounds from building products and furnishing – Emission test chamber method), after 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), formaldehyde and acetaldehyde (ISO 16000-3:2011). Evaluation according to EN 16516:2017 (EU-LCI values).

### Method

The test was started 2019-02-25 by unwrapping the test sample. Backside and edges were sealed with aluminium foil and aluminium tape.

Open surface area was 0.25 m<sup>2</sup>. The specimen was placed in a room with controlled climate conditions of 23 ± 2 °C and 50 ± 5 % RH. The test specimen was put into the chamber three days prior to air samplings. Air samplings after 28 days of conditioning were carried out on 2019-03-22.

Test conditions in the chamber:

Chamber volume:	0.25 m <sup>3</sup>
Temperature:	23 ± 0.5 °C
Relative humidity:	50 ± 5 % RH
Surface area of test specimen:	0.25 m <sup>2</sup>
Air exchange rate:	0.5 h <sup>-1</sup>
Area specific air flow rate:	0.5 m <sup>3</sup> /m <sup>2</sup> h.

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Air velocity at specimen surface: 0.1 – 0.3 m/s

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 FID signals are used for compound quantification. 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 8 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 35 to 50 L.

## Results

The results in Table 1 are expressed as area specific emission rates and as concentrations in a reference room (according to EN 16516:2017). 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 **3091-F00 HG Denver White** 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>	--	6.8 – 38.6	B	13	26	--	--
<b>Volatile Carcinogens <sup>2</sup></b>		6.8 – 38.6					
No substances detected	--	--	B	< 1	< 1	--	--
<b>VOC with LCI <sup>3</sup></b>		6.8 – 38.6					
pentanal	110-62-3	9.2	A	4	8	800	0.01
Hexanal	66-25-1	12.6	A	15	31	900	0.03
<b>Σ VOC with LCI</b>	--	--	A	19	39	--	
<b>VOC without LCI <sup>4</sup></b>							
No substances detected	--	--	B	< 2	< 5	--	--
<b>Σ VOC without LCI</b>	--	--	B	< 2	< 5	--	--
<b>SVOC (C<sub>16</sub> – C<sub>22</sub>) <sup>5</sup></b>		38.6 - 50.0					
No substances detected	--	--	B	< 2	< 5	--	--
<b>Σ SVOC</b>	--	--	B	< 2	< 5	--	--
<b>VVOC (&lt; C<sub>6</sub>) <sup>6</sup></b>		4.5 – 6.8					
Formaldehyde <sup>7</sup>	50-00-0	--	A	28	60	100	0.6
Acetaldehyde <sup>7</sup>	75-07-0	--	A	12	25	1 200	0.02
Acetic acid, methyl ester	79-20-9	5.7	B	4	8	--	--
<b>Σ VVOC</b>	--	--	A	44	93	--	
<b>R = Σ C<sub>i</sub> / LCI<sub>i</sub> <sup>8</sup></b>	--	--	--	--	--	--	0.66

<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)

<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, carcinogenic compounds ≥ 1 µg/m<sup>3</sup>. Only the compounds with a concentration in the reference room > 5 µg/m<sup>3</sup> 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 20 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 2.

**Table 2.**  
Summary of the emission results after 28 days of **3091-F00 HG Denver White**

Compounds	Emission rate ( $\mu\text{g}/\text{m}^2\text{h}$ )	Concentration in reference room (wall scenario) ( $\mu\text{g}/\text{m}^3$ )
TVOC	13	26
$\Sigma$ Carcinogenic VOCs	< 1	< 1
$\Sigma$ VOC with LCI	19	39
$\Sigma$ VOC without LCI	< 2	< 5
$\Sigma$ VVOC	44	93
Formaldehyde	28	60
$\Sigma$ SVOC	< 2	< 5
$R = \Sigma C_i / LCI_i$	0.66	

## Evaluation of the test results

Byggvarubedömningen has criteria regarding Emissions to indoor environment. The emissions are to measured according to a standard method such as ISO 16000-9. 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.

**Table 3.**  
The test results of **3091-F00 HG Denver White** are compared to the relevant requirements in M1

Compounds	Requirement M1 ( $\text{mg}/\text{m}^2\text{h}$ )	Test Results ( $\text{mg}/\text{m}^2\text{h}$ )	Pass / Fail
TVOC	< 0.2	<b>0.013</b>	<b>PASS</b>
Formaldehyde	< 0.05	<b>0.028</b>	<b>PASS</b>
CMR 1A+1B	< 0.005	<b>&lt; 0.001</b>	<b>PASS</b>
Ammonia	< 0.03	not measured	--
Odour	$\geq 0.0$	not measured	--

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

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**Appendices**

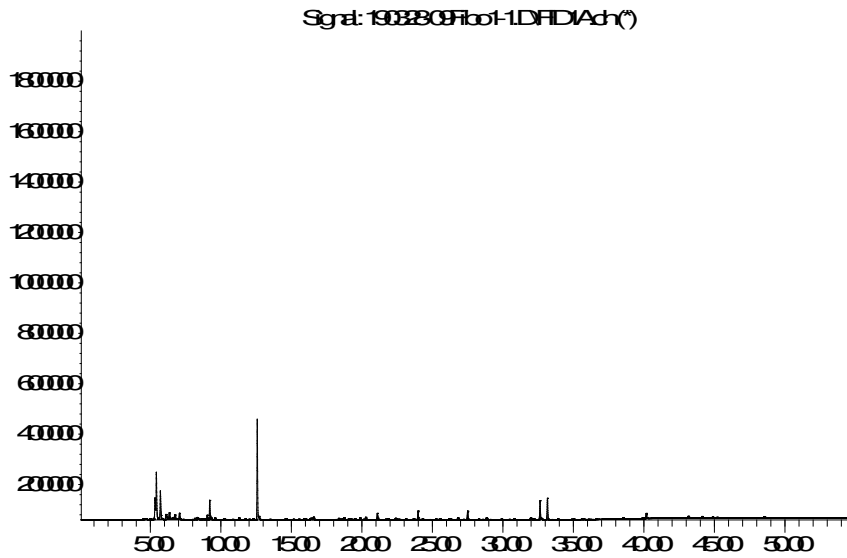
1. Gas Chromatogram
2. Photo of the test specimen

Appendix 1

Gas chromatogram

3091-F00 HG Denver White, after 28 days:

Abundance



Time->

TVOC between C<sub>6</sub> and C<sub>16</sub>, means compounds eluting between 6.8 and 38.6 minutes.

## Appendix 2

**Photo of test specimen****3091-F00 HG Denver White**