

## Emission measurements according to M1

(3 appendices)

### Assignment

Emission measurement according to “M1 Emission Classification of Building Materials: Protocol for Chemical and Sensory Testing of Building Materials”, ver 15.11.2017, after 28 days of conditioning regarding volatile organic compounds, carcinogenic compounds (EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), formaldehyde, ammonia and sensory acceptability.

### Product/test specimen

Table 1.

Product type:	PVC Wet room walls
Product name:	<b>Onyx+</b>
Manufacturer:	Forbo Flooring AB
Manufacturing date:	2024-01-17
Batch No:	4312041
Sampling date:	2024-01-21
Size of sample, packaging:	1 x 2 m rolled up and wrapped in aluminium and plastic foil.
Arrived at RISE:	2024-01-29
Test specimen preparation:	<p>Wall scenario is used for the testing.</p> <p>Chemical testing: Four pieces of 14.5 x 51 cm were cut out from the material. The pieces were placed back-to-back and the cut edges and part of the surface were sealed with aluminium tape, leaving a total exposed surface area of 0.27 m<sup>2</sup>.</p> <p>Sensory testing: Four pieces of 52 x 55 cm were cut out from the material. The pieces were placed back-to-back and the cut edges and part of the surface were sealed with aluminium tape, leaving a total exposed surface area of 1.1 m<sup>2</sup>.</p>
Deviation from protocol:	No
Test period started, date:	2024-01-30
Conditions during ageing:	23 ± 2 °C, 50 ± 5 % RH
Emission samplings, date:	2024-02-27
Place for testing:	Chemistry and Applied Mechanics, Brinellgatan 4, Borås

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Accred. No. 1002  
Testing  
ISO/IEC 17025

## Methods

The specimens were conditioned outside the testing chambers in separate conditioning containers (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. The specimens were placed in the chambers three days before the measurements of the chemical emission and the sensory evaluation.

**Table 2.**

Chamber conditions of the test of chemical emissions

Test chamber volume:	0.27 m <sup>3</sup> , stainless steel
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH
Air exchange rate:	0.5 h <sup>-1</sup>
Air velocity at specimen surface:	0.1 – 0.3 m/s
Area of sample:	0.27 m <sup>2</sup>
Area specific air flow rate:	0.5 m <sup>3</sup> /m <sup>2</sup> h

**Table 3.**

Chamber conditions of the test of sensory acceptability

Test chamber volume:	1.0 m <sup>3</sup> , stainless steel
Temperature:	23 ± 1 °C
Relative Humidity:	50 ± 3 % RH
Supply air flow rate:	0.6 l/s = 2.2 m <sup>3</sup> /h
Area of sample:	1.1 m <sup>2</sup>

**Table 4.**

Emission sampling and analytical methods

Test	Sampling method	Adsorbent	Sampling volume (litre)	Analysis method / Quantification	Detection limit
VOC	ISO 16000-9:2006 <sup>1</sup>	Tenax TA	2.7 – 6.2	ISO 16000-6:2021 <sup>2</sup> / FID quantification	1 µg/m <sup>3</sup>
Formaldehyde	ISO 16000-9:2006 <sup>1</sup>	DNPH	23 - 31	ISO 16000-3:2022 /HPLC-UV	0.03 µg/sampler
Ammonia	ISO 16000-9:2006 <sup>1</sup>	Treated silica gel	260, 325	Liquid chromatograph with conductivity detector <sup>3</sup>	0.9 µg/sampler
Sensory evaluation	ISO 16000-28:2012 <sup>4</sup>	--	--	Acceptability, Untrained panel of min 15 persons	--

<sup>1</sup>) In accordance with ISO 16000-9:2006 and M1 protocol.

<sup>2</sup>) In accordance with ISO 16000-6:2021 and M1 protocol.

<sup>3</sup>) The determinations of the sampled silica gel tubes were done by Sahlgrenska Universitetssjukhuset, Miljökemiska laboratoriet, Göteborg, not accredited method

<sup>4</sup>) In accordance with M1 protocol, not accredited method.

Tenax TA and multisorbents were used as adsorption mediums for VOC. The tubes were thermally desorbed and analysed in accordance with ISO 16000-6:2021(Indoor air — Part 6: Determination of organic compounds (VOC, SVOC) in indoor and test chamber air by active sampling on sorbent tubes, thermal desorption and gas chromatography using MS or MS FID). This means an analysis in a gas chromatograph and detection with a flame ionisation detector (FID) and mass selective detector (MS). The FID signals are used for compound

quantification. The TVOC is quantified as toluene equivalents. The mass selective detector is used for identification of compounds. The capillary column used is coated with 5% phenyl/ 95 % methylpolysiloxane. Tenax TA and multisorbents were also used as adsorption mediums for testing of volatile carcinogenic compounds, according to EU Regulation No 1272/2008 Annex VI, cat 1A and 1B), (exclusive formaldehyde), 0.001 mg/m<sup>3</sup> and above.

The sampling of formaldehyde was carried out with DNPH samplers. The samplers were analysed according to ISO 16000-3:2022 (Indoor air – Part 3: Determination of formaldehyde and other carbonyl compounds in indoor air and test chamber air – Active sampling method), which means analysis on a liquid chromatograph with absorbance detector.

The sampling of ammonium was carried out with silicagel treated adsorbent tubes and analysis on a liquid chromatograph with conductivity detector. Minimum two subsequent samples were taken for the VOC determination, for the formaldehyde and for the ammonia respectively.

## Results

The results relate only to the items tested. 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.

The results of the chemical testing are expressed as area specific emission rates and as concentrations in a model room. The model 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/ceiling 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:

$$Conc = \frac{SER_A \times A}{n \times V}$$

Conc = concentration of a VOC in the model room, in µg/m<sup>3</sup>  
SER<sub>a</sub> = area specific emission rate, in µg/m<sup>2</sup>h  
A = area of sample, in m<sup>2</sup>  
n = air exchange rate, in changes per hour  
V = volume of the model room, in m<sup>3</sup>

**Table 5.**

Results of the chemical testing of **Onyx**+after 28 days

Compound	Concentration in model room mg/m <sup>3</sup>	Emission rate mg/m <sup>2</sup> h	Criteria M1 mg/m <sup>2</sup> h
TVOC <sup>5</sup>	0.099	<b>0.047</b>	< 0.2
Carcinogens	< 0.001	< <b>0.001</b>	< 0.001
Single VOC (µg/m <sup>3</sup> )	< EU-LCI	--	≤ EU-LCI
Formaldehyde	< 0.001	< <b>0.001</b>	< 0.05
Ammonia <sup>6</sup>	< 0.003	< <b>0.002</b>	< 0.03

<sup>5</sup>) The TVOC is the sum of the individual concentration ≥ 5 µg/m<sup>3</sup> in model room.

<sup>6</sup>) Not accredited method. Test report from Sahlgrenska Universitetssjukhuset: test report 24\_5 dated 2024-03-08

**Table 6.**  
Results of the sensory acceptability evaluation of **Onyx+**, after 28 days

Evaluator	Sensory evaluation	Criteria M1
1	0.50	
2	0.84	
3	0.00	
4	0.76	
5	0.88	
6	0.22	
7	0.85	
8	0.82	
9	0.94	
10	1.00	
11	0.95	
12	0.83	
13	-0.38	
14	0.86	
15	0.91	
Arithmetic mean of acceptability <sup>7)</sup>	<b>0.67</b>	≥ + 0.0
Standard deviation	0.41	
90 % confidence interval of arithmetic mean	0.17	≤ 0.2

<sup>7)</sup> Not accredited method.

The empty sensory test chamber acceptability was determined 2024-02-23. The mean acceptability vote of the empty chamber was ≥ 0.8.

**Interpretation of the results**

The tested product **Onyx+** complies with all the requirements of M1 for the tested parameters.

**Detailed results**

**Table 7.**  
Detailed results (emission rates) of the chemical testing after 28 days

Sample	TVOC (mg/m <sup>2</sup> h) as toluene equivalents between C <sub>6</sub> -C <sub>16</sub>	Formaldehyde (mg/m <sup>2</sup> h)	Ammonia (mg/m <sup>2</sup> h)	Carcinogens (mg/m <sup>2</sup> h) between C <sub>6</sub> -C <sub>16</sub>
1	0.047	< 0.001	< 0.001	< 0.001
2	0.048	< 0.001	< 0.002	< 0.001

**Table 8.**  
Single VOCs above 5 µg/m<sup>3</sup> in the model room

Single VOCs	CAS number	Retention time (min)	ID <sup>8</sup>	Emission rate (µg/m <sup>2</sup> h)	Concentration (µg/m <sup>3</sup> )
<b>Single VOCs C<sub>6</sub>-C<sub>16</sub>:</b>					
Ethyl Acetate	141-78-6	6.3	B	36	76
1-Methoxy-2-propyl acetate	108-65-6	13.6	B	8	16
Phenol	108-95-2	17.9	B	3	7
<b>TVOC</b>	--	6.2 - 38	B	47	99
<b>Volatile Carcinogens <sup>9</sup></b>					
No substances detected	--	--	B	< 1	< 1
<b>Single VOC outside C<sub>6</sub> – C<sub>16</sub>:</b>					
<b>VVOC (&lt; C<sub>6</sub>) <sup>10</sup></b>					
No single VVOC detected	--	--	B	< 2	< 5
<b>SVOC (C<sub>16</sub> – C<sub>22</sub>) <sup>11</sup></b>					
No single SVOC detected	--	--	B	< 2	< 5

<sup>8)</sup> ID: A = quantified compound specific. B = quantified as toluene equivalent

<sup>9)</sup> Volatile carcinogens = VOCs according to EU Regulation No 1272/2008 Annex VI. cat 1A and 1B

<sup>10)</sup> VVOC = very volatile organic compounds, as defined in ISO 16000-6

<sup>11)</sup> SVOC = semi-volatile organic compounds, as defined in ISO 16000-6

TVOC is the sum of all individual substances with concentrations ≥ 5 µg/m<sup>3</sup> (in toluene equivalents).

Level of identification of compounds is 100 % for all compounds ≥ 5 µg/m<sup>3</sup>.

**Table 9.**  
Detected EU LCI-compounds ≥ 5 µg/m<sup>3</sup> quantified by compound specific response factor

Single VOCs	CAS number	Retention time (min)	ID <sup>8</sup>	Concentration (µg/m <sup>3</sup> )	EU LCI <sub>i</sub> (Dec 2021) (µg/m <sup>3</sup> )
<b>Single VOCs C<sub>6</sub>-C<sub>16</sub>:</b>					
1-Methoxy-2-propyl acetate	108-65-6	13.6	A	40	650
Phenol	108-95-2	17.9	A	11	70

<sup>8)</sup> ID: A = quantified compound specific, B = quantified as toluene equivalent

### Measurements uncertainty

The expanded measurement uncertainty of VOC result is 25 % (rel) and formaldehyde is 36 % (rel). For ammonia the measurement uncertainty is estimated to 14 % (rel).

See Appendix 1 for a gas chromatogram from the VOC determination and Appendix 2 for a photo of the test specimen. Appendix 3 is the Sampling report received from the customer

**RISE Research Institutes of Sweden AB**  
**Chemistry and Applied Mechanics - Chemical Product Safety**

Performed by

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**Appendices**

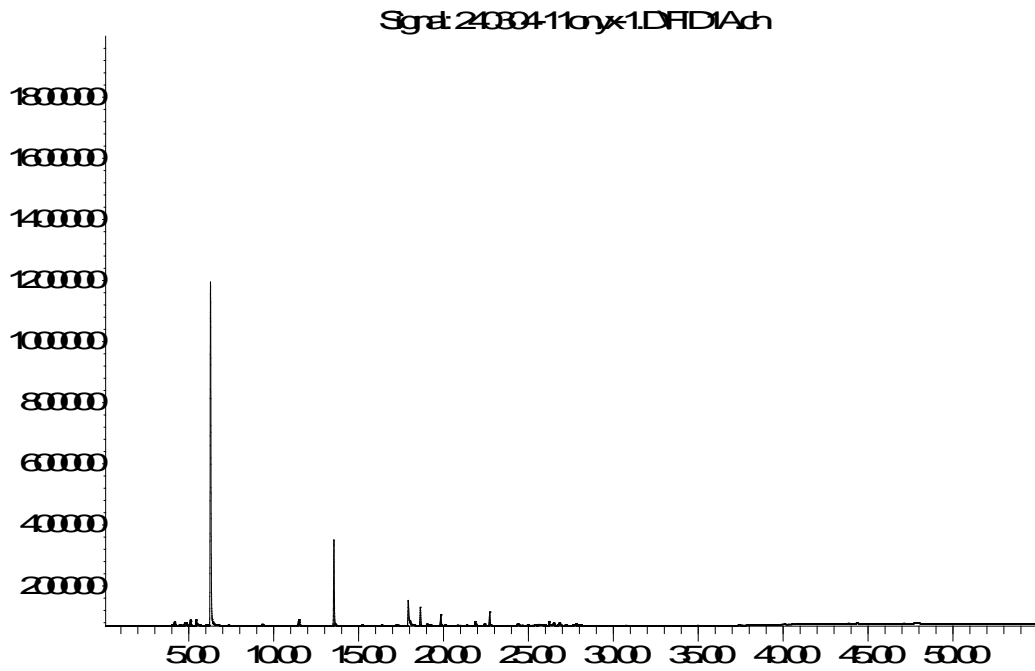
1. Gas Chromatogram
2. Photo of test specimen
3. Sampling report

Appendix 1

**Gas chromatogram**

Sample: **Onyx+**. after 28 days

Abundance



Time->

TVOC between C<sub>6</sub> and C<sub>16</sub>. means compounds eluting between 6.2 and 38 minutes.

## Appendix 2

## Photo of test specimen



The test specimen of the chemical evaluation.



Appendix 3

**Sampling Report**

<b>Sampler</b> (Name, Company, contact info):  <b>Bo Hallblom</b> <u>Technical Service</u>  <u>Forbo Flooring AB</u>   Box 9046   SE-400 91 Göteborg   Sweden Tel: +46 (0)705-892124   E-mail: <a href="mailto:bo.hallblom@forbo.com">bo.hallblom@forbo.com</a>	<b>Manufacturer of the product</b> (Company, address): <b>Forbo Flooring AB</b> <u>August Barks gata 26</u> <u>421 32 Västra Frölunda</u>
<b>Name of product:</b> Onyx+	<b>Type of product:</b> PVC Wet room walls 0,92 mm
<b>Manufacturing Date:</b> 2024-01.17	<b>Batch No:</b> 4312041
<b>Date of sampling:</b> 2024-01-21	<b>Amount/size of material sampled:</b> 1m width 2 m long out of roll  <b>Packing material:</b> <u>Aluminumfoil plastic</u>
<b>Sample is taken from:</b> Production line <input type="checkbox"/> Stock / Storage <input checked="" type="checkbox"/> Miscellaneous <input type="checkbox"/> -where, specify:	<b>How was the product stored before sampling?</b> Central Warehouse
<b>If a sub-sample was collected from a larger material amount, describe how the sub-sample was taken:</b> Rolled out a few meters and collected material within.	
<b>Observations and remarks:</b>	
<b>Confirmation</b> I hereby confirm that the sample was selected, taken and packed in accordance with the instructions.	
<b>Date:</b> 2024-01-26	<b>Signature:</b> Bo Hallblom

# Verification

Transaction 09222115557513461111

## Document

**1242324-3 Forbo, Onyx, M1**

Main document

9 pages

*Initiated on 2024-03-22 09:05:54 CET (+0100) by Ulrika Johansson (UJ)*

*Finalised on 2024-03-22 10:45:23 CET (+0100)*

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